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25. The sting ray. *Trygon pastinaca.*
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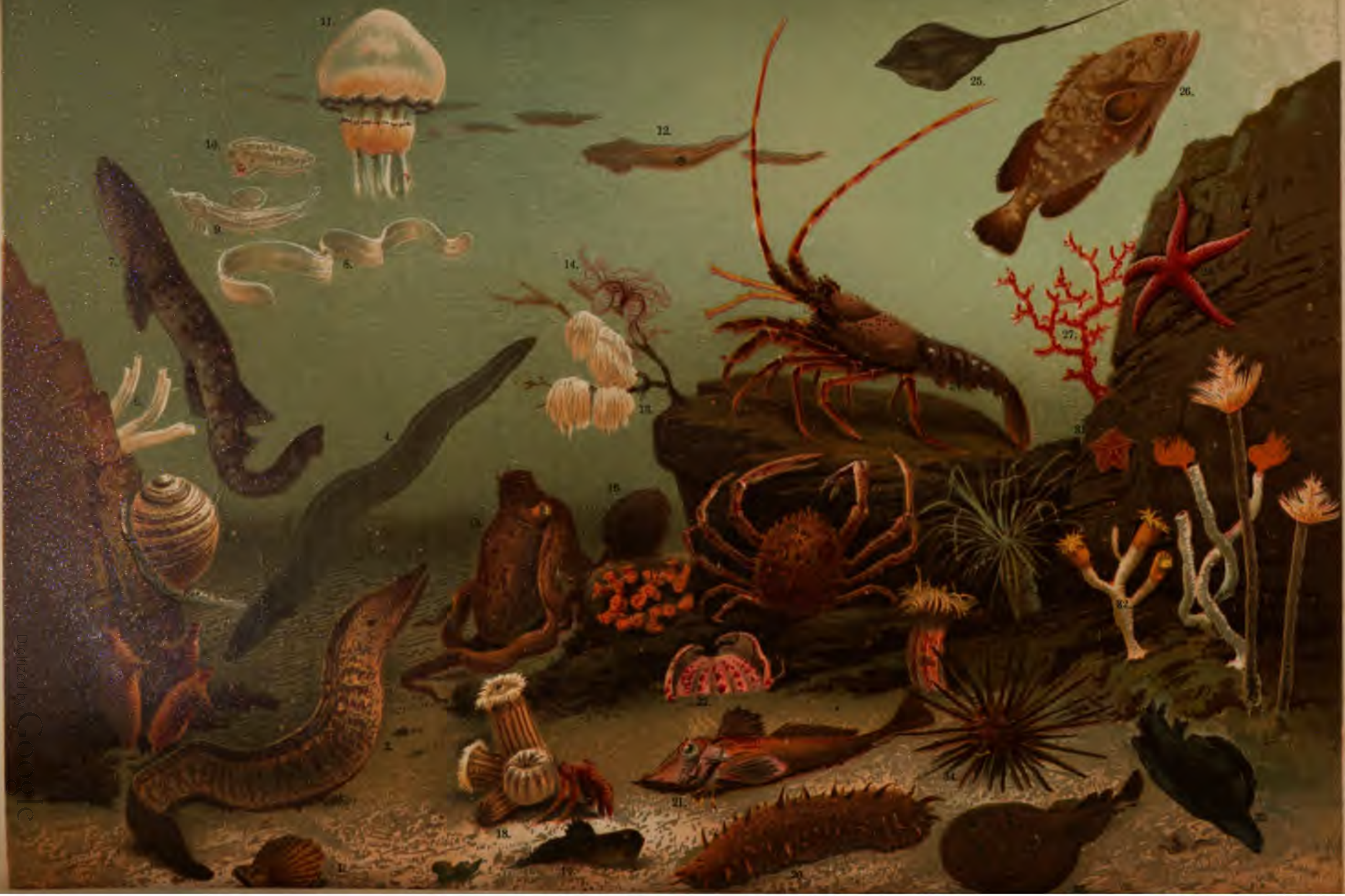
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L

ENCYCLOPÆDIA BRITANNICA.

SIBBALD—SIBERIA.

SIBBALD, Sir Robert (1641–1712), may be considered as the most eminent representative of science and medicine in Scotland towards the close of the 17th century. He was born near Leslie in Fifeshire in 1641. Educated at Edinburgh, Leyden, and Paris, he settled as a physician in Edinburgh and soon rose to eminence. His career is one of marked initiative: he was the first professor of medicine in the university of Edinburgh, and the first president of the college of physicians, and, along with Sir Andrew Balfour, founded the botanic garden. He was also geographer-royal, and his numerous and miscellaneous writings deal effectively with historical and antiquarian as well as botanical and medical subjects. He died in 1712.

Amongst Sibbald's historical and antiquarian works may be mentioned *A History of Fife and Kinross* (Edinburgh, 1710, and Cupar, 1803), which is still indispensable to the student of local history and antiquities; *An Account of the Scottish Atlas* (folio, Edinburgh, 1683); *Vindiciæ Scoticæ Illustratæ* (folio, Edinburgh, 1710); and *Description of the Isles of Orkney and Shetland* (folio, Edinburgh, 1711 and 1845). See also his *Autobiography* (Edinburgh, 1833), to which is prefixed an account of his MSS.

Plate I.

Name and extension.

SIBERIA (Russ. *Sibir*, a word of unknown origin, probably Permian) in the 16th century indicated the chief settlement of the Tatar khan Kutchum,—Isker on the Irtish. Subsequently the name was extended so as to include the whole of the gradually increasing Russian dominions in Asia, and in the first half of the 19th century it was applied to the immense region stretching from the Ural Mountains to the Pacific, and from the Arctic Ocean to the Chinese frontier and the Kirghiz steppes. This region, however varied in its separate parts, constituted a geographical whole having its own characteristic physical features. The division into Western and Eastern Siberia which naturally came into general use had also a geographical meaning. In 1856, after the annexation of the Amur and Usuri regions, Eastern Siberia was extended so as to include the Russian dominions on the Pacific, although these latter in reality belong climatically and physically to a quite separate region,—that of the North Pacific littoral; and, as the Russian dominions extended into the Kirghiz steppes, these last were also reckoned to Siberia, although mostly belonging in their physical features to another geographical domain,—the Aral-Caspian depression. Later on these steppes were transferred to the "Orenburg region," or to the "steppe region"; but, on the other hand, some districts which really belong to Western Siberia were included under this new denomination. What is now called "Siberia" has thus lost its geographical unity. There still remains, however, for the geographer a vast tract of northern Asia which might be included under this general name, as representing some special features characteristic of the region. It would be limited by the Ural Mountains on the west, by the Arctic and North Pacific Oceans on the north and east respectively, and on the south by a line broadly corresponding to the 50th degree of latitude, running from the sources of the river Ural to the Tarbagatai range (thus separating the steppes of the Irtish basin from those of the Aral and Balkash basins), thence along the Chinese frontier as far as the southeast corner of Transbaikalia, whence it might be drawn to the Great Khingan, and along it to the upper Zeya (tributary of the Amur) and Udskoi Ostrog on the Sea of Okhotsk. This wide area would be naturally subdivided into Western Siberia (basins of the Ob and Irtish) and Eastern Siberia (the remainder of the region). Western Siberia would include the governments of Tobolsk and Tomsk, as well as the parts of Perm situated to the east of the Ural Mountains, and those northern parts of Semipalatinsk which belong to the basins of the Irtish and the Tobol;[1] while Eastern Siberia would include the governments of Yeniseisk and Irkutsk, the provinces of Yakutsk and Transbaikalia, together with the northwestern part of the province of Amur and the northern parts of the Maritime Province. In fact, the northwestern parts of Manchuria situated between the Argun and the Great Khingan, as well as the upper parts of the Selenga and the Yenisei (Shishkit) belonging to Mongolia, are so intimately connected with Eastern Siberia as regards their physical features that it is difficult for the geographer to separate them.

Administrative divisions.

Since the inclusion of Uralsk, Turgai, Akmolinsk, and Semipalatinsk within the governor-generalship of the steppes, the present administrative subdivisions stand as shown in Table I.

General description.

It is evident that a territory so immense—covering more than 25 degrees of latitude and 120 degrees of longitude—must include a great variety of orographical and climatological characters, and that the popular conception which persists in representing Siberia as a snow-clad desert is erroneous. In fact—not to speak of the rich prairies of the middle Amur and the Usuri region, where the wild vine grows freely—we find in Siberia proper the very fertile black earth prairie steppes, or rather pampas, of the Tobol and Ishim,—not mere patches of fertile land, but plains covering some 25,000,000 acres and ready to receive millions of inhabitants; the highlands of the Altai, with their rich valleys, alpine lakes, glaciers, and snow-clad peaks,—a country three times as large as Switzerland and presenting almost the same variety of aspects; the high plains of Eastern Siberia, where watermelons are grown in the fields during the short but hot summer; the rich steppes of Minusinsk, profusely adorned with flowers; the lower plateaus of Transbaikalia, embellished with the beautiful Daurian flora and supplying food to hundreds of thousands of cattle; the high inhospitable marshy plateaus of the Selenga and Vitim; vast hilly tracts densely covered with forests, and visited only by hunters and gold-diggers; and beyond these the frozen *tundras* of the north,—all these constitute an immense world, with the most striking contrasts of scenery and vegetation, of manners and customs. In one direction only is the popular conception true: throughout its extension Sibéria is the coldest country of the world in consequence of its protracted and exceedingly severe winter. This variety of characters will be best understood from the following brief sketch of the orography.

---

[1] This natural subdivision has been adopted by P. Semenoff in his valuable sketch of Western Siberia in *Picturesque Russia* (Jivopisnaya Rossiya), vol. xi.

TABLE I.

	Area Square Miles.	Population.	Pop. per Square Mile.
Tobolsk	531,982	1,283,168	2.4
Tomsk	329,039	1,134,748	3.4
Western Siberia[1]	861,021	2,417,916	2.8
Yeniseisk	992,870	421,010	.42
Irkutsk	309,190	398,873	1.2
Yakutsk	1,517,127	243,443	.16
Transbaikalia	240,781	497,760	2.1
Eastern Siberia[1]	3,059,968	1,561,086	.51
Amur	173,559	40,533	.23
Maritime Province	730,022	74,000	.10
Amur[1]	903,581	114,533	.12
Total	4,824,570	4,093,535	.85

Orography.

The leading features of the orography of Siberia are so much at variance in our best maps that a few words are necessary to explain the views taken in what follows. The inhabited districts are well laid down; but the immense areas between and beyond these have only been visited by geographers and are mapped only along a few routes hundreds of miles apart. The intermediate spaces are filled according to information derived from native hunters. With regard to a great many rivers we know only the position of their mouths and their approximate lengths estimated by natives in terms of a day's march. Even the hydrographical network is very imperfectly known, especially in the uninhabited hilly tracts.[2] The orographical representation of Siberia is nothing more than a combination of a few surveys and journeys, in which conscious or unconscious hypothesis is resorted to in order to connect the isolated facts. As soon as the river systems of Siberia began to be approximately known, chains of mountains were drawn in all hilly tracts,—higher ones on the chief watersheds and lower ones along the secondary ones. This representation conveyed quite a false idea as to the surface configuration of Siberia. The immense plateaus which play so predominant a part in the structure of Asia (as they also do in the western parts of North America) were quite overlooked. Chains of mountains were drawn as if they rose in the midst of plains, where in reality we have either the slopes of one side of the plateaus or border-chains. Lofty mountains appeared where none exist, as, for instance, in those parts of Yakutsk where tributaries of the Lena and the Amur start from common marshes; and some of the highest chains were represented as minor upheavals because they are pierced by rivers descending from the high plateaus to the lowlands. It was only by making use of rich unpublished collections of barometrical observations for the calculation of hundreds of heights that many sections of Siberia could be drawn,[3] and by going into a minute study of topographical materials scattered through the bulky literature of Siberia and certain MS. field-books—the whole controlled by personal journeys—that it became possible to arrive at the following general conclusions as to the structure of the country, which may be of service until more complete surveys shall have given more reliable data.[4] This study has shown how predominant has been the part played in the formation of Siberia by huge swelling of the earth's crust (plateaus), and how subordinate that played by isolated chains of mountains, which latter are regulated in their direction in northeastern Asia by the border ridges of the plateaus; and it has enabled us to make out a close connection between the structure of Central Asia and Tibet and that of northeastern Asia, and to establish a link between the two.

Great plateau.

A vast plateau, beginning in the south at the foot of the gigantic semicircular border range of the Himalayas, and having the lofty plateau of Pamir in the west and the little-known high tracts of the upper Hoang-ho and Yang-tse-kiang in the east, extends towards the northeastern extremity of Asia. Broadly speaking, it has the shape of a South America pointed towards Behring Strait. It attains a width of no less than 1800 miles and an altitude of from 11,000 to 14,000 feet in the south; but both width and altitude diminish towards the northeast. In northwest Mongolia the average height is but 4000 to 5000 feet, and this diminishes to 3500 feet in the Vitim plateau; while its width is not more than 700 miles in the latitude of Lake Baikal. On the 50th parallel of latitude there occurs in the plateau a broad lateral indentation, occupied by Lake Baikal and the plains of Kansk, and this renders the resemblance of the plateau to South America still more striking. This immense plateau is the remainder of a vast and very old continent, which, so far as we know, has not been submerged since at least the Devonian period.[5] It extends from the Himalayas to the land of the Tchuktchis, but does not, of course, present a plane surface of the same altitude in all its parts. It is diversified in the following ways: (1) Like other plateaus, it has on its surface a number of gentle eminences (*angehäufte Gebirge* of Ritter), which, although reaching great absolute heights, are relatively low. These chains for the most part follow a northeasterly direction in Siberia; but in the southern parts of the plateau, as we approach the Himalayas, they seem to assume a direction at right angles (towards the northwest). (2) On the outskirts of the plateau there are several excavations which can best be likened to gigantic trenches, like railway cuttings when with an insensible gradient a higher level has to be reached. These trenches for successive geological periods have been the drainage valleys of immense lakes (probably also of glaciers) which formerly spread over the plateau, or fiords of the seas which surrounded it. Now the chief commercial routes have been made to follow these trenches to reach the higher level of the plateau. Their steep excavated sides, which have the appearance of chains of mountains to the traveller who follows the bottom of the trench, have often been described as such; in reality they are merely unilateral slopes, which may best be compared with the steep slope of the Jura turned towards the Lake of Geneva. We have examples of such trenches in the valley of the Uda to the east of Lake Baikal (route to the Amur); in the valley of the Orkhon, leading to Urga and Mongolia (route to Peking), with a branch up the Djida; in the broad depression of the Ulungur leading from Lake Zaisan to Barkul; and in a few others which have been utilised as routes from the Lena to the Sea of Okhotsk. (3) There are, moreover, two terraces in the plateau,—a higher and a lower, which are very well pronounced in TRANSBAIKALIA (*q.v.*) and in Mongolia. The Yablonovoi range and its southwestern continuation the Kentei are border-ridges of the upper terrace. Both rise very gently above it, but have steep slopes towards the lower terrace, which is occupied by the Nertchinsk steppes in Transbaikalia and by the Gobi in Mongolia (2000 to 2500 feet above the sea). They rise to from 5000 to 7000 feet above the sea; the peak of Sokhondo in Transbaikalia reaches nearly 8500 feet. Several low chains of mountains have their base on the lower terrace and run from southwest to northeast; they are known as the Nertchinsk Mountains in Transbaikalia, and their continuations reach the northern parts of the Gobi.[1]

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[1] Governor-generalships.

[2] The wide area between the middle Lena and the Amur, as well as the hilly tracts west of Lake Baikal, the Yeniseisk mining region, and many others, are in this condition. An instance of a map distinguishing between surveys and information derived from natives is given on a cartoon of map 4 of *Mem. Russ. Geogr. Soc.*, General Geography, vol. iii.

[3] A catalogue of heights in East Siberia is given in the appendix to the present writer's "Report on the Olekma and Vitim Expedition" (*Mem. Russ. Geogr. Soc.*, General Geography, vol. iii., 1873); also in *Petermann's Mitth.*, 1872. The height of Irkutsk, taken as a basis for the catalogue, has been determined since that date by a levelling through Siberia at 1486 feet.

[4] "General Sketch of the Orography of Siberia," with map and sections, and "Sketch of the Orography of Minusinsk, etc.," by the same writer (same series, vol. v., 1875). The views taken in these writings have been embodied by A. Petermann in his map of Asia, sheet 58 of Stieler's *Hand-Atlas*.

[5] The great plateau of North America, also turning its narrower point towards Behring Strait, naturally suggests the idea that there was a period in the history of our planet when the continents turned their narrow extremities towards the northern pole, as now they turn them towards the southern.

Border-ridges of great plateau.

The great plateau is fringed on the northwest by a series of high border-ridges, which have their southern base on the plateau and their northern at a much lower level. They may be traced from the Thian-Shan to the arctic circle, and have an east-northeasterly direction in lower latitudes and a northeasterly direction farther north. Both the Alai ridge of the Pamir, continued by the Kokshaltau range and the Khan-Tengri group of the Thian-Shan, and the Sailughem range of the Altai (see TOMSK), which is continued, in the opinion of the present writer, in the yet unnamed border-ridge of West Sayan (between the Bei-khem and the Us),[2] belong to this category. There are, however, in these border-ridges several breaches of continuity,—broad depressions or trenches leading from Lake Balkash and Lake Zaisan to the upper parts of the plateau. On the other hand, there are on the western outskirts of the plateau a few mountain chains which take a direction at right angles to the above (that is, from the northwest to the southeast), and parallel to the great line of upheavals in southwest Asia. The Tarbagatai Mountains, on the borders of Siberia, as well as several chains in Turkestan, are instances of these upheavals. But, notwithstanding these complications, it remains certain that the Alai Mountains, the Khan-Tengri group, the Sailughem range and the West Sayan are border ridges of the high plateau fringing it from 70° to 100° E. long. These border-ridges contain the highest peaks of their respective regions; they are immense walls which render access to the high plateau extremely difficult, unless the traveller follows the above-mentioned trenches. Beyond 100° E. long. the above structure is complicated by the great lateral indentation of Lake Baikal. But around and beyond this lake we again find the same huge border-ridge fringing the plateau and turning its steep northwestern slope towards the valleys of the Irkut, the Barguzin, the Muya, and the Tchara, while its southern base lies on the plateaus of the Selenga (nearly 4000 feet high) and the Vitim (see TRANSBAIKALIA). The peaks of the Sailughem range reach from 9000 to 11,000 feet above the sea, those of West Sayan about 10,000. In East Sayan is Munku-Sardyk, a peak 10,000 feet high, together with many others from 8000 to 9000 feet. Farther east, on the southern shore of Lake Baikal, Khamar-daban rises to 6900 feet, and the huge dome-shaped, bald summits of the Barguzin and Southern Muya Mountains attain an elevation of 6000 to 7000 feet above the sea-level. The orography of the Aldan region is but little known; but travellers who journey from the Aldan (tributary of the Lena) to the Amur or to the Sea of Okhotsk have to cross the same plateau and its border-ridge, the former becoming narrower and barely attaining an average altitude of 3200 feet. Whether it projects farther into the land of the Tchuktchis remains unsettled, although the probability is that it does.

Longitudinal valleys.

A typical feature of the northeastern border of the high plateau is a succession of broad longitudinal[3] valleys along its outer base, shut in on the outer side by walls of wild mountains having a very steep slope towards them. Formerly filled with alpine lakes, these valleys have now a flat alluvial soil occupied by human settlements, and are watered by rivers which flow along them before they make their way to the north through narrow gorges pierced in the mountain-wall just mentioned. This structure is seen in the valley of the Us in West Sayan, in that of the upper Oka and Irkut in East Sayan, in the valley of the Barguzin, the upper Tsipa, the Muya, and the Tchara, at the foot of the Vitim plateau, as also, probably, in the Aldan.[4] The chains of mountains which fringe these valleys on the northwest belong to the wildest parts of Siberia. They are named the Usinsk Mountains in West Sayan and the Tunka Alps in East Sayan; the latter, pierced by the Angara at Irkutsk, in all probability are continued northeastwards in the Baikal Mountains, which run from Irkutsk to Olkhon Island and the Svyatoi Nos peninsula of Lake Baikal, thus dividing the lake into two parts, the great and the little.[5] The Barguzin Mountains (on the right bank of the Barguzin river) and the Northern Muya range continue them farther to the northeast, and most probably they are prolonged still farther on the left bank of the Aldan.

Alpine region.

A strip of alpine region, 100 to 150 miles in breadth, fringes the northwestern border of the plateau beyond the ridges just mentioned. This constitutes what is called in Eastern Siberia the *taiga:* it consists of separate chains of mountains whose peaks rise from 4800 to 6500 feet above the sea, beyond the upper limits of forest vegetation (the *goltsy*); while the narrow valleys afford difficult means of communication, their floors being thickly covered with boulders, or else swampy; the whole is clothed with thick impenetrable forests. The orography of this alpine region is very imperfectly known; but the chains have a predominant direction from southwest to northeast. They are described under different names in Siberia: the Altai Mountains (see TOMSK) in Western Siberia, which also belong to this category, the Kuznetskiy Ala-tau and the Us and Oya Mountains in West Sayan (see YENISEISK), the Nijne-Udinsk *taiga* or gold-mine district, several chains pierced by the Oka river, the Kitoi Alps in East Sayan, the mountains of the upper Lena and Kirenga, the Olekminsk gold-mine district, and the yet unnamed mountains which protrude northeast between the Lena and the Aldan.

Elevated plains.

A broad belt of elevated plains, ranging between 1200 and 1700 feet above the sea, extends beyond these alpine regions. These plains, which are entered by the great Siberian highway about Tomsk[6] and extend farther in a southwesterly direction, fringing the Altai Mountains, are the true abodes of Russian colonizers; they are fertile for the most part, although sometimes dry, and are rapidly being covered with Russian villages. About Kansk in Eastern Siberia they penetrate in the form of a broad gulf southeastwards as far as Irkutsk. Those on the upper Lena, having a somewhat greater altitude and being situated in higher latitudes, are almost wholly unfitted for agriculture. The northwestern border of these elevated plains cannot yet be determined with exactitude. In the region between Viluisk (on the Vilui) and Yeniseisk a broad belt of alpine tracts, reaching their greatest elevation in the northern Yeniseisk *taiga* (between the Upper and the Podkamennaya Tunguska) and continued to the southwest in lower upheavals, separates the elevated plains from the lowlands which extend towards the Arctic Ocean. In Western Siberia these high plains seem to occupy a narrower area towards Barnaul and Semipalatinsk, and it is difficult to say whether they are separated by an abrupt slope from the Aral-Caspian depression.

Northern lowlands.

Farther to the northwest, beyond these high plains, we find a broad belt of lowlands extending as far as the Ural Mountains and the Arctic Ocean. This vast tract, which is now only a few dozen feet above the sea, and most probably was covered by the sea during the Post-Pliocene period, stretches from the Aral-Caspian depression to the lowlands of the Tobol, Irtish and Ob, and thence towards the lower parts of the Yenisei and the Lena. Only a few separate mountain ranges, like the Byrranga on the Taimyr peninsula, the Syverma Mountains, the Verkhoyansk and the Kharaulakh ranges, diversify the monotonous surface of these lowlands, which are covered with a thick sheet of black earth in the south and assume the character of barren tundras in the north (see TOBOLSK and YENISEISK).

The southeastern slope of the great plateau of Asia can-

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[1] The lower terrace is obviously continued in the Tarim basin of East Turkestan; but in the present state of our knowledge we cannot determine whether the further continuations of the border-ridge of the higher terrace (Yablonovoi, Kentei) must be looked for in the Great Altai or in some other range situated farther to the south. There may be also a breach of continuity in some depression towards Barkul.

[2] See "Orographical Sketch of Minusinsk, etc.," *ut supra.*

[3] The word "longitudinal" is here used in an orographical not a geological sense. Meglitzki in 1856 and recently M. Chersky have shown that these valleys are not synclinal foldings of rocks; they seem to be erosion-valleys.

[4] We do not know at present whether the same structure is exhibited in the Altai at the foot of the Sailughem range. The upper Bukhtarma valley seems, however, to belong to the same type.

[5] The deep crevice filled up by Lake Baikal would thus appear to be made up of two longitudinal valleys connected together by the passage between Olkhon and Svyatoi Nos.

[6] "Levelling of Siberia," in *Isvestia* of the Russian Geogr. Soc. vol. xxi.

South-eastern slope of plateau.

not properly be reckoned to Siberia, although parts of the province of Amur and the Maritime Province are situated on it; they have quite a different character, climate and vegetation, and ought properly to be reckoned to the Manchurian region. As already said, we have to the east of the Yablonovoi border-ridge the lower terrace of the high plateau, reaching about 2000 to 2500 feet in Transbaikalia and extending farther to the southwest through the Gobi to East Turkestan. The southeastern edge of this lower terrace is fringed by a massive border-ridge—the Khingan—which runs in a northeasterly direction from the Great Wall of China to the sources of the Nonni-ula. The traveller crossing it from the west is hardly aware of its existence; but it has a very steep slope towards the east, and forms a most important boundary for the Manchurian flora, which does not extend over the plateau. The northern parts of the Khingan are quite unexplored, the most northerly point that has been visited is the sources of the Gaſi, where the present writer crossed it on his way to Mergeñ; and we have no direct data for determining where it is crossed by the Amur. But, considering the structure of the country on the left bank of the Amur, it appears probable that this river crosses it below Albazin (between Toïbuzina and Kuznetsova, where it makes great windings), and the Zeya where it is joined by the Gilui,—the upper parts of the Zeya flowing on the plateau, while the Ud flows at its base; so that, as shown elsewhere with greater detail,[1] we must admit the Okhotsk coast range to be a continuation of the Great Khingan. The Stanovoi range was drawn on old maps to connect the Okhotsk range with the Yablonovoi; but the journeys of the great Siberian expedition have shown that in reality no such range exists,—the upper tributaries of the Gilui (tributary of the Amur) and those of the Konam (basin of the Lena) having their sources in common marshes on the plateau.

A narrow alpine region (40 to 50 miles), consisting of a series of short secondary ridges parallel to the border-ridge, fringes this latter on its eastern slope. Two such plications may be distinguished, corresponding on a smaller scale to the belt of alpine tracts fringing the plateau on the northwest. The resemblance is further maintained by a broad belt of elevated plains, ranging from 1200 to 1700 feet, which follow the eastern border of the plateau. The eastern Gobi, the occasionally fertile and occasionally sandy plains between the Nonni and the Sungari, and the rich plains of the Bureya and Selimja in the Amur province belong to this belt, 400 miles in breadth, the surface of which is diversified by the low hills of the Ilkhuri-alin, the Khuluñ, and the Turan. These high plains are bordered on the southeast by a picturesque chain of mountains (the Amur gorge of which has been often described),—the Bureya Mountains (also Little Khingan). It extends, with unaltered character, from Moukden and Ghirin (Kirin) to Ulban Bay in the Sea of Okhotsk (close by the Shantar Islands), its peaks covered from top to bottom with a rich forest vegetation rising to a height of 4500 to 6000 feet. A lowland belt about 200 miles broad runs in the same direction from southwest to northeast along the outer border of the above chain. The lower Amur occupies the northern part of this broad valley. These lowlands, covered with numberless marshes and lakes, seem to have emerged from the sea at a quite recent geological period; the rivers that lazily flow over their surface are still excavating their valleys. They are shut off from the Pacific by an alpine belt as yet but imperfectly known, in which at least two separate high chains (the Pribreshnyi and the Tatar) can be distinguished,—their continuations probably appearing in SAGHALIN (*q.v.*), while Kamchatka contains several chains, the orography of which is almost quite unknown.

Geology.

The geology of Siberia is still but incompletely known; some detached regions have been explored, while the vast intermediate spaces remain untouched. Viewed broadly,[2] the great plateau with the alpine tracts fringing it on the northwest and southeast is built up of Palæozoic rocks. On the Vitim and Selenga plateaus immense tracts are composed exclusively of granite, grenatite, and syenite, with subordinate layers of gneisses, which very often are mere modifications, more or less stratified, of the granites and syenites. In some of the ridges that run over the surface of the plateau we find a variety of metamorphic slates, with subordinate layers of crystalline limestones. Extensive beds of lava occur in some parts of the plateau, and in the valleys of the rivers layers of Tertiary sands with petrified wood (*Cupressonoxylum aleuticum*). The plateaus of the Vitim and the Selenga are covered with erratic boulders brought from great distances and show unmistakable traces of glaciation; and immense lakes—small in comparison with their former size—and extensive marshes cover large areas. Besides older metamorphic slates and granites, Silurian and most probably Devonian rocks are widely spread on the lower plateau and in the low chains of mountains which rise above its surface. Silver, lead, gold, and iron are found in these mountains, as also precious stones. Jurassic deposits, yielding many species of fossil insects and plants, occupy several large depressions. They are all of fresh-water origin and were deposited in great lakes. Like the Jurassic beds of China and Turkestan, they contain layers of coal. The alpine tracts in the northwest of the plateau are built up of granites, syenites, gneisses, and chiefly of metamorphic slates, the age of which cannot yet be precisely ascertained (Laurentian, and possibly also Silurian, or even Devonian). Talc schists, and especially clay slates, both intersected with veins of quartz, have also a very great development here. The alluvial and glacial deposits of the valleys contain a rich percentage of gold, derived from the trituration of the clay slates and their quartz veins. Conglomerates, belonging probably to the Tertiary period, fill several valleys. Unmistakable traces of glaciers have been found in West and East Sayan, as also in the Olekma and Vitim regions. In the Altai the mountains are built up of granites, syenites and diorites covered with metamorphic slates belonging to the Laurentian, Silurian, Devonian, and Carboniferous periods. The Jurassic strata on the outskirts are all fresh-water deposits and contain coal, as in Eastern Siberia and China. The Ala-tau are of more modern origin, containing extensive Jurassic beds, no longer deposited in depressions, but entering into the structure of the hills. The elevated plains of Western and Eastern Siberia have a more varied structure. On the Lena and the Yenisei we find Silurian, Devonian, Carboniferous, and Triassic marine deposits, covered here and there with fresh-water Jurassic. Immense tracts on the upper Lena are covered with horizontal sheets of red sandstone, the age of which is not yet determined, but seems to be Devonian; while in the government of Irkutsk large areas are covered with Jurassic coal-bearing sandstones. The same structure is found on the outskirts of the Altai, the Carboniferous and older slates having depressions covered with horizontal strata of Jurassic coal-bearing sandstones. The hilly tracts which rise amidst the Eastern Siberian plains on the Angara and Yenisei consist also of granites, syenites, and diorites covered with Palæozoic rocks up to the Carboniferous, while Jurassic strata are found in the Vilui Mountains. The broad lowlands of Western Siberia are covered throughout with Post-Pliocene deposits which conceal the older rocks,—shells from this period having been found as far south as Omsk (55° N. lat.). The lowlands and plains of Eastern Siberia exhibit a greater variety of structure,—Carboniferous, Triassic, marine Jurassic, and Chalk deposits being met with both in the deeper ravines and in the few ridges which appear beyond 60° N. lat. Extensive layers of fresh-water Tertiary have been found in depressions of the plateau, in some valleys of the alpine region, and in the plains and lowlands.

Glaciation.

There has been much discussion as to the extent of the glaciers in Siberia during the Glacial period,—the want of polish and scratched surfaces like those of Scandinavia having been urged as proof that they cannot have been considerable. It must, nevertheless, be held that the high plateau was at one time covered with a vast ice-sheet, and that in the alpine regions of the Altai, Sayan, Olekma, and Aldan glaciers had a much greater extension than at present, descending in the valleys to at least a level of 2000 feet above the sea, and covering the subordinate swellings between the mountain ranges. Thick layers of Post-Glacial deposits, indicating a climate somewhat more genial than the present, and containing numberless remains of extinct mammals, are extensively spread both in valleys throughout the lowlands and on the islands of the Arctic Ocean; while in the tundras of the north well-preserved carcasses of the mammoth and rhinoceros are occasionally found in the frozen soil.

Traces of Palæolithic man have not as yet been met with in Siberia; but relics of the Neolithic period are exceedingly numerous. One may almost say that they have been found wherever they were looked for, especially on the banks of the numberless lakes with which Siberia was dotted during the Lacustrine period (see below).

Volcanoes.

Volcanic formations, so far as is known, appear chiefly along the northwestern border-ridge of the great plateau. Ejections of basaltic lava have been found on the southern slope of this ridge, extending over wide areas on the plateau itself on a stretch of more than 600 miles,—namely, in East

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[1] "Orographical Sketch of East Siberia," *ut supra*.

[2] For further details, see the descriptions of the different provinces of Siberia.

Sayan about Lake Kossogol and in the valley of Tunka (river Irkut), in the vicinity of Selenghinsk, and widely spread on the Vitim plateau (rivers Vitim and Tsipa). Extensive layers of trap cover more than 1200 miles along the Tunguska; they appear also in the Noril Mountains on the Yenisei, whence they extend towards the Arctic Ocean. Basaltic lavas are also reported to have been found in the Aldan region. On the Pacific slope extinct volcanoes (mentioned in Chinese annals) have been found in the Ilkhurialin Hills to the east of Mergeñ.

Minerals.

The mineral wealth of Siberia is considerable. Gold-dust is found in almost all the alpine regions fringing the great plateau, where clay slates, talc slates, and dioritic slates, intersected by quartz veins, make up the bulk of the mountains. The chief gold-mining regions in these tracts are the Altai, the upper (or Nijne-Udinsk) and the lower (or Yeniseisk) *taigas*, and the Olekma region. Gold is found on the high plateau in the basin of the upper Vitim, on the lower plateau in the Nertchinsk district, and on the upper tributaries of the Amur (especially the Oldoi) and the Zeya, in the northeast continuation of the Nertchinsk Mountains. It has been discovered also in the Bureya range, and in its northeast continuation in the Amguñ region. Auriferous sands, but not very rich, have been discovered in the feeders of Lake Khangka and the Suifun river, as also on the smaller islands of the Gulf of Peter the Great. Silver and lead ores are found in the Altai and the Nertchinsk Mountains, as well as copper, cinnabar, and tin. Iron-ores are known at several places on the outskirts of the alpine tracts (as about Irkutsk), as well as in the Selenghinsk region and in the Altai. The chief ironworks of the Urals are situated on the Siberian slope (see URAL). Coal occurs in many Jurassic fresh-water basins,—namely, on the outskirts of the Altai, in south Yeniseisk, about Irkutsk, in the Nertchinsk district, at many places in the Maritime Province, and on the island of Saghalin. Beds of excellent graphite have been found in the Kitoi Alps (Mount Alibert) and in the Turukhansk district. Rock-salt occurs in thinner deposits at several places on the Lena and in Transbaikalia, and salt-springs are numerous,—those of Ust-kut on the Lena and of Usolie near Irkutsk being the chief. A large number of lakes, especially in Transbaikalia and in Tomsk, yield salt. Lastly, from the Altai region, as well as from the Nertchinsk Mountains, precious stones, such as jasper, malachite, beryl, dark quartz, and the like, are exported. The Ekaterinburg stone-polishing works in the Urals and those of Kolyvañ in the Altai are well known.

Rivers.

Water communication.

The orography sketched above explains the great development of the river-systems of Siberia and the uniformity of their course. The three chief rivers—the Ob, the Yenisei, and the Lena—take their rise on the high plateau or in the alpine regions fringing it, and, after descending from the plateau and piercing the alpine regions, flow for a few thousands of miles over the high plains and lowlands before they reach the Arctic Ocean. The three smaller rivers of northeastern Siberia—the Yana, Indighirka, and Kolyma—have the same general character, their courses being, however, much shorter, as in these latitudes the plateau approaches the Arctic Ocean. The Amur, the upper tributaries of which rise in the eastern border-ridge of the high plateau, is similar. The Shilka and the Arguñ, which form it, flow first towards the northeast, through the bendings of the lower terrace of the great plateau; from this the Amur descends, traversing the Great Khingan and flowing down the terraces of the eastern slope towards the Pacific. A noteworthy feature of the principal Siberian rivers is that each is formed by the junction of a pair of great rivers. Examples are the Ob and the Irtish, the Yenisei and the Angara (itself a double river formed by the Angara and the Lower Tunguzka), the Lena and the Vitim, the Arguñ and the Shilka, uniting to form the Amur, which in its turn receives a tributary as large as itself,—the Sungari. Owing to this twofold composition and to the circumstance that, the alpine regions once crossed, their course lies over the high plains and lowlands and crosses the few ridges which rise above the plains (as, for example, the Yenisei below Yeniseisk), instead of following the valleys between them, the rivers of Siberia offer immense advantages for inland navigation, not only in the line of their main direction from north to south but also across it, *i.e.*, from west to east. It is this circumstance that has facilitated the rapid invasion of Siberia by Russian Cossacks and hunters: they followed the courses of the double rivers in their advance towards the east, and discovered short portages which permitted them to transfer their boats from the system of the Ob to that of the Yenisei, and from the latter to that of the Lena, a tributary of which—the Aldan—brought them close to the Sea of Okhotsk. At the present day steamers ply from Tyumeñ, at the foot of the Urals, to Semipalatinsk on the border of the Kirghiz steppe and to Tomsk in the very heart of Siberia. And the time is not far distant when the Ob and the Yenisei, both traversing the high plains on nearly the same level and separated only by low hills, will be connected by a canal, thus permitting steamers to reach Krasnoyarsk and Irkutsk. As the population becomes denser no difficulty should be found in connecting some of the navigable tributaries of the Yenisei with one of those of the Lena, for they flow within a short distance from one another on the high plain, and Cossack boats have already been transported from the Yenisei to the Lena. An uninterrupted water communication will then have been established from Tyumeñ to Yakutsk, Aldansk, and the gold-mines of the Vitim. Owing to the great plateau separating the Lena from the Amur, no easy water communication can be established between the latter and other Siberian rivers. The tributaries of the Amur (the Shilka with its affluent the Ingoda) become navigable only on the lower terrace of the plateau. But the trench of the Uda to the east of Lake Baikal offers an easy access for a railway up to and across the high plateau; and at the very foot of its eastern border-ridge lie Tchita, whence boats are floated down (in spring) to the Pacific, and Nertchinsk, whence steamers may ply to the mouth of the Amur, as also up the Sungari to Ghirin and up the Usuri to Lake Khangka. Unfortunately all the rivers are frozen for many months every year. Even in lower latitudes (52° to 55° N.) they are ice-bound from the beginning of November to the beginning of May[1]; while in 65° N. lat. they are open only for 90 to 120 days, and only for 100 days (the Yenisei) or even 70 days (the Lena) in 70° N. lat. During the cold winter the smaller tributaries freeze to the bottom, and about 1st January Lake Baikal becomes covered with a solid crust of ice capable of bearing files of loaded sledges.

Enumeration of rivers.

The chief rivers of Siberia are the following: (1) The Ob (Obi) is formed by the confluence of the Biya and the Katuñ (400 miles), both of which rise in the Altai Mountains; it flows northwest and north for 2120 miles, past Barnaul, Tomsk, and Narym, and enters the great Ob Bay of the Arctic Ocean. Its tributary (2) the Irtish, which joins it in 60° N. lat., has an even greater length (2520 miles). It rises in the high plateau, under the name of Black Irtish (500 miles); then, descending from the highlands, it enters Lake Zaisan, whence it flows north and northwest, past Semipalatinsk, Omsk, and Tobolsk, to join the Ob. It receives a great number of tributaries, the chief being the Tobol, the Ishim, and the Tara. Tyumeñ on the last-named will soon be connected by rail with Perm on the Kama, and is already the head of a great line of water communication; navigation is also open to Lake Zaisan and for a considerable distance up the Black Irtish. The chief tributaries of the Ob are the Anui (160 miles), Tcharysh (230), Tom (450), Tchulym (600), Ket (240), and Sosva (200),—all for the most part navigable. (3) The Yenisei rises on the high plateau in northwestern Mongolia, where it is formed by the confluence of two great rivers—the Shishkit and the Bei-khem—and has the name of Ulu-khem. After descending the high plateau on the Chinese frontier, it flows north and enters the Arctic Ocean in a deep bay situated close by that of the Ob. The area of its basin is estimated at 1,380,000 square miles. It receives (4) the Upper Tunguzka or Angara (1100 miles) which itself has a basin of 275,000 square miles, (5) the Podkamennaya Tunguzka, and (6) the Lower Tunguzka. The Angara, whose tributaries on the left (Irkut, Oka, and Uda) are each large rivers, flows from Lake Baikal (40 miles above Irkutsk) and, describing a huge bend to the northeast, joins the Yenisei a little above Yeniseisk. (7) The Selenga, which enters Lake Baikal from the east, might be considered as the real source of the Angara. It is a very large river and rises on the high Mongolian plateau, entering Siberia about Kiachta. Its length may be estimated at more than 600 miles; it receives (8) the Uri (outflow of Lake Kossogol), (9) the Orkhon, (10) the Tchikoi (300 miles), (11) the Khilok (300), (12) the Uda (130), and (13), the Djida (200). Lake Baikal has two other considerable feeders—the Barguzin and the Upper Angara. (14) The Lena is also an immense river, having an estimated length of not less than 3000 miles. It rises in the Baikal Mountains, some scores of miles from the lake, and flows north and east past Kirensk, Olekminsk, and Yakutsk. Thence it turns to the northwest and enters the Arctic Ocean, forming a wide delta. It receives several large tributaries—(15) the Vitim, which has a greater length (about 1400 miles) than the Lena above the point of junction, (16) the Olekma (about 800), (17) the Aldan (about 1300)—which receives in its turn (18) the

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[1] The Lena at Verkholensk is navigable for 170 days, at Yakutsk for 153 days; the Yenisei at Krasnoyarsk for 180 days; see *Isvestia* of the Eastern Siberian Geographical Society, vol. xii. *sq*

Utchur (350), (19) the Maya, and (20) the Amga—and (21) the Vilui (about 1300). (22) The Taz (about 750), (23) the Khatanga (400), (24) the Anabara (670), and (25) the Olenek (1200), which enter the Arctic Ocean to the west of the Lena, and (26) the Yana (1000), (27) the Indighirka (950), and (28) the Kolyma (1000) to the east of it are also considerable rivers, but small in comparison with the former. (29) The Anadyr enters the gulf of the same name in the Sea of Behring. (30) The Okhota (270) and (31) the Ud (350) are relatively small streams flowing into the Sea of Okhotsk. Of the rivers flowing to the Pacific the chief is (32) the Amur, which is navigable for more than 2400 miles from its entrance into the Tartar Strait (between the mainland and the island of Saghalin) to Sryetensk on the Shilka,—boats being floated from Tchita on the Ingoda. It bears the name Amur after the confluence of (33) the Shilka and (34) the Arguñ (see TRANSBAIKALIA) at Ust-Stryelka, and from this point flows east and southeast until its junction with its great tributary the Sungari; thence it flows northeast and north, and finally (for some 50 miles) east, before entering the Pacific. Its length, taking the Onon for its source, is about 2700 miles, and its basin is at least 785,000 square miles in area, but has diminished recently,—the waters of the Dalai-nor no longer reaching the Arguñ. It receives a great many large tributaries,—(35) the Zeya, whose affluent (36) the Selimja, is itself a considerable river, (37) the Bureya, (38) the Kur, (39) the Gorin, and (40) the Im from the left; while from the right it receives (41) the Sungari and (42) the Usuri, whose affluent, the navigable Sungatcha, brings the Amur into steam communication with Lake Khangka. The rivers flowing into the Sea of Japan are mostly short, only (43) the Suifun being worthy of particular mention.

Lakes.

Numberless lakes occur in both Eastern and Western Siberia. There are wide areas in the plains of Western Siberia, or on the high plateau of Eastern Siberia, where the country may be said to be still passing through the Lacustrine period; but the total area now under water bears but a trifling proportion to the immense extent which the lakes had even at a very recent period, when Neolithic man already inhabited Siberia. All the valleys and depressions bear traces of immense Post-Pliocene lakes. Even within historical times and during the 19th century the desiccation of lakes has gone on at a very rapid rate.[1] The chief lake is Lake Baikal, more than 400 miles long, from 20 to 53 broad, and 12,430 square miles in area. Its surface is 1560 feet above sea-level, and it reaches in its southwest part a maximum depth of 751 fathoms. Another great lake, Lake Kossogol, on the Mongolian frontier, is 120 miles long and 50 broad, 5000 feet above the sea. The large Lake of Oron on the Vitim has not yet been visited by geographers. Vast numbers of small lakes stud the Vitim and upper Selenga plateaus: the lower valley of the latter river contains the Goose Lake (Gusinoye). In the basin of the Amur are Lake Khangka (1692 square miles), connected with the Usuri; Lakes Kada and Kizi, by which the lower Amur once flowed to the Pacific; and very many smaller ones on the left bank of the lower Amur. Numerous lakes and extensive marshes cover the low plains of Western Siberia; the Baraba steppe is dotted with lakes and ponds,—Lake Tchany (1300 square miles) and the innumerable smaller lakes that surround it being but trifling remains of former lacustrine basins; while at the junction of the Irtish and Ob impassable marshes extend for many thousands of square miles. Several alpine lakes, of which the picturesque Teletskoye may be specially mentioned, fill up the depressions of the valleys of the Altai.

Coasts and islands.

The coast-line of Siberia is very extensive both on the Arctic Ocean and on the Pacific. The former ocean is ice-bound for at least ten months out of twelve; and, though navigation along its shores has been proved by Nordenskjöld to be possible, it is exceedingly doubtful whether it can ever become a commercial route of any importance. The coast-line has few indentations, the chief being the double bay of the Ob and the Taz, separated from the Sea of Kara by an elongated peninsula (Samoyede), and from the bay of the Yenisei by another. The immense peninsula of Taimyr—a barren tundra intersected by the wild Byrranga Hills—projects in Cape Tcheluskin as far north as 77° 46′ N. lat. The bay of the Yana, east of the delta of the Lena, is a wide indentation, sheltered on the north by the islands of New Siberia. The bays of the Kolyma, the Tchaun, and Kolutchin are of little importance. The group of four larger and several smaller islands called New Siberia, situated off the mouth of the Yana, are occasionally visited by a few hunters, as is also the small group of the Bears' Islands opposite the mouth of the Kolyma. Kellett's or Wrangel's Land is still quite unknown. The Strait of Behring at the northeast extremity of Siberia and the Sea of Behring between the land of the Tchuktchis and Alaska, with its great Gulf of Anadyr, are often visited by seal-hunters, and the Commander Islands off Kamchatka are valuable stations for this pursuit. The Sea of Okhotsk, separated from the Pacific by the Kurile Archipelago and from the Sea of Japan by the islands of Saghalin and Yesso, is notorious as one of the worst seas of the world, owing to its dense fogs and its masses of floating ice. The Shantar Islands in the bay of the Ud are worthy of notice only for their geological interest. The double bay of Ghijiga and Penjinsk, as well as that of Taui, would be useful as harbors were they not frozen seven or eight months every year and covered with dense fogs in summer. The northern part of the Sea of Japan, which borders the shores of the Usuri region, has, besides the smaller Bays of Olga and Vladimir, the beautiful Gulf of Peter the Great, on which stands Vladivostok, the chief Russian naval station on the Pacific (see MARITIME PROVINCE). Okhotsk and Ayan on the Sea of Okhotsk, Petropavlovsk on the east shore of Kamchatka, Nikolaievsk, Konstantinovsk, and Vladivostok on the Sea of Japan, and Dui and Korsakovo on SAGHALIN (*q.v.*) are the only ports of Siberia.

Climate.

Although Siberia is nearly all included between 50° and 72° N. lat.,[2] its climate is extremely severe, even in its southern parts. This severity arises chiefly from the orographical structure: the vast plateau of Central Asia prevents the moderating influence of the sea from being felt. The extensive lowlands which cover more than one-half of its area, as well as the elevated plains, lie exposed to the influence of the Arctic Ocean. The warm southwest winds have to cross the elevated plateau of Persia before reaching the Aral-Caspian depression, and there they deposit nearly all their moisture. And, if a current of warmer air flows from the west over Siberia (several data, such as meteorological observations on Mount Alibert and at the Vozmesensk mine in the Olekma region render its existence most probable in Eastern Siberia), it only makes its influence felt in the higher parts of the hilly tracts, by raising the line of perpetual snow in Eastern Siberia to the unusual height of 10,000 feet,[3] and by elevating by a few degrees the temperature of places situated in the alpine regions above the 3000 or 4000 feet level. The air, after being refrigerated on the plateaus during the winter, drifts, owing to its greater density, down upon the lowlands; hence in the region of the lower Lena we find an exceedingly low temperature throughout the winter, and at Verkhoyansk, in 67° N. lat., the pole of cold of the eastern hemisphere.[4] Nevertheless Siberia enjoys a warm summer; owing to the dryness of the climate, the unclouded sun fully warms the earth during the long summer days in those high latitudes, and gives a short period of warm and even hot days in the immediate neighborhood of the pole of cold. The Siberian winter may be said to last from the end of October until March, and it is exceedingly severe. As early as November mercury freezes in the latitude of Irkutsk (51° to 52° N. lat.), while in December, January, and even February it remains frozen for weeks together in south Siberia. Frosts of —13° to —18° Fahr. are not uncommon at Krasnoyarsk, Irkutsk, and Nertchinsk; even in the warmer southern regions of Western Siberia and of the Amur the average winter temperature is respectively 2.4° Fahr. and —10.2°; while at Yakutsk and Verkhoyansk the thermometer occasionally falls as low as —75° and —85° Fahr. Trees, as observed by Middendorff, become frozen to their very heart, and the axe, which becomes as fragile as glass, can hardly make any impression upon them. Rivers are frozen to the bottom, and water flowing over the ice adds new layers. The soil freezes many feet deep over immense areas even in southern Siberia. The atmosphere becomes laden with frozen vapors. Man, however, successfully resists these rigors, provided he adopts the customary costume of Siberia (two dresses of fur, the upper of which has the hair turned outside), and this all the more as the hardest frosts occur only when an absolute stillness of the air prevails. More dreaded than the frosts are the terrible *burans* or snow-storms, which occur in early spring and destroy thousands of horses and cattle that have been grazing in the steppes throughout the winter. Although there are very heavy falls of snow in the alpine tracts—especially about Lake Baikal—on the other side, in the steppe regions of the Altai and Transbaikalia and in the neighborhood of Krasnoyarsk, the amount of snow is so small that travellers use wheeled vehicles and cattle can find food in the steppes. Spring sets in with remarkable rapidity and charm at the end of April; but in the second half of May come the "icy saints' days," so blighting that it is impossible to cultivate the apple or pear. After this short period of frost and snow summer comes in its full beauty; the days are very hot, and, although they are always followed by cold nights, vegetation advances at an astonishing rate. Corn sown about Yakutsk in the end of May is ripe in the end of August. Still, at many places night frosts set in as early as the second half of July. They become quite common in August and September. Nevertheless September is much warmer than May, and October than April, even in the most continental parts of Siberia. By the end of October the rivers begin to freeze, and in the first days of November they are all frozen; even the Amur becomes a highway for sledges, while the Baikal is usually frozen before the middle of January. The isotherms are exceedingly interesting. That of 32° Fahr. crosses Western Siberia in its middle parts and Eastern Siberia in its southern parts, running through Bogoslovsk, Tobolsk, a little above Omsk and Tomsk, close by Irkutsk, Tchita, Nertchinsk, Blagovyeschensk, and Konstantinovsk. The isotherms of July run as follows: That of 68° Fahr., which in Europe passes through Cracow and Kaluga, here traverses Omsk, Krasnoyarsk, and Irkutsk, whence it turns north to Yakutsk, and then south again to Vladivostok. Even the mouths of the Ob, Yenisei, Lena, and Kolyma in 70° N. lat. have in July an average temperature of 40° to 50°. Quite contrary is the course of the January isotherms. That of 14° Fahr., which passes in Europe through Uleåborg, only touches the southern part of Western Siberia in the Altai Mountains. That of —4° Fahr., which crosses Nova Zembla in Europe, passes through Tobolsk, Tomsk, Krasnoyarsk, and Irkutsk, and touches 45° N. lat. at Urga, turning north in the Amur region and reaching the Pacific at Nikolaievsk. The isotherm of —22° Fahr., which touches the north point of Nova Zembla, passes in Siberia through Turukhansk and descends as low as 55° N. lat. in Transbaikalia, whence it turns north to the Arctic Ocean. The following figures will give a more complete idea of the climate:

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[1] See Yadrintseff, in *Isvestia* of the Russian Geogr. Soc., 1886, No. 1 (with maps).

[2] Only the narrow fringe of the tundras extends beyond 70° N. lat.

[3] Although rising to heights ranging from 6000 to 10,000 feet, the mountain peaks of Eastern Siberia do not reach the snow-line, which is found only on the Munku-Sardyk in East Sayan, above 10,000 feet. Patches of perpetual snow occur in Eastern Siberia only on the mountains of the far north. On the Altai Mountains the snow-line is about 7000 feet.

[4] The average temperature of winter (December to February) at Yakutsk is —40.2° Fahr., at Verkhoyansk —58.1°. At the polar meteorological station of Sagastyr, in the delta of the Lena (73° 23′ N. lat.), the following average temperatures were observed in 1882 and 1883—January —34.8° Fahr. (February —43.6°), July 40.8°, year 2.1°. The lowest average temperature of a day is —61.6° Fahr.

TABLE II.

	N. Lat.	Height above Sea in Feet.	Average Temperature in Degrees Fahr.			Yearly Rainfall in Inches	Nebulosity, per cent.
			Year.	Jan.	July.		
Ust Yansk (Yana)	70° 55′	30	3.4°	-42.7°	56.0°	..	..
Verkhoyansk......	67° 34′	160	2.0°	-56.0°	59.8°	..	..
Turukansk	65° 55′	70	20.8°	-16.1°	59.5°	..	..
Berezoff (Ob)	63° 56′	100	23.7°	- 8.0°	62.0°	..	..
Yakutsk.............	62° 2′	520	12.0°	-46.7°	65.8°	..	..
Okhotsk..............	59° 21′	10	22 8°	-10.7°	55.2°	..	..
Narym (Ob).........	58° 55′	200	28.5°	- 8.0°	67.1°	..	..
Voznesensk mine	58° 45′	2800	21.8°	-12.5°	61.9°	..	..
Yeniseisk............	58° 27′	260	28.0°	-12.0°	66.0°	15.4	55
Tobolsk...	58° 12′	160	31.9°	- 2.2°	66.7°	12.6	59
Tomsk................	56° 29′	230	30.9°	- 3.5°	66.3°	..	59
Ishim..................	56° 6′	330	31.9°	- 4.1°	66.0°	12.6	59
Krasnoyarsk,......	55° 1′	560	33.0°	- 3.5°	67.0°	..	..
Barnaul...............	53° 20′	460	32.5°	- 2.8°	67.5°	9.4	64
Nikolaievsk.........	53° 8′	70	27.2°	- 9.8°	61.8°	18.9	..
Irkutsk...............	52° 17′	1486	32.0°	- 4.1°	65.6°	17.3	..
Nertchinsk mine	51° 19′	2170	25.3°	-21.0°	65.1°	15.4	34
Semipalatinsk.....	50° 24′	590	36.2°	- 0.6°	72.5°	9.4	..
Blagovyeschensk	50° 16′	370	29.8°	-13.8°	69.1°	..	..
Khabarovka........	48° 28′	250	32.1°	-12.8°	67.8°	..	..
Urga (Mongolia)..	47° 56′	3770	27.2°	-12.7°	62.6°	10.2	30
Vladivostok	43° 7′	100	40.1°	4.5°	67.3°	12.6	42

Flora.

The flora of Siberia presents very great local varieties, not only on account of the diversity of physical characteristics through this wide territory, but also in consequence of the intrusion of new species in various proportions from the neighboring tracts, as widely different as the arctic littoral, the dry steppes of Central Asia, and the wet monsoon regions of the Pacific littoral. A complete description of the flora of Siberia would have to treat of (1) the high plateau; (2) the alpine tracts—(*a*) the Altai and (*b*) East Sayan, with a sub-region to the east of Lake Baikal; (3) the steppe regions of Western Siberia; (4) the Ishim and Baraba plains of the same; (5) the high plains of Eastern Siberia, with the sub-region (6) of Minusinsk; (7) the Daurian flora of the lower terrace of the plateau in Transbaikalia; (8) the Amur; (9) the Usuri and Pacific littoral region; (10) the arctic tundras, which, as shown by the "Vega" expedition, may be subdivided into those (*a*) west of Yenisei and (*b*) east of the same to Behring Strait; and (11) Kamchatka. Each of these has distinct features; nevertheless, if the basin of the Amur and Kamchatka be set aside, all have so much in common that the "Siberian flora" may be spoken of as a whole. Siberia is situated for the most part in the great domain which Grisebach describes as the "forest region of the Eastern continent."[1] The northern limit of this region must, however, be drawn near to the Arctic Ocean. Only a narrow strip, 60 to 200 miles wide (becoming broader in the Taimyr and Samoyede peninsulas), is totally devoid of tree vegetation. The last trees, it is true, which struggle for existence on the edge of the tundras are crippled dwarfs and almost without branches; a few buds each summer are the only evidence that life has not left their frozen stems; and trees a hundred years old are only a few feet long and a few inches thick, concealed amidst lichens.[2] Some 200 species of flowering plants are still found in the tundra region,—the frozen ground and the want of humus militating more against them than the want of warmth.[3] From this northern limit to the Aral-Caspian and Mongolian steppes we have all over Siberia the forest region, where, however, forests are very unequally distributed, covering from 50 to 99 per cent. of the areas of the separate districts. In the hill tracts and the marshy depression of the Ob they are unbroken, except by the bald summits of the loftier mountains (*goltsy*); they have the aspect of agreeable bosquets in the Baraba; and they are thinly scattered through the southeastern corner of Transbaikalia, where the dryness of the Gobi steppe is so much felt; while immense marshy plains covered with the dwarf birch take their place in the north as the tundras are approached. Over this immense area the trees are for the most part the same as we are familiar with in Europe. The larch becomes predominant and presents itself in two new species (*Larix sibirica* and *L. dahurica*). The fir appears in the Siberian varieties *Picea obovata* and *P. ayanensis*. The silver fir (*Abies sibirica*, *Pinus Pichta*) and the stone-pine (*P. Cembra*) are quite common; they reach the higher summits, where the last-named becomes a recumbent species (*Cembra pumila*), while the larch and the silver fir also acquire a tendency to spread their side branches instead of rising in height. The willow at high altitudes grows only two inches high, but still bears a few leaves and fully developed flowers. The birch in the loftier alpine tracts and plateaus becomes a shrub (*Betula nana*, *B. fruticosa*), or in Transbaikalia assumes a new and very elegant aspect with a dark bark (*B. dahurica*). In the deeper valleys or on the lowlands of Western Siberia the larches, pines, and silver firs, mixed with birches and aspens, reach a great size, and the streams are fringed with thickets of poplar and willow. The alpine rose (*Rhododendron dahuricum*) flourishes in large masses on the higher mountains; *Juniper*, *Spiræa*, *Sorbus*, the pseudo-acacia (*Caragana sibirica* and *arborescens*, *C. jubata* in some of the higher tracts), various *Rosaceæ*—*Potentilla fruticosa* and *Cotoneaster uniflora*—the cherry-plum (*Prunus Padus*), and many other shrubs fill up the spaces between the trees. Berry-yielding plants are found everywhere, even on the *goltsy*, at the upper limit of tree vegetation; on the lower grounds they are an article of diet to the hunter, and even to the agriculturist. The red whortleberry (*Vaccinium Vitis idæa*), the bog whortleberry (*V. uliginosum*), the bilberry or cowberry (*V. Myrtillus*), and the arctic bramble (*Rubus arcticus*) extend very far northwards; raspberries and red and black currants form a rich undergrowth in the forests, together with the *Ribes dikusha* in Eastern Siberia. The oak, the lime, the maple, disappear to the east of the Urals, to reappear, however, in new varieties on the eastern slope of the border-ridge of the great plateau (timidly penetrating west for some little distance up the valleys of the Amur and the Arguñ).[1] There we have the oak (*Q. mongolica*), the maple (*Acer ginala*, Max.), the ash (*Fraxinus manchurica*), the elm (*Ulmus montana*), the hazel (*Corylus heterophylla*), and several other European acquaintances. Farther east, in the Amur region, a great number of new species of European trees, and even new genera, such as the cork-tree (*Phellodendron amurensis*), the walnut (*Juglans manchurica*), the acacia (*Maackia amurensis*), the graceful climber *Maximowiczia amurensis*, the Japanese *Trochostigma*, and many others—all unknown to Siberia proper—make their appearance.

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[1] According to Engler's *Versuch einer Entwickelungsgeschichte der Pflanzenwelt* (1879), we should have in Siberia—(*a*) the arctic region; (*b*) the sub-arctic or conifer region, north Siberian province; (*c*) the Central-Asian domain,—Altai and Daurian hilly regions; and (*d*) the east Chinese, intruding into the basin of the Amur.

[2] Middendorff's observations on vegetable and animal life on the borders of and in the tundras—so attractively told in vol. iv. of his *Sibirische Reise*—will long remain classical.

[3] M. Kjellmann (*Vega Exp. Vet. Iakttageleer*) reckons their number at 182; 124 species were found by Middendorff on the Taimyr peninsula, 219 along the borders of the forest region of Olenek, and 344 species within the forest region of the same; 470 species were collected by M. Maack in the Vilui region.

The greatest uniformity prevails on the high plateau, where the larch predominates over all other species of conifers or deciduous trees; the wide and open valleys—or rather shallow depressions—are covered with *Betula nana* and *B. fruticosa* in the north and with thick grasses (poor in species) in its southern and drier parts. The same Siberian larch covers the alpine tracts fringing the plateau on the north; but the tree assumes different characters in development and growth according to the physical features of the region; and the fir, the stone-pine, the aspen, and the birch also become mixed with it; in the narrow sheltered valleys the forests attain their full development. In the drier parts, on the slopes covered with sand or with a richer soil, the Scotch fir (*Pinus sylvestris*) makes its appearance. In the alpine tracts of the north the narrowness of the valleys (*padi*) and the steep stony slopes covered with débris, on which only lichens and mosses can grow, make each green plot of grass (even if it be only of *Carex*) valuable to the gold-diggers and hunters. For days consecutively the horse of the explorer can get no other food than the dwarf birch. But even in these districts the botanist and geographer can easily distinguish between the *tcherñ* of the Altai and the *taiga* of different parts of Eastern Siberia. The lower plateau exhibits, of course, new characteristics. Its open spaces are lovely prairies, on which the Daurian flora appears in its full beauty. In spring the traveller crosses a sea of grass from which the flowers of the pæony, aconite, *Orobus*, *Carallia*, *Saussurea*, and the like rise to a height of 4 or 5 feet. As the Gobi desert is approached the forests disappear, the ground becomes chiefly covered with dry *Gramineæ*, and *Salsolaceæ* make their appearance on a gravelly clay impregnated with salt. The high plains of the west slope of the plateau are also covered with rich prairies diversified with woods. Nearly all the species of these prairies are common also to Europe (pæonies, hemerocallis, asters, pinks, gentians, violets, *Cypripedium*, *Aquilegia*, *Delphinium*, aconites, irises, and so on); but here the plants attain a much larger size,—so large indeed that a man standing erect is concealed by the grasses. The flora of Minusinsk—the Italy of Siberia—is well known; the prairies on the Ishim and of the Baraba (see TOMSK) are adorned with the same rich vegetation, so vividly described by Middendorff and Finsch. Farther north we again reach the domain of forests; but these once more present new characteristics. They are the *urmans* of Western Siberia, into which the hunter does not venture to penetrate far from his village,—immense tracts covered with thickets of trees closely packed and therefore poor in aspect, and often rising from a treacherous carpet of thickly woven grass which conceals deep marshes (*sybuny*), where even the bear has to tread circumspectly. The prairies of the middle Amur and the rich plains of the Selimja and Zeya, where Russian Raskolniks are so successful as agriculturists, belong to Manchuria.

Fauna.

The fauna of Siberia is closely akin to that of central Europe; and the Ural Mountains, although the habitat of a few species which warrant the naturalist in regarding the south Urals as a separate region, are not so important a boundary zoologically as they are botanically. As in European Russia, so in Siberia, three great zones—the arctic, the boreal, and the middle—may be distinguished; and these, according to M. Syevertsoff,[2] may be subdivided into several sub-regions. The arctic (hyperboreal) zone has the same characters as the tundra zones of European Russia. The boreal (circumboreal) zone, which corresponds to the forest region of Russia, embraces Western Siberia, with the exception of the Urals and the southern steppes, and a notable part of Eastern Siberia,—Transbaikalia and the hilly tracts to the north of it being distinguished as a separate "Eastern Siberian" sub-region. The middle zone, extending from south Russia to south Siberia, has two separate sub-regions,—the Ural-Baraba and the Daurian. The zone of the steppes extends from the Caspian Sea through Central Asia, only touching Western Siberia and the neighborhood of the Gobi in Transbaikalia. Finally, the Amur region shares the characteristics of the north Chinese fauna. On the whole, we may say that the arctic and boreal faunas of Europe extend over Siberia, with a few additional species in the Ural and Baraba region,—a number of new species also appearing in Eastern Siberia, some spreading along the high plateau and others along the lower plateau from the steppes of the Gobi. The arctic fauna is very poor. According to Nordqvist,[3] it numbers but twenty-nine species of mammals, of which seven are marine and only seventeen or eighteen may be safely considered as living beyond the forest limit. Of these, again, four are characteristic of the land of the Tchuktchis. The wild reindeer, the arctic dog (*Canis lagopus*), the fox, the hare, the wolf, the lemming (*Myodes obensis*), the collar-lemming (*Cuniculus torquatus*), and two species of voles (*Arvicolæ*) are the most common on land. The avifauna is very rich in migratory water and marsh fowl (*Grallatores* and *Natatores*), which come to breed in the coast region; but only five land birds—the ptarmigan (*Lagopus alpinus*), the snow-bunting, the Icelandic falcon, the snow-owl, and the raven—are permanent inhabitants of the region. The boreal fauna is of course much richer; but here also the great bulk of species, both of mammals and birds, are common to Europe and Asia. The bear. the badger, the wolverene, the pole-cat, the ermine, the common weasel, the otter, the wolf, the fox, the lynx, the mole, the hedgehog, the common shrew. the water-shrew, and the lesser shrew (*Sorex vulgaris*, *fodiens*, and *pygmæus*), of bats the long-eared, and four species of *Vespertilio* (*V. daubentoni*, *nattereri*, *borealis*, and *mystacinus*), the flying and the striped squirrel (*Tamias striatus*), the brown, common, field, and harvest mouse (*Mus decumanus*, *musculus*, *sylvaticus*, *agrarius*, and *minutus*), four voles (*Arvicola amphibius*, *rufocanus*, *rutilus*, and *schistocolor*), the beaver, the variable hare, the wild boar, the roebuck, the stag, the reindeer, the elk,—all common alike to Europe and to Siberia,—and the *Phoca annelata* of Lake Baikal; while the bear, the musk-deer (*Moschus moschiferus*), the ermine and the sable, the ground squirrel (*Spermophilus eversmani*), *Arvicola obscurus*, and *Lagomys hyperboræus*, also spread over Siberia, may be considered as belonging to the arctic fauna. In addition to the above we find in Eastern Siberia *Mustela alpina*, *Canis alpinus*, the sable antelope (*Ægocerus sibiricus*), several species of mouse (*Mus gregatus*, *œconomus*, and *saxatilus*), two voles (*Arvicola russatus* and *macrotus*), *Syphneus aspalax*, and the alpine *Lagomys*, which penetrate from the Central Asian plateaus; while the tiger makes incursions not only in the Amur region but occasionally as far as Lake Baikal. In all, of fifty-seven species of Siberian mammals forty-one are common also to Europe, twenty-seven common to the arctic region, and only sixteen special to Asia. On the lower terrace of the great plateau we find an admixture of Mongolian species, such as *Canis corsac*, *Felis manul*, *Spermophilus dauricus*, the jerboa (*Dipus jaculus*), two hamsters (*Cricetus songarus* and *furunculus*), three new voles (*Arvicolæ*), the Tolai hare, the Ogotona hare (*Lagomys ogotona*), *Ægocerus argali*, *Antilope gutturosa*, and *Equus hemionus* (*jighitai*); while the number of species common to Asia and Europe diminishes notably. The same is true with respect to birds. No less than 285 species have been observed in Siberia, but of these forty-five only are absent from Europe. In southeast Siberia we find forty-three new species belonging to the north Manchurian or Amur fauna; and in southeast Transbaikalia, on the borders of the Gobi steppe, only 103 species were found by Radde, among which the most numerous are migratory birds and the birds of prey which pursue them. The rivers and lakes of Siberia abound in fish; but little is known of their relations with the species of neighboring regions.[4]

The insect fauna is very similar to that of Russia; but a few genera, as the *Tentyria*, do not penetrate into the steppe region of Western Siberia, while the tropical *Colasposoma*, *Popilia*, and *Languria* are found only in southeastern Transbaikalia, or are confined to the southern Amur. On the other side, several American genera (*Cephalaon*, *Ophryastes*) extend into the northeastern parts of Siberia.[5] As in all uncultivated countries, the forests and prairies of Siberia become almost uninhabitable in summer on account of the mosquitoes. Eastern Siberia suffers less from this plague than the marshy Baraba; but on the Amur and the Sungari large gnats become an unsupportable plague, and travellers who have had experience of the mosquitoes of the tropics readily admit that they yield to those of Siberia. Burning the prairies is the only expedient for destroying them, and is freely resorted to, with the result that the forest is frequently set on fire.

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[1] Nowhere, perhaps, is the change better seen than on crossing the Great Khingan. The change in the flora witnessed by the present writer on his way from Transbaikalia to Mergeñ was really astonishing.

[2] "Horizontal Distribution of Animals," in the Bulletin (*Isvestia*) of the Society of Friends of Natural Science, vol. viii., 1873.

[3] "Anteckningar och Studier," etc., in *Vega Exp. Vet. Iakt.*, vol. ii.

[4] Czekanowski (*Izvestia Sib. Geog. Soc.*, 1877) has described fifty species from the basin of the Amur; he considers that these constitute only two-thirds of the species inhabiting that basin.

[5] L. Schrenck, *Reisen und Forschungen im Amurlande*, 1858-80.

In Molluscs Siberia is much richer than had been supposed. The dredgings of the "Vega" expedition in the Arctic Ocean disclosed an unexpected wealth of marine fauna, and those of L. Schrenck in the north of the Japanese Sea have led to the discovery of no fewer than 256 species (Gasteropods, Brachiopods, and Conchifers). Even in Lake Baikal Dr. Dybowski and Dr. Godlewski have discovered no fewer than ninety-three species of Gammarides and twenty-five of Gasteropods.[1] The Sea of Okhotsk is very interesting in this respect, owing to its local species and the general composition of its fauna (70 species of Molluscs and 21 of Gasteropods). The land Molluscs, notwithstanding the unfavorable conditions of climate, number about seventy species,—Siberia in this respect thus being not far behind north Europe.

The Siberian fauna is very unequally distributed. The alpine tracts of Eastern Siberia and the *urmans* of Tobolsk are from the zoologist's point of view exceedingly poor, owing to the want of grass and of a mouldy soil. It is on the plateau, and especially on the lower plateau, as well as on the high plains, where the grazing grounds become numerous, that the fauna appears in its full richness. Much remains to be done in the way of investigating the distribution of animals over Siberia with reference to the physical conditions of its different parts. Although differing little from the European, the fauna of Siberia possesses great interest for the zoologist and geographer. The increase of many animals in size (becoming twice as large as in Europe); the appearance of white varieties among both mammals and birds, and their great prevalence among domesticated animals (Yakut horses); the migrations of birds and mammals over immense regions, from the Central Asian steppes to the arctic coast, performed not only in connection with the usual rotation of seasons but also as a result of occasional climacteric conditions which are not yet fully known (*e.g.*, the occasional migration of thousands and thousands of roebuck from Manchuria across the Amur to the left bank of the river, or the migration of reindeer so well related by Wrangel); the various coloration of many animals according to the composition of the forests they inhabit (the sable and the squirrel are well-known instances); the mixture of northern and southern faunas in the Amur region and the remarkable consequences of that mixture in the struggle for existence;—all these render the study of the Siberian fauna most attractive. Finally, the laws of distribution of animals over Siberia cannot be made out until the changes undergone by its surface during the Glacial and Lacustrine periods are well established and the Post-Tertiary fauna is better known. The remarkable finds of Quaternary mammals about Omsk and their importance for the history of the *Equidæ* are but a hint of what may be expected in this field.

Population.

Russian immigration.

The great bulk of the population are Russians, whose number has increased with great rapidity during the 19th century; although not exceeding 150,000 in 1709 and 500,000 a century later, they now (1887) number more than 3,000,000, and not far from 4,000,000 if the eastern slopes of the Urals are reckoned to Siberia. At the same time the entire indigenous population does not exceed 700,000, if the Kirghizes of Semipalatinsk are reckoned to Turkestan, and many indigenes are rapidly dying out. The Russians, issuing from the middle Urals, have travelled as a broad stream through south Siberia, sending lateral branches to the Altai, to the Ili river in Turkestan, and to Minusinsk, as well as down the chief rivers which flow to the Arctic Ocean, the banks of which are studded with villages 15 to 20 miles apart. As Lake Baikal is approached the stream of Russian immigration becomes narrower, occupying only the valley of the Angara, with a series of villages up the Irkut; but it widens again in Transbaikalia, sending lateral branches up the Selenga and its tributaries. It follows the course of the Amur, again in a succession of villages some 20 miles apart, and can be traced up the Usuri to Lake Khangka and Vladivostok, with an extension of villages on the plains between the Zeya and the Selimja. Small Russian settlements also occur on a few bays of the North Pacific and the Sea of Okhotsk, as well as on Saghalin (see SAGHALIN). The Russians have thus occupied all the best agricultural tracts in Western and Eastern Siberia.

Indigenous races.

As to the indigenous races, the Ugrian stocks which occupy the northwest of Siberia are represented by (1) the Voguls (about 6400), on the eastern slopes of the Urals, in Perm and Tobolsk, extending partly over the western slope; they closely resemble the Ostiaks, in some features approximating the Mongol race, and speak the same language; (2) the OSTIAKS (*q.v.*); and (3) the SAMOYEDES (*q.v.*).

Turkish stocks.

Survivals of Turkish stocks, once much more numerous, are spread all over south Siberia as far as Lake Baikal. Their territories are rapidly being occupied by Russians, and their settlements are cut in two by the Russian stream,—the Baraba Tatars and the Yakuts being to the north of it, and the others having been driven back to the hilly tracts. According to M. Radloff,[2] they are as follows: (1) the Karagases in the Yeniseisk and Irkutsk spurs of the Sayan Mountains (about 500); (2) the Abakan Tatars (about 10,000),—driven from the Irtish, they occupied the Abakan steppes after the emigration of the Kalmucks; (3) those of the Tcholym scattered amidst Russians (500); (4) the Tatars of the north and northeast Altai, in all about 20,000,—(*a*) the Kumandintsy, (*b*) the Lebed Tatars, (*c*) the *tcherñ* or forest Tatars, (*d*) the Shorghintses; (5) those of the Altai proper,—(*a*) Altaians (11,800), (*b*) Dvoedantsy (2000), who until 1865 paid tribute to both Russia and China, and (*c*) the Teleutes (5800), mostly Russified; (6) the Soyotes and Uryankhes of East Sayan, of whom a few families are in Siberian territory; (7) the Baraba Tatars (4650), mostly driven northwards to the forest and marsh region; (8) the Irtish and Tobolsk Tatars (some 7000 to 10,000 on the Tara and 15,700 in the Tobolsk district). In all they number about 78,000, to whom should be added a number of Kirghiz from Turkestan. The great Turkish stock of the Yakuts (see YAKUTSK) in the basin of the Lena numbers about 200,000. Most of these Turkish stocks live by cattle-breeding and some by agriculture, and are a most laborious and honest population.

Mongols.

The Mongols (about 350,000) extend into Western Siberia from the high plateau,—nearly 20,000 Kalmucks living in the eastern Altai. In Eastern Siberia the Buriats occupy the Selenga and Uda, parts of Nertchinsk, and the steppes between Irkutsk and the upper Lena, as also the Baikal Mountains and the island of Orkhon; they support themselves chiefly by stock-breeding, but some of them, especially in Irkutsk, are agriculturists (see TRANSBAIKALIA). On the left of the Amur there are about 10,000 Chinese and Manchurians about the mouth of the Zeya, and nearly 3000 Coreans on the Pacific coast. The Tunguses, although few in numbers (50,000), occupy as their hunting-grounds an immense region on the high plateau and its slopes to the Amur, but their limits are yearly becoming more and more circumscribed both by Russian gold-diggers and by Yakut settlers.

Finally, in the northeast we find a group of stocks whose ethnological place is not yet accurately determined. They are united into a separate North Asian linguistic group, and include the Tchuktchis, who may number 12,000, the Koryaks (5000), and the Kamchadales (3000), the Ghilyaks (nearly 5000) of the lower Amur and north Saghalin, and the Ainos (3000) of south Saghalin. The Yukaghirs (1600) seem to be merely Tunguses. Some 5000 Gypsies wander about Siberia.

Condition of indigenes.

Much has been written of late about the sad state of the indigenous populations of Siberia.[3] They are pitilessly deprived of their hunting and grazing grounds and compelled to resort to agriculture—a modification exceedingly hard for them, not only on account of their poverty but also because they are compelled to settle in the less favorable regions. European civilization has made them familiar with all its worst sides and with none of its best. Taxed with a tribute in furs (*yasak*) from the earliest years of the conquest, they often revolted in the 17th century, but were cruelly reduced to obedience. The tribute was never great (about 1¼ roubles [61 cts.] per head); but the official valuation of furs was always only one-third to one-fourth of their real value and the exactions of the authorities trebled it again. In 1824 the settled indigenes had to pay the very heavy rate of 11 roubles [$5.35] per head, and the arrears, which soon became equal to the sums levied, were rigorously exacted. It must be fully ackowledged that severe measures taken by the Government in the last two centuries prevented the growth of anything like legalized slavery on Siberian soil; but the people, ruined as they were both by the intrusion of agricultural colonists and by the exactions of Government officials, fell into what was practically a kind of slavery (*kabala*) to the merchants. Even the best-intentioned Government measures, such as the importation of corn, the prohibition of the sale of spirits, and so on, became new sources of oppression. The action of missionaries, who cared only about nominal Christianizing, had no better effect. It is worthy of notice that the spread of Mohammedanism among the Tatars and Kirghizes and of Lamaism among the Buriats took place under the Russians and was favored by the Government.

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[1] *Mém. de l'Acad. des Sc. de St. Pétersb.*, vol. xxii., 1876.

[2] *Aus Sibirien*, 2 vols., Leipsic, 1884; also in *Jivopisnaya Rossiya*, vol. xii.

[3] Yadrintseff's *Siberia as a Colony* contains a summary of this literature with bibliography.

Siberian Russians.

The Russians of Siberia differ to some extent from those of the mother-country. They might have been expected to intermix largely with the Finnish, Turkish, and Mongol elements with which they came in contact; but, in consequence of causes already mentioned under RUSSIA (vol. xxi. p. 74), the mixture is much less than might be supposed; and the continuous arrival of new immigrants contributed to lessen the effects of mixtures which really took place. One is accordingly struck to find in Western Siberia compact masses of Russians who have lost so little of their primitive ethnographical features, and to hear throughout Siberia a language which differs from that of northern Russia only by a slight admixture of words borrowed from the natives (mostly relating to hunting or cattle-rearing), and a few expressions of Polish origin. The case is otherwise, however, on the outskirts. Castrén characterized Obdorsk (mouth of the Ob) as a true Samoyedic town, although peopled with "Russians." The Cossacks of Western Siberia have the features and customs and many of the manners of life of the Kalmucks and Kirghiz. Yakutsk is thoroughly Yakutic; marriages of Russians with Yakut wives are common, and some forty years ago the Yakut language was predominant among the Russian merchants and officials. At Irkutsk and in the valley of the Irkut the admixture of Tungus and Buriat blood is obvious, and still more in the Nertchinsk district and among the Transbaikalian Cossacks settled for the last two centuries on the Argufi. They speak the Buriat language as often as Russian, and in a Buriat dress the Argufi Cossack can hardly be distinguished from a Buriat. In separate parts of Siberia, on the borders of the hilly tracts, the mixture with Tatars was quite common. Of course it is now rapidly growing less, and the settlers who entered Siberia in the 19th century married Russian wives and remained thoroughly Russian. There are accordingly parts of Siberia, especially among the Raskolniks, where the north Russian, the Great Russian, and the Ukrainian types have maintained themselves in their full purity, and only some differences in domestic architecture, in the disposition of their villages, and in the language and character of the population remind the traveller that he is in Siberia. The Russians in Siberia have emigrated from all parts of European Russia; but the special features of the language and partly also of the national character are due to the earliest settlers, who came mostly from northern Russia.

The natural rate of increase of population is very slow as a rule, and does not exceed 7 or 8 per 1000 annually. The great mortality, especially among children, is one of the causes of this, the birth-rate being also lower than in Russia. In Western Siberia the former is 38 per 1000 in towns and 30 in villages, while the births are 43 in towns and 44 in villages. The climate of Siberia, however, cannot be called unhealthy, except in certain localities where goitre is common (on the Lena, in several valleys of Nertchinsk, and in the Altai Mountains). The rapid growth of the actual population is chiefly due to immigration.

Agriculture.

Agriculture is the chief occupation both of the settled Russian and of the native population. South Siberia has a very fertile soil and yields rich crops, but immense tracts are utterly unfit for tillage. In the lowlands of Western Siberia it is carried on up to 61° N. lat.[1] On the high plains fringing the alpine tracts on the northwest it can be carried on only in the south, farther north only in the valleys, reaching 62° N. lat. in that of the Lena, and in the alpine tracts in only a few valleys, as that of the Irkut. On the high plateau all attempts to grow cereals have failed,—only the wide trenches (Uda, Selenga, Djida), already described, giving encouragement to the agriculturist. On the lower plateau, in Transbaikalia, grain is successfully raised in the Nertchinsk region,—with serious risks, however, from early frosts in the valleys of the mountain-ridges which rise above its surface. Southeast Transbaikalia suffers from want of water, and the Buriats irrigate their fields. Although agriculture is carried on on the upper Amur, where land has been cleared from virgin forests, it really prospers only below Kumara and on the rich plains of the Zeya and Selimja. In the depression between the Bureya range and the coast-ranges it suffers greatly from the heavy July and August rains, and from inundations; while on the lower Amur the agriculturists barely maintain themselves by growing cereals in clearances on the slopes of hills, so that the settlements on the lower Amur and Usuri continually require help from Government to save them from famine. The chief grain-producing regions of Siberia are—the Tobol and Ishim region, the Baraba, the region about Tomsk, and the outskirts of the Altai, which cover an aggregate of 330,000 square miles (155,000 in the Altai); they have a thoroughly Russian population of nearly 2,000,000 inhabitants, and nearly 8,600,000 acres are under crops. The Tobolsk region, mostly covered with *urmans*, but having nearly 1,000,000 acres cultivated, and the northern districts of Semipalatinsk, which are being rapidly colonized, must be added to the above. On the whole, in the basins of the Ob and Irtish, the annual yield is about 2,350,000 quarters of summer wheat, 1,260,000 of summer rye, 3,240,000 of oats, and 6,000,000 bushels of potatoes. The figures for Eastern Siberia are not so reliable,—about 1,100,000 quarters of various grains in Irkutsk (one-third raised by the Buriats), 400,000 in Transbaikalia, 40,000 in Yakutsk, about 100,000 in the Amur province, and 25,000 in the Maritime Province; and the Yeniseisk peasants sell every year about 700,000 cwts. of corn. The Minusinsk district, one of the richest in Siberia (45,000 inhabitants, of whom 2800 are settled and 24,000 nomadic), has more than 45,000 acres under crops; and in the whole province of Yeniseisk about 3,000,000 acres are cultivated.

Cattle-breeding.

Cattle-breeding is extensively carried on in many parts. In the Ob and Irtish region of Western Siberia there are about 2,000,000 horses, 1,500,000 head of horned cattle, 3,000,000 sheep, and 100,000 reindeer; for Eastern Siberia the figures are approximately 850,000 horses, 1,100,000 horned cattle, 1,120,000 sheep, and about 50,000 reindeer. The industry is, however, carried on in the most primitive manner. In Transbaikalia little hay is made, and the Buriat horses seek their food throughout the winter beneath the thin sheet of snow which covers the steppes. A single snowstorm in spring sometimes destroys in a few days thousands of horses thus weakened. In Western Siberia the "Siberian plague" makes great ravages, and the average losses are estimated at about 37,500 head of cattle annually.

Bee-keeping.

Bee-keeping is widely diffused, especially in Tomsk and the Altai. Honey is exported to Russia. The seeds of the stone-pine are collected for oil in Western Siberia.

Hunting.

Hunting still continues to be a profitable occupation, the male population of whole villages in the hilly and woody tracts setting out in October for a month's hunting. The sable, however, which formerly constituted the wealth of Siberia, is now so scarce that four sables per man is the maximum in the best districts. Squirrels, bears, foxes, snow-foxes, antelopes, and especially deer in spring, are at present the principal objects of the chase. But even in Yakutsk the total produce of hunting was in 1879 only 65 sables, 2360 snow-foxes, 23,440 ermines, 140,550 squirrels, 1780 foxes, 145 bears, 1310 reindeer, and 26,780 hares. The forests on the Amur yielded a rich return of furs during the first years of the Russian occupation, and the Amur sable, although much inferior to the Yakutsk and Transbaikalian, was largely exported. In 1862 1800 sables and 40,000 squirrels were killed in the province of Amur, and 9300 in the Maritime Province; but in 1877 the total export from the former did not exceed in value £1700 to £2000 [$8260 to $9720].

Fishing.

The same falling-off is observable in the fisheries,—one species at least, the *Rhytina stelleri*, having completely disappeared within the 19th century. Fishing is still a valuable source of income on the lower courses of the great rivers, especially the Ob, where the yearly earnings amount to about £30,000 [$145,800]. The fisheries on Lake Baikal supply cheap food (the *omul*) to the poorer classes of Irkutsk and Transbaikalia. The native populations of the Amur—Golds and Ghilyaks—support themselves chiefly by their fisheries, when the salmon enters in dense masses the Amur and its tributaries.

Manufactures.

Though Siberia has within itself all the raw produce necessary for prosperous industries, it continues to import from Russia without exception all the manufactured articles it uses. Owing to the distances over which they are carried and the bad organization of trade, all manufactured articles are exceedingly dear, especially in the east. The manufactories of Siberia employ less than 15,000 workmen, and their aggregate production does not exceed £1,600,000 [$7,776,000] in value; of these 11,500 are employed in Western Siberia, the yearly production being about £1,200,000 [$5,832,000]. Nearly one-third of the total represents wine-spirit, 23 per cent. tanneries, 18 per cent. tallow-melting, and a considerable sum cigarette-making. The villages of Siberia do not carry on a variety of petty trades like the villages in Russia, except in the districts of Tobolsk nearest the Urals, where tanning, boot-making, carpet-making, and the like are prosecuted.

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[1] The northern limits of agriculture are 60° N. lat. on the Urals, 62° at Yakutsk, 61° at Aldansk, 54° 30′ at Udskoi, and 58° to 54° in the interior of Kamchatka (Middendorff, *Sibirische Reise*, vol. iv.).

Mining.

Mining is in the same backward state as manufacturing industry. The chief attention is given to gold-mining. But the use of improved machinery is far from common, and the condition of the workmen wretchedly bad,—insufficient food, bad lodgings, and overwork under the most unsanitary conditions. As the geology of the gold-mining districts is quite unknown, immense sums are sunk in futile search. The amount of gold obtained has much increased since mining was begun in the Nertchinsk district and parts of the Altai (a right formerly reserved for the imperial Government), and since the discovery of auriferous deposits in the basin of the Amur and in the Maritime Province. It reached in 1882 4563 ℔ in Western Siberia (nearly all in the Altais), and 58,420 ℔ in Eastern Siberia (about 27,000 in Yakutsk, more than 10,000 in Nertchinsk, and about 8000 in the province of Amur). The Altai mines (12,000 workmen) yielded in 1881 16,670 ℔ of silver (13,310 in 1882), 13,140 cwts. of lead, 6700 of copper (the last two decreasing items), 3200 of iron, 240,000 of coal, and about 320,000 of salt. Silver-mining is almost entirely abandoned in Nertchinsk, and in 1882 only 1900 ℔ were extracted.

Trade.

Trade is in the hands of a few merchants. The chief market is the Nijni-Novgorod fair, where Siberian merchants get twelve or eighteen months' credit at correspondingly high rates.[1] Prices on the Amur are not more favorable, since the trade by sea is prevented from developing owing to the facility with which great profits are made by the exchange of wine-spirit and sables for whiskey. The villages are in a still worse condition, whole populations being dependent for the necessaries of life upon a few merchants. The foreign trade is insignificant, and the hundred merchant ships (thirty English) which visited the port of Vladivostok in 1883 came chiefly for the needs of the garrison. The imports of manufactured wares from Russia amount to an annual value of £12,000,000 [$58,320,000], the corresponding exports of raw produce are only about £4,000,000 [$19,440,000] — tallow, hides, furs, and grain being the chief items. There are several great fairs in Siberia, that of Irbit (with an annual turnover of £5,000,000 [$24,300,000] to £7,000,000 [$34,020,000]) being the most important. Those of Ishim, Tomsk, Irkutsk, and Verkhne-Udinsk deserve mention. In the north and northeast several fairs, where natives gather to pay tribute, to sell furs, and to purchase food and necessaries for hunting, have a local importance.

Communication.

The main line of communication is the great Moscow road. It starts from Perm on the Kama, and, crossing the Urals, reaches Ekaterinburg—the centre of mining industry—and Tyumeñ on the Tara, whence steamers ply *via* Tobolsk to Tomsk. A railway has of late been constructed between Perm and Ekaterinburg, touching the chief ironworks of the eastern slope of the middle Urals, and has been continued *via* Kamyshłoff to Tyumeñ. From Tyumeñ the Moscow road proceeds to Omsk, Tomsk, Krasnoyarsk, and Irkutsk, sending off from Kolyvañ a branch south to Barnauł in the Altai and to Turkestan. From Irkutsk it proceeds to Transbaikalia, and Lake Baikal is crossed either by steamer or (when frozen) on sledges, in either case from Listvenitchnaya to Posolskoye. A route was laid out about 1868 round the south shore of Lake Baikal in order to maintain communications with Transbaikalia during the spring and autumn, which were frequently interrupted when the old route from Selenghinsk across the Khamar-daban had to be resorted to. From Posolskoye on Lake Baikal the great road proceeds to Verkhne-udinsk, Tchita, and Sryetensk on the Shilka, whence steamers ply to the mouth of the Amur and up the Usuri and Sungatcha to Lake Khangka. When the rivers are frozen communication is maintained by sledges on the Amur; but in spring and autumn the only continuous route down the Shilka and the Amur, to its mouth, is on horseback along a mountain path (very difficult across the Bureya range). On the lower Amur and on the Usuri the journey is also difficult even on horseback. On the whole the steamer communication is in an unsatisfactory state, and when the water on the upper Amur is low vessels are sometimes unable to reach the Shilka. The Yenisei is navigated as far as Minusinsk, and communication is maintained along its banks in the summer by boat and horse. The Angara offers great difficulties to navigation on account of its rapids; regular water communication begins only below these and is continued to its mouth. On the Lena, which is an important waterway from Kirensk, merchandise is shipped for the gold-mining companies on the Lena below the Vitim, and sometimes up the lower Vitim. Another route of importance before the conquest of the Amur is that which connects Yakutsk with Okhotsk or Ayan. Regular postal communication is maintained by the Russians between Kiachta and Kalgan (close by Peking) across the desert of Gobi. Owing to the relatively good condition of the great highway the journey to Siberia is not so difficult or formidable as is generally supposed. As a rule the Siberians travel freely, and long journeys are undertaken more readily than short railway journeys are in Europe.

Colonization.

Siberia has been colonized in two different ways. On the one hand, the Government sent parties (1) of Cossacks to settle on the frontiers, (2) of peasants who were bound to settle at appointed places and maintain the communications along the routes, (3) of *stryeltsys* to garrison forts, (4) of *yamschiks*—a special organization of Old Russia intrusted with the maintenance of horses for postal communication, and finally (5) of convicts. Even so recently as 1856–57 a good deal of the Amur region was peopled in this way. Serfs in the imperial mines were liberated and organized in Cossack regiments (the Transbaikalia Cossacks); some of them were settled on the Amur, forming the Amur and Usuri Cossacks. Other parts of the river were colonized by peasants who emigrated with Government aid, and were bound to settle in villages, about 20 miles apart, on the Amur, at spots designated by officials. As a rule, this kind of colonization has not produced the results that were expected. On the other hand, free colonization has been more successful and has been undertaken on a much larger scale. Soon after the first appearance of the Cossacks of Yermak in Siberia thousands of hunters (*promyshlonyie*), attracted by the furs, immigrated from north Russia, explored the country, traced the first footpaths, and erected the first houses in the wilderness. Later on serfdom, religious persecutions, and conscription were the chief causes which led the peasants to make their escape to Siberia and build their villages in the most inaccessible forests, in the prairies, and even on Chinese territory. The severe measures of the Government against such "runaways" could not prevent their immigration to Siberia. While governmental colonization studded Siberia with forts, free colonization filled up the intermediate spaces. This free colonization has continued throughout the 19th century, occasionally assuming larger proportions, as in 1848–55. Since the emancipation of the serfs it has been steadily increasing. In spite of the involved formalities which the peasants have to go through before emigrating, and the great expense, whole villages emigrate from Russia to Siberia. During the twenty-five years ending 1879 no fewer than 100,000 persons crossed the Urals; and in 1882 the Ural Railway conveyed 7025 emigrants, while the total number of emigrants to Siberia in the same year was estimated at not less than 40,000.[2]

Exiles.

Siberia is a great penal colony. Exile to Siberia began in the first years of its discovery, and as early as 1658 we find the Non-conformist priest Avvakum[3] following in chains the exploring party of Pashkoff on the Amur. Raskolniks in the second half of the 17th century, rebel *stryeltsy* under Peter I., courtiers of rank during the reigns of the empresses, Polish confederates under Catherine II., the "Decembrists" under Nicholas I., nearly 50,000 Poles after the insurrection of 1863, and later on whole generations of socialists were sent to Siberia; while the number of common-law convicts and exiles transported thither has steadily increased since the end of the 18th century. No exact statistics of Siberian exile were kept before 1823. But it is known that in the first years of the 19th century nearly 2000 persons were transported every year to Siberia. This figure had reached an average of 18,250 in 1873–77 and rose above 20,000 in 1882. Between 1823 and 1877 the total was 393,914,[4] to which ought to be added the families of many exiles, making more than 600,000 men, women, and children transported since the beginning of the 19th century. Of 151,584 transported during the ten years 1867–76 18,582 were condemned to hard labor, 28,382 to be settled with loss of civil rights (*ssylno-poselentsy*), 23,383 to be settled without loss of rights (*na vodvorenie*), 2551 to live nearly free (*na jitie*), while 78,686 were transported simply by orders of the administration or decisions of the village communities. In 1884 21,104 exiles, followed by 1752 women and 3631 children, were transported to Siberia. Their distribution under different heads was nearly the same as the above. The hard-labor convicts (some 1800 or 1900) sent every year are distributed among several prisons in Western and Eastern Siberia, the imperial gold-washings at Kara on the Shilka, and the salt-works of Usolie and Ust-Kut; but, as these prisons and works cannot take more than 10,000 in all, the surplus have to be sent to SAGHALIN (*q.v.*), where they are employed in the coal-mines, or settled. After liberation the hard-labor convicts enter the category of *ssylno-poselentsy*, and are settled in villages. It appears from recent inquiries that nearly all are in a wretched condition, and that of the 200,000 on the official registers more than one-third have disappeared without being accounted for. Nearly 20,000 men (40,000 according to other estimates) are living in Siberia the life of *brodyaghi*, trying to make their way through the forests to their native provinces in Russia. The exile population of Siberia is much smaller than is generally supposed, being—in Tobolsk, 59,000, 4.6 per cent. of population; in Tomsk, 29,800, 2.6; in Yeniseisk, 45,000, 10.6; in Irkutsk, 40,000, 10; in Transbaikalia, 21,335, 4.3; in Yakutsk, 3000, 1.2; total, 198,153, or 4.9 per cent.

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[1] Salt in the Altai region (where it is obtained) is retailed at 2 roubles 40 copecks the *pud* (4s. 10d. [or $1.17] for 32 ℔); sugar, which is sold at 7 to 8 roubles the *pud* in Western Siberia (14s. to 16s. [or $3.40 to $3.89] the 32 ℔), reaches 12 to 20 roubles [$5.83 to $9.72] in Transbaikalia, and occasionally 40 roubles [$19.44] at Yakutsk.

[2] Yadrintseff, *Siberia as a Colony*; Levitoff, *Guide to West Siberia* (Russian); *Russkaya Mysl*, July, 1882.

[3] The autobiography of the protopope Avvakum is one of the most popular books with Russian Nonconformists.

[4] The Poles are not reckoned in the above figures.

Education. Education stands at a very low level. The chief town of every province is provided with a classical gymnasium, where the sons of the local officials prepare for the university, and a gymnasium or progymnasium for girls; but the education there received is not of a high grade, and the desire of the local population for "real schools" is not satisfied. The sum of £10,000 [$48,600] bequeathed by Demidoff in 1817 for the foundation of a university in Siberia, together with an additional £40,000 [$194,400] raised by subscription, remains unemployed, and, although the Government finally permitted the erection of buildings for a university at Tomsk, it again decided (1885), for political reasons, to postpone its opening. In 1883 there were in Western Siberia only 534 schools of all descriptions, with 14,097 male and 4915 female pupils. Transbaikalia had in 1881 108 schools of a very inferior kind, with 3828 pupils; Yakutsk, 23 schools, with 633 pupils in 1882. There are in all five gymnasia and five progymnasia for boys, three gymnasia and two progymnasia for girls, two "real schools," and three normal schools; but many vacant teaching posts in gymnasia remain unoccupied. Primary education is in a very unsatisfactory state, and primary schools very scarce.

Administrative divisions. Siberia is divided into four governments,—Tobolsk, Tomsk, Yeniseisk, and Irkutsk,—and four provinces,—Yakutsk, Transbaikalia, Amur, and Maritime or Primorskaya. The first two are under governors, like Russian governments; the next four are under the governor-general of Eastern Siberia, who resides at Irkutsk; the Amur and Maritime provinces are under the governor-general of the Amur, who resides at Khabarovka, at the junction of the Amur and the Usuri. The respective chief towns are—Tobolsk, Tomsk, Krasnoyarsk, Irkutsk, Yakutsk, Tchita, Blagoveschensk, and Khabarovka. The provinces of Akmolinsk (chief town, Akmoly) and Semiryetchensk (chief town, Vyernyi) are now parts of the steppe governor-generalship. Each government and province is subdivided into districts; the administrative head is a civil governor in the governments and a military governor in the provinces. By the regulations of 1834 each governor and governor-general is assisted by a council composed of chiefs of several departments (nominated by the governor-general), and several officials depending directly upon the respective ministries. The council has only a consultative voice, the final decision resting with the administrative head. The governors-general and military governors command the military forces of the provinces,—Cossacks and regulars. The new system of legal procedure introduced in Russia in 1866 has not yet been extended to Eastern Siberia, where the old courts are still in force. It has been introduced in Western Siberia, but without juries. The towns have received the new municipal organization. The *zemstvo* is not yet organized. The districts are under the control of *ispravniks* and *zasedatels*, who have very extensive powers, and are not controlled by self-government of the peasantry. The Cossacks—the Siberian on the Kirghiz frontier (90,000 persons, stretching in villages along a line of 1200 miles), the Transbaikalian, and those of the Amur and the Usuri, whose villages are dotted along the Amur to its junction with the Usuri and along the Usuri to Lake Khangka and Vladivostok—are under their own officers, and special administrative functions are intrusted to the military chief (*ataman*) of each separate Cossack *voisko*. The Altai and Nertchinsk mines, with their territories and populations, are under the imperial cabinet,—all private mines being under the inspection of mining engineers.

Since the earliest years of conquest Siberia has been placed under the rule of *voivodes* (governors), under a special department at Moscow. In 1708 it was divided into five provinces, depending upon a governor residing at Tobolsk. Catherine II. introduced in 1764 a vice-royalty, which existed, however, only until 1799, when governors and governors-general were introduced. This system prevailed until 1819. This part of the history of Siberia was an unbroken record of robbery, tyranny, and folly on the part of the governors and *ispravniks*, such as would seem incredible were the facts not testified to by the annals and documents recently published in Russia. In vain were the severest measures resorted to. Peter I. ordered the governor Prince Gagarin to be hanged, and the governor Joloboff was executed in 1736, while many minor officials were condemned to hard labor or the knout. The robberies and the cruelties of rulers like Kryloff, Pestel, Treskin, Loskutoff, and their myrmidons compelled the Government to undertake a thorough inquiry, and for this purpose Speranskiy was sent in 1819. To him Siberia is indebted for the new system of administration which has since remained in force.

Towns. The chief towns of Siberia are—Ekaterinburg (25,150 inhabitants), which belongs, however, to Perm, although situated on the eastern slope of the Urals; Tomsk (31,550), a commercial city, selected as the site of the university; and Irkutsk (36,120 in January, 1884), capital of Eastern Siberia, a trading city. Tobolsk (20,130), Krasnoyarsk (16,800), Tchita (12,600), Blagovyeschensk (8000), and Khabarovka (2500) are mere administrative centres. Biysk in Tomsk (18,700) yearly acquires more importance from its trade with the Kirghis steppe. Kurgan (8915) and Yalutorovsk (4500) in Tobolsk are large villages, dependent chiefly on agriculture and some trade. Barnaul (17,350), Kolyvañ (12,450), Kuznetsk (7355), Zmeinogorsk (6160), and Zyrianovsk (4450) in the Altai are mining centres; Barnaul is the seat of the mining administration. Tyumeñ (14,300) and Tara (8650) in Tobolsk, Mariinsk in Tomsk, Kainsk (8050) and Minusinsk (7400) in Yeniseisk, Kiachta (4300), Verkhne-udinsk (4150), and Nertchinsk (4070) in Transbaikalia, may be mentioned as local commercial centres—Kiachta having once had great importance in the tea-trade with China. The others are merely administrative centres. Towns like Obdorsk, Beresoff, Narym, Viluisk, Verkhoyansk, Okhotsk, and many others which figure on the maps are merely administrative centres for levying the *yasak*, each with less than 1000 or even fewer than 500 and 300 inhabitants. Of the fifty-three towns of Western and Eastern Siberia only two have more than 30,000 and eight from 12,000 to 21,000 inhabitants each; in ten towns the population ranges from 5000 to 10,000.

History. The shores of all the lakes which filled the depressions during the Lacustrine period are covered with remains dating from the Neolithic Stone period; and numberless *kurgans* (tumuli), ovens, and so on bear witness to a much denser population than the present. During the great migrations in Asia from east to west many populations were probably driven to the northern borders of the great plateau and thence compelled to descend into Siberia; succeeding waves of immigration drove them still farther towards the barren grounds of the north, where they melted away. According to Radloff, the earliest inhabitants of Siberia were the Yeniseians, who spoke a language different from the Ural-Altaic; some few traces of them (Yeniseians, Sayan-Ostiaks, and Kottes) have been found among the Sayan Mountains. The Yeniseians were followed by the Ugro-Samoyedes, who also came originally from the high plateau and were compelled, probably during the great migration of the Huns in the 3d century B.C., to cross the Altai and Sayan ranges and to enter Siberia. To them must be assigned the very numerous remains dating from the Bronze period which are scattered all over south Siberia. Iron was unknown to them; but they excelled in bronze, silver, and gold work. Their bronze ornaments and implements, often polished, evince a great development of artistic taste; and their irrigated fields covered wide areas in the fertile tracts. On the whole, their civilization stood much higher than that of their more recent successors. Eight centuries later the Turkish stocks of "Tukiu" (in Chinese spelling), Khagasses, and Uigurs—also compelled to migrate northwestwards from their former seats—subdued the Ugro-Samoyedes. These new invaders have likewise left numerous traces of their sojourn, and two different periods may be easily distinguished in their remains. They were acquainted with iron, and learned from their subjects the art of bronze-casting, which they used for decorative purposes only, and to which they gave a still higher artistic stamp. Their pottery is also much more perfect and more artistic than that of the Bronze period, and their ornaments now have a place among the finest collections at the St. Petersburg Hermitage. This Turkish empire of the Khagasses must have lasted until the 13th century, when the Mongols, under Jenghiz Khan, subdued them and destroyed their civilization. A decided decline is shown by the graves which have been discovered, until the country reached the low level at which it was found by the Russians on their arrival towards the close of the 16th century. In the beginning of the 16th century Tatar fugitives from Turkestan subdued the loosely associated tribes inhabiting the lowlands to the east of the Urals. Agriculturists, tanners, merchants, and mollahs (priests) were called from Turkestan, and small principalities sprang up on the Irtish and the Ob. These were united by Khan Ediger, and conflicts with the Russians who were then colonizing the Urals brought him into collision with Moscow; his envoys came to Moscow in 1555 and consented to a yearly tribute of a thousand sables. This source of wealth attracted Russian adventurers to the trans-Ural regions. As early as the 11th century the Novgorodians had occasionally penetrated into Siberia; but the fall of the republic and the loss of its northeastern dependencies checked the advance of the Russians across the Urals. On the defeat of Stepan Razin many who were unwilling to submit to the iron rule of Moscow made their way to the settlements of Stroganoff in Perm, and tradition has it that, in order to get rid of his guests, Stroganoff suggested to their chief, Yermak, that he should cross the Urals into Siberia, promising to help him in this enterprise with supplies of food and arms. Yermak entered Siberia in 1580 with a band of 1636 men, following the Taghil and Tura rivers. Next year they were on the Tobol, and 500 men successfully laid siege to Isker, the residence of Khan Kutchum, in the neighborhood of what is now Tobolsk. Kutchum fled to the steppes, abandoning his domains to Yermak, who, according to tradition, purchased by the present of Siberia to Ivan IV. his own restoration to favor. Yermak was drowned in the Irtish in 1584, after having been defeated by the Tatars. After his death the Cossacks abandoned Siberia; but new bands of hunters and adventurers, attracted by the furs, poured every year into the country, and were supported by regular troops from Moscow. To avoid conflicts with denser populations in the south, they preferred to advance eastwards along higher latitudes; meanwhile Moscow sent fresh detachments of troops under *voivodes*, who erected forts and settled laborers around them to supply the garrisons with food, gunpowder, and arms. Within eighty years the Russians had reached the Amur and the Pacific. This rapid conquest is accounted for by the circumstance that they met with no organized resistance; they found only the Tatar Kutchum on the Tobol, and in the Altai the Turkish stocks under the Kalmuck Altyn Khan, the centre of whose power was on the Kemtchik, and who collected tribute from the Teleuts, Uryankhs, Telesses, Beltirs, Buruts (Kirghiz), and other smaller tribes. Neither Tatars nor Turks could offer any serious resistance. When travelling down the Yenisei in 1607–10 the Cossacks first encountered Tunguses, who strenuously fought for their independence, but were at last subdued about 1623. In 1628 the Russians reached the Lena, founded the fort of Yakutskiy in 1637, and two years later reached the Sea of Okhotsk at the mouth of the Ulia river. The Buriats offered some opposition, but between 1631 and 1641 the Cossacks erected several palisaded forts in their territory, and in 1648 the fort on the upper Uda (Verkhne-Udinskiy Ostrog) beyond Lake Baikal. In 1643 Poyarkoff's boats descended the Amur, returning to Yakutsk by the Sea of Okhotsk and the Aldan, and in 1649–50 Khabaroff occupied the course of the Amur. The resistance of the Chinese, however, obliged the Cossacks to quit their forts, and by the treaty of Nertchinsk (1689) Russia abandoned her advance into the basin of the river. In her anxiety to keep peace with China and not to endanger the Kiachta trade, Russia rigorously prohibited and punished all attempts of the Siberians to advance farther towards that river until 1855. In 1849 the Russian ship "Baikal" discovered the estuary of the Amur; in 1851 the military post of Nikolaievskiy was established at its mouth, and two years later the post of Mariinsk near Lake Kizi. Next year a Russian military expedition under Muravioff explored the Amur, and in 1857 a chain of Russian Cossacks and peasants had already settled along the whole course of the river. The accomplished fact was recognized by China in 1857 and 1860 by a treaty. In the same year in which Khabaroff explored the Amur (1648) the Cossack Dejneff, starting from the Kolyma, sailed round the northeastern extremity of Asia through the strait which was rediscovered and described eighty years later by Behring (1728). Cook in 1778, and after him La Pérouse, settled definitively the broad features of the northern Pacific coast. Although the Arctic Ocean had been reached as early as the first half of the 17th century, the exploration of its coasts by a series of expeditions under Ovtsyn, Minin, Prontchischeff, Lasinius, and Lapteff—whose labors constitute a brilliant page in the annals of geographical discovery—was begun only in the 18th century (1735–39.)

The scientific exploration of Siberia begun in the period 1733 to 1742 by Messerschmidt, Gmelin, and De Lisle de la Croyère was soon followed up by Müller, Fischer, and Georgi. Pallas, with several Russian students, laid the first foundation of a thorough exploration of the topography, fauna, flora, and inhabitants of the country. The journeys of Hansteen and Erman (1828–33) were a most important new step in the exploration of the territory. Humboldt, Ehrenberg, and Gustav Rose also paid in the course of these years short visits to Siberia, and gave a new impulse to the accumulation of scientific knowledge; while Ritter elaborated in his *Asien* the true foundations of a sound knowledge of the structure of Siberia. Middendorff's journey (1841–43) to northeastern Siberia—contemporaneous with Castrén's journeys for the special study of the Ural-Altaian languages—directed attention to the far north and awakened interest in the Amur, whose basin soon became the scene of the expeditions of Akhte and Schwarz (1852), and later on (1854–57) of the great Siberian expedition to which we owe so marked an advance in our knowledge of Eastern Siberia. The Siberian branch of the Russian Geographical Society was founded at the same time at Irkutsk, and afterwards became a permanent centre for the exploration of Siberia; while the opening of the Amur and Saghalin attracted Maack, Schmidt, Glehn, Radde, and Schrenck, whose works on the flora, fauna, and inhabitants of Siberia have become widely known.

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(2) *Flora and Fauna.*—Besides the works of Gmelin, Georgi, Pallas, Ledebour, Middendorff, Maack, Schrenck, Radde, Schmidt, Glehn, and Maximowicz, see a large number of monographs by Schmidt, Regel, Trautvetter, Herder, Brandt, Polyakoff, Martynoff, Budischeff, and many others scattered through the publications of the Academy of Sciences, the St. Petersburg Botanical Garden, the Society of Naturalists of Moscow, the Society of Friends of Natural Sciences of Moscow, and the Geographical Societies of St. Petersburg and Irkutsk. Several of them are complete *florulæ* of separate regions, or important monographs of separate classes of the vegetable or animal kingdom, or lists of plants and animals collected during separate journeys; see also Taczanowski's lists of birds in *Bull. de la Soc. Zool. de France*, 1882. Mezhoff's *Bibliographical Indexes*, yearly published by the Geographical Society, and the *Indexes* of the Kieff Society of Naturalists give full details.

(3) *Geology.*—Geological observations occur in nearly all the above-mentioned works of travel and serial publications. Of recent monographs the following, published in periodical publications, may be mentioned: Meglitzky, in *Verh. der Miner. Gez. zu St. Petersburg*, 1856; Schmidt, "Mammuth Reise," in *Mem. of St. Petersburg Ac.*; Lopatin, on the Vitim, Yenisei, and Krasnoyarsk, in *Mining Journal* and serials of the St. Petersburg and East Siberian Geographical Society; Czekanowski, in *Mem. Ac. of Sciences*; Czerski (map of shores of Baikal), in *Izvestia*, East Siberian Geographical Society, and several papers, especially on mining districts, in the *Gornyi Journal*.

(4) *Ethnology.*—Slovtsoff, *History of Siberia*; Shashkoff, a series of papers on the "Indigenous Races of Siberia," "The Native Question," "Serfdom in Siberia," "Historical Sketches," in various reviews; Polyakoff, *Journey to the Ob* (translated into German); Schapoff, in various historical works and in the *Izvestia* of the Siberian Geographical Society; Samokvasoff, *Customary Law of Siberian Indigenes*, 1876; papers in *Otetchestvennyia Zapiski*, vols. ccxxxix. and ccxciii.; Yadrintseff, *Siberia*, 1882. Argentoff and Kostroff in the serials of the Geogr. Soc. give information about the present state of the indigenes and their relations to Russia.

(5) *Exile.*—Maximoff, *Siberia and Hard Labor*, 1871, Foinitzky, *Administration of Exile*, 1879; Vagin, "Historical Documents on Siberia," in the collection *Sibir*, vol. i.: Nikitin, "Prisons and the Prisons Question," in *Russkiy Vyestnik*, 1878; Mishlo, "On Siberian Prisons," in *Otetch. Zapiski*, 1881; Yadrintseff, *Siberia as a Colony*, 1882; Dostoievsky, *Buried Alive*, 1881; Rosen, *Memoiren eines Decabristen*, 1870. (P. A. K.)

SIBSÁGAR, or SEEBSAUGOR, a British district of India, in the upper valley of the province of Assam, lying between 26° 19′ and 27° 16′ N. lat. and 93° 21′ and 95° 25′ E. long., and covering an area of 2855 square miles. It is bounded on the N. and E. by Lakhimpur district, on the S. by independent Nágá Territory, and on the W. by the Nowgong and Nágá Hills districts. Sibságar consists of a level plain, much overgrown with grass and jungle, and intersected by numerous tributaries of the Brahmaputra. It is divided by the little stream Disai into two tracts, which differ in soil and general appearance. The surface of the eastern portion is very flat, the general level being broken only by the long lines of embankments raised by the Aham kings to serve both as roadways and as a protection against floods. The soil consists of a heavy loam of a whitish color, which is well adapted for rice cultivation. West of the Disai, though the surface soil is of the same character, the general aspect is diversified by the protrusion of the subsoil, which consists of a stiff clay abounding in iron nodules, and is furrowed by frequent ravines and water-courses, which divide the cultivable fields into innumerable small sunken patches or *holas*. The chief river is the Brahmaputra, which is navigable throughout the year by steamers and large native craft. The navigable tributaries of the Brahmaputra comprise the Dhaneswari, the Burí Dihing, the Disang, and the Dikhu, all flowing in a northerly direction from the Nágá Hills. Included within the district is the island of Maguli, which is said to have been formed by the silt brought down by the Subansiri river from the Himálayas and deposited in the wide channel of the Brahmaputra. Coal, iron, petroleum, and salt are found in the district. Wild beasts of all kinds abound, including the elephant, rhinoceros, tiger, buffalo, and deer. The climate, like that of the rest of the Assam valley, is comparatively mild and temperate, and the average annual rainfall is about 94 inches.

In 1881 the population of Sibságar was 370,274 (males 195,194, females 175,080), of whom Hindus numbered 339,663, Mohammedans 15,665, hill tribes 13,829, and Christians 804. The only place of more than 5000 inhabitants is SIBSÁGAR (see below). Of the total area 359,225 acres were under cultivation in 1883–84, besides 78,710 acres of forests. The staple product is rice, which yields two crops in the year; tea is also extensively grown, Sibságar being second only to Cachar among the tea-growing districts of India; other crops include food-grains, pulses, oil-seeds, sugar-cane, and cinchona. The local industries are limited to the weaving of silk and cotton cloth, the making of brass and bell-metal utensils, and coarse pottery. The principal exports are tea, silk, mustard-seed, cotton, and jungle products; the imports include salt, oil, opium, piece-goods, and miscellaneous hardware.

On the decline of the Aham dynasty Sibságar, with the rest of the Assam valley, fell into the hands of the Burmese. They were expelled by the British in 1823, and in the following year the valley was annexed to British India. The British, however, were indisposed to undertake the responsibilities of administration beyond what seemed absolutely necessary. The country now forming Sibságar district, together with the southern portion of Lakhimpur, was placed under the rule of Raja Purandhar Sinh, on his agreeing to pay an annual tribute of £5000 [$24,300.] Owing to the raja's misrule, Sibságar was reduced to a state of great poverty, and, as he was unable to pay the annual tribute, the territories were resumed by the government of India, and in 1838 Sibságar was placed under the direct management of a British officer. The tea industry soon brought back prosperity, and the Sibságar peasants now rank among the most contented and wealthy in Assam.

SIBSÁGAR, chief town and civil headquarters of the above district, is situated about 11 miles south from the Brahmaputra, being picturesquely placed around a magnificent tank covering an area of 114 acres. Besides the houses of the civil officials, it possesses a straggling bazaar, in which a brisk business is carried on during the cold season with the neighboring hill tribes. In 1881 the population of the town was 5868.

SIBYL. Certain women who prophesied under the inspiration of a deity were called by the Greeks Sibyls. The inspiration manifested itself outwardly in distorted features, foaming mouth, and frantic gestures. The notion that hysterical, convulsive, and epileptic affections are proof of divine inspiration has been common all over the world (see Tylor's *Primitive Culture* ii. p. 131 *sq.*). Homer does not refer to a Sibyl, nor does Herodotus. The first Greek writer, so far as we know, who does so, is Heraclitus (flourished about 500 B.C). As to the number and native countries of the Sibyls much diversity of opinion prevailed, as is evinced by the contradictory statements of ancient writers. Aristophanes, Plato, and the author of the θαυμάσια ἀκούσματα, attributed to Aristotle, appear to know of only one Sibyl. Heraclides Ponticus, a pupil of Plato, seems to be the first writer who distinguished several Sibyls,—the Erythræan, the Phrygian, and the Hellespontine. Later writers speak of two, three, four, eight, ten, and twelve. Pausanias (x. 12) enumerates four. According to him, the oldest was the Libyan[1] Sibyl, a daughter of Zeus and Lamia. The second was Herophile, a native of Marpessus or Erythræ in the Troad; she lived mostly in Samos, but visited Clarus, Delos and

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[1] There is a gap in the text of Pausanias, and his meaning is not quite certain.

Delphi. She lived before the Trojan War, which she is said to have predicted. The third was the Sibyl of Cumæ in Italy, and the fourth was a Hebrew Sibyl called Sabbe; others, however, called the last-mentioned Sibyl a Babylonian or Egyptian. According to Plutarch (*De Pyth. Orac.*, 9), the first Sibyl was she of Delphi. Varro enumerates ten Sibyls,—the Persian, Libyan, Delphic, Cimmerian, Erythræan, Samian, Cuman, Hellespontine, Phrygian, and Tiburtine. The Sibyl of whom we hear most was the Sibyl of Cumæ, whom Æneas consulted before his descent to Hades. She was supposed to live 1000 years. It was she who sold to Tarquin the Proud the Sibylline books. She first offered him nine; when he refused them, she burned three and offered him the remaining six at the same price; when he again refused them, she burned three more and offered him the remaining three still at the same price. Tarquin then bought them. They were entrusted to a college of fifteen men (*quindecemviri sacris faciundis*), who preserved them and consulted them on occasions of national danger. It would seem that they were consulted with a view to discover, not exact predictions of definite future events, but the religious observances necessary to avert extraordinary calamities and expiate prodigies. They were written in hexameter verse and in Greek; hence the college of curators was always assisted by two Greek interpreters. The books were kept in the temple of Jupiter on the Capitol and shared the destruction of the temple by fire in 83 B.C. After the restoration of the temple the senate sent ambassadors in 76 to Erythræ to collect the oracles afresh and they brought back about 1000 verses; others were collected in Ilium, Samos, Sicily, Italy, and Africa. In the year 12 Augustus sought out and burned a great many spurious oracles and subjected the Sibylline books to a critical revision; they were then placed by him in the temple of Apollo Patrous, where we hear of them still existing in 363. They seem to have been burned by Stilicho shortly after 400. According to the researches of Klausen (*Æneas und die Penates*, Hamburg, 1839–40), the oldest collection of Sibylline oracles appears to have been made about the time of Solon and Cyrus at Gergis on Mount Ida in the Troad; it was attributed to the Sibyl of Marpessus and was preserved in the temple of Apollo at Gergis. Thence it passed to Erythræ, where it became famous. It was this very collection, it would appear which found its way to Cumæ and from Cumæ to Rome.

The collection of so-called Sibylline oracles which has descended to us is obviously spurious, bearing marks of Jewish and Christian origin. Ewald assigns the oldest of them to about 124 B.C. and the latest to about 668–672 A.D. They have been edited by Friedlieb (Leipsic, 1852) and Alexandre (2d ed., Paris, 1869). For an examination of the different lists of Sibyls, see E. Maass, *De Sibyllarum Indicibus*, Berlin, 1879.

SIBYLLINE BOOKS. See APOCALYPTIC LITERATURE, vol. ii. p. 156–7.

SICILY.

PART I.—HISTORY.

Geographical position.

SICILY, slightly surpassed by Sardinia in superficial extent, is, in its geographical and historical position, the greatest island of the Mediterranean. As such it holds among European lands a position answering that of Great Britain, the greatest island of the Ocean, and the events of their history have at more than one period brought the two islands into a close connection with one another. The geographical position of Sicily (see vol. xiii. pl. IV.) led almost as a matter of necessity to its historical position, as the meeting-place of the nations, the battle-field of contending races and creeds. Lying nearer to the mainland of Europe and nearer to Africa than any other of the great Mediterranean islands, Sicily is, next to Spain, the connecting link between those two quarters of the world. It stands also as a breakwater between the eastern and western divisions of the Mediterranean Sea. In prehistoric times those two divisions were two vast lakes, and Sicily is a surviving fragment of the land which once parted the two united seas and united the continents which are now distinct. That Sicily and Africa were once joined we know only from modern scientific research; that Sicily and Italy were once joined is handed down in legend, unless the legend itself is not rather an obvious guess. Sicily then, comparatively near to Africa, but much nearer to Europe, has been a European land, but one specially open to invasion and settlement from Africa. Dividing the eastern and western basins of the Mediterranean, it has been a part of western Europe, but a part which has had specially close relations with eastern Europe. It has stood at various times in close connection with Greece, with Africa, and with Spain; but its closest connection has been with the neighboring land of Italy. Still Italy and Sicily are thoroughly distinct lands, and the history of Sicily should never be looked on as simply part of the history of Italy. Lying thus between Europe and Africa, Sicily has been the battle-field of Europe and Africa. That is to say, it has been at two separate periods the battle-field of Aryan and Semitic man. In the later stage of the strife it has been the battle-field of Christendom and Islam. This history Sicily shares with Spain to the west of it and with Cyprus to the east. And with Spain the island has had several direct points of connection. There was in all likelihood a near kindred between the earliest inhabitants of the two lands. In later times Sicily was ruled by Spanish kings, both alone and in union with other kingdoms. The connection with Africa has consisted simply in the settlement of conquerors from Africa at two periods, first Phœnician, then Saracen. On the other hand, Sicily has been more than once made the road to African conquest and settlement, both by Sicilian princes and by the Roman masters of Sicily. The connection with Greece, the most memorable of all, has consisted in the settlement of many colonies from Old Greece, which gave the island the most brilliant part of its history, and which made the greater part practically Greek. This Greek element was strengthened at a later time by the long connection of Sicily with the Eastern, the Greek-speaking, division of the Roman empire. And the influence of Greece on Sicily has been repaid in more than one shape by Sicilian rulers who have at various times held influence and dominion in Greece and elsewhere beyond the Hadriatic (Adriatic). The connection between Sicily and Italy begins with the primitive kindred between some of the oldest elements in each. Then came the contemporary Greek colonization in both lands. Then came the tendency in the dominant powers in southern Italy to make their way into Sicily also. Thus the Roman occupation of Sicily ended the struggle between Greek and Phœnician. Thus the Norman occupation ended the struggle between Greek and Saracen. Of this last came the long connection between Sicily and southern Italy under several dynasties. Lastly, comes the late absorption of Sicily in the modern kingdom of Italy. The result of these various forms of Italian influence has been that all the other tongues of the island have died out before the advance of a peculiar dialect of Italian. In religion again both Islam and the Eastern form of Christianity have given way to its Italian form. The connection with England amounts to this, that both islands came under Norman dynasties, that under Norman rule the intercourse between the two countries was extremely close, and that the last time that Sicily was the seat of a separate power it was under British protection.

The Phœnician, whether from old Phœnicia or from Carthage, came from lands which were mere strips of sea-coast with a boundless continent behind them. The Greek of old Hellas came from a land of islands, peninsulas, and inland seas. So did the Greek of Asia, though he had, like the Phœnician, a vast continent behind him. In Sicily they all found a strip of sea-coast with an inland region behind; but the strip of sea-coast was not like the broken coast of Greece and Greek Asia, and the inland region was not a boundless continent like Africa or Asia. In Sicily therefore the Greek became more continental, and the Phœnician became more insular, than either nation had been in its own land. Neither people ever occupied the whole island; the presence of the other hindered either from occupying even the whole of the coast; nor was either people ever able to spread its dominion over the earlier inhabitants very far inland. Sicily thus remained a world of its own, with interests and disputes of its own, and divided among inhabitants of various nations. The history of the Greeks of Sicily is constantly connected with the history of old Hellas, but it runs a separate course of its own. Their position answers somewhat to that of the English people of the United States with regard to the mother-country of Great Britain. It differs in this, that the independence of the Greek cities in Sicily was not the result of warfare with the mother-country. Otherwise the analogy would have been almost exact, if France or Spain had kept its old power in North America. The Phœnician element ran an opposite course, as the independent Phœnician settlements in Sicily sank into dependencies of Carthage. The entrance of the Romans put an end to all practical independence on the part of either nation. But Roman ascendency did not affect Greeks and Phœnicians in the same way. Phœnician life gradually died out. But Roman ascendency nowhere crushed out Greek life where it already existed, and in some ways it strengthened it. Though the Greeks never spread their dominion over the island, they made a peaceful conquest of it. This process was in no way hindered by the Roman dominion; the work of assimilation went on still faster.

Original inhabitants.

The question now comes, Who were the original inhabitants of Sicily? The island itself, Σικελία, *Sicilia*, plainly takes its name from the Sikels (Σικελοί, *Siculi*), a people whom we find occupying a great part of the island, chiefly east of the river Gela. They appear also in Italy, in the toe of the boot, and older history or tradition spoke of them as having in earlier days held a large place in Latium and elsewhere in central Italy. They were believed to have crossed the strait into the island about 300 years before the beginning of the Greek settlements, that is to say in the 11th century B.C. They found in the island a people called Sikans (Σικανοί, *Sicani*), whose name might pass for a dialectic form of their own, did not the ancient writers straitly affirm them to be a wholly distinct people, akin to the Iberians. Sikans also appear with the Ligurians among the early inhabitants of Italy (Virg., *Æn.*, vii. 795, viii. 328, xi. 317, and Servius's note). It is possible then that the likeness of name is accidental, that the Sikels belonged to the same branch of the Aryan family as the Italians, while Sikans, like Ligurians and Iberians and the surviving Basques, belonged to the earlier non-Aryan population of western Europe. But, whatever the origin of either, in the history of the island Sikans and Sikels appear as two distinct nations with a clear geographical boundary. And we may venture to set down the Sikels as undeveloped Latins, who were hindered by the coming of the Greeks from reaching the same independent national life as their kinsfolk in Italy, and, instead of so doing, were gradually Hellenized. On the other hand, some Sikel elements made their way into the Greek life of Sicily. That the Sikels spoke a tongue closely akin to Latin is plain from several Sikel words which crept into Sicilian Greek, and from the Sikeliot system of weights and measures,—utterly unlike anything in old Greece. When the Greek settlements began, the Sikans had hardly got beyond the life of villages on hill-tops (Dion. Hal., v. 6), more truly perhaps villages with places of shelter on the hill-tops. The more advanced Sikels had their hill-forts also, but they had learned the advantages of the sea, and they already had settlements on the coast when the Greeks came. As we go on, we hear of both Sikel and Sikan towns; but we may suspect that any approach to true city life was owing to Greek influences. Neither people grew into any form of national unity. There was neither common king nor common confederation either of Sikels or of Sikans. They were therefore partly subdued, partly assimilated, slowly, but without much effort.

In the northeast corner of the island we find a small territory occupied by a people who seem to have made much greater advances towards civilized life. The Elymoi were a people of uncertain origin, but they claimed a mixed descent, partly Trojan, partly Greek. Thucydides however unhesitatingly reckons them among barbarians. They had considerable towns, as Segesta (the Greek Egesta) and Eryx, and the whole history, as well as the remains, of Segesta, shows that Greek influences prevailed among them very early. In short, we find in the island three nations distinct from the Greeks, two of which at least easily adopted Greek culture and came in the end to pass for Greeks by adoption.

Early Phœnician settlements.

But, as we have already seen, the Greeks were not the first colonizing people who were drawn to the great island. As in Cyprus and in the islands of the Ægæan, the Phœnicians were before them. And it is from this presence of the highest form of Aryan and of Semitic man that the history of Sicily draws its highest interest. Of Phœnician occupation there are two, or rather three, marked periods. We must always remember that Carthage—the new city—was one of the latest of Phœnician foundations, and that the days of the Carthaginian dominion show us only the latest form of Phœnician life. Phœnician settlement in Sicily began before Carthage became great, perhaps before Carthage came into being. A crowd of small settlements from the old Phœnicia, settlements for trade rather than for dominion, factories rather than colonies, grew up on promontories and small islands all round the Sicilian coast. These were unable to withstand the Greek settlers, and the Phœnicians of Sicily withdrew step by step to form three considerable towns in the northwest corner of the island,—Motye, Soloeis or Solunto, on a hill overhanging the sea on the north coast, and the great Panormos, the *all-haven* (see PALERMO), the city destined to be, in two different periods of the world's history, the head of Semitic power in Sicily.

Greek colonization.

Our earlier notices of Sicily, of Sikels and Sikans, in the Homeric poems and elsewhere, are vague and legendary. Both races appear as given to the buying and selling of slaves (*Od.*, xx. 383, xxiv. 30, 210). The intimate connection between old Hellas and Sicily begins with the foundation of the Sicilian Naxos by Chalkidians of Euboia under Theokles, which is assigned to the year 735 B.C. The site, a low promontory on the coast, immediately below the height of Tauromenion, marks an age which had advanced beyond the hill-fortress and which thoroughly valued the sea. The next year Corinth began her system of settlement in the west: Korkyra (Corcyra), the path to Sicily, and Syracuse on the Sicilian coast were planted as parts of one enterprise. From this time, for about 150 years, Greek settlement in the island, with some intervals, goes steadily on. Both Ionian and Dorian colonies were planted, both from the older Greek lands and from the older Sicilian settlements. The east coast, nearest to Greece and richest in good harbors, was occupied first. Here, between Naxos and Syracuse, arose the Ionian cities of Leontinoi and Katana (Catina, Catania) and the Dorian Megara by Hybla. Settlement on the south-western coast began about 688 B.C. with the joint Cretan and Rhodian settlement of Gela, and went on in the foundation of Selinous (the most distant Greek city on this side), of Kamarina (Camarina), and in 588 B.C. of the Geloan settlement of Akragas (Agrigentum, Girgenti), planted on a high hill, a little way from the sea, which became the second city of Hellenic Sicily. On the north coast the Ionian Himera was the only Greek city in Sicily itself, but the Knidians founded Lipara in the Æolian Islands. At the north-east corner, opposite to Italy, and commanding the strait, arose Zankle, a city of uncertain date and mixed origin, better known under its later name of Messana (Messene, Messina).

7th cent.–454 B.C.

Prosperous Greek period.

Thus nearly all the east coast of Sicily, a great part of the south coast, and a much smaller part of the north, passed into the hands of Greek settlers,—Sikeliots (Σικελιῶται), as distinguished from the native Sikels. This was one of the greatest advances ever made by the Greek people. The Greek element began to be predominant in the island. Among the earlier inhabitants the Sikels were already becoming adopted Greeks. Many of them gradually sank into a not wholly unwilling subjection as cultivators of the soil under Greek masters,—a relation embodied perhaps in the legend that a native Sikel prince led the Greek settlers to the foundation of Megara. But there were also independent Sikel towns in the interior, and there was a strong religious intercommunion between the two races. Sikel Henna (Enna, Castrogiovanni) is the special seat of the worship of Demeter and her daughter. The Sikans, on the other hand, seem more distinct and more steadily hostile. The Phœnicians, now shut up in one corner of the island, with Selinous on one side and Himera on the other founded right in their teeth, are bitter enemies; but the time of their renewed greatness under the headship of Carthage has not yet come. The 7th century B.C. and the early part of the 6th were a time in which the Greek cities of Sicily had their full share in the general prosperity of the Greek colonies everywhere. For a while they outstripped the cities of old Greece. Their political constitutions were aristocratic; that is, the franchise was confined to the descendants of the original settlers, round whom an excluded body (*δῆμος* or *plebs*) was often growing up. The ancient kingship was perhaps kept on or renewed in some of the Sikeliot and Italiot towns; but it is more certain that civil dissensions led very early to the rise of tyrants. The first and most famous is Phalaris of Akragas, whose exact date is uncertain, whose letters are now cast aside, and whose brazen bull has been called in question, but who clearly rose to power very soon after the foundation of Akragas. Under his rule the city at once sprang to the first place in Sicily, and he was the first Sikeliot ruler who held dominion over two Greek cities, Akragas and Himera. This time of prosperity was also a time of intellectual progress. To say nothing of lawgivers like Charondas, the line of Sikeliot poets began early, and the circumstances of the island, the adoption of many of its local traditions and beliefs—perhaps a certain intermingling of native blood—gave the intellectual life of Sicily a character in some things distinct from that of old Hellas. Stesichoros of Himera (*c.* 632–556 B.C.) holds a great place among the lyric poets of Greece, and some place in the political history of Sicily as the opponent of Phalaris. The architecture and sculpture of this age have also left some of their most remarkable monuments among the Greek cities of Sicily (see SYRACUSE). The remains of the old temples of Selinous, attributed to the 7th century B.C., show us the Doric style in its earlier state, and the sculptures of their metopes (preserved at Palermo) are as distinctly grotesque as any Romanesque sculpture of the 11th or 12th century. In both ages the art of the builder was far in advance of that of the ornamental carver.

Growth of tyrannies.

Gelon.

Hieron I.

This first period of Sicilian history lasts as long as Sicily remains untouched from any non-Hellenic quarter outside, and as long as the Greek cities in Sicily remain as a rule independent of one another. A change begins in the 6th century and is accomplished early in the 5th. The Phœnician settlements in Sicily become dependent on Carthage, whose growing power begins to be dangerous to the Greeks of Sicily. Meanwhile the growth of tyrannies in the Greek cities was beginning to group several towns together under a single master, and thus to increase the greatness of particular cities at the expense of their freedom. Thus Theron of Akragas (488–472), who bears a good character there, acquired also, like Phalaris, the rule of Himera. One such power held dominion both in Italy and Sicily. Anaxilaos of Rhegion, by a long and strange tale of treachery, occupied Zankle and changed its name to Messana. But the greatest of the Sikeliot powers began at Gela in 505, and was in 485 translated by Gelon to Syracuse. That city now became the centre of a greater dominion over both Greeks and Sikels than the island had ever before seen. But Gelon, like several later tyrants of Syracuse, takes his place—and it is the redeeming point in the position of all of them—as the champion of Hellas against the barbarian. The great double invasion of 480 B.C. was planned in concert by the barbarians of the East and the West (Diod., xi. 20; schol. on Pind., *Pyth.*, i. 146; Grote, v. 294). While the Persians threatened old Greece, Carthage threatened the Greeks of Sicily. There were Sikeliots who played the part of the Medizers in Greece: Selinous was on the side of Carthage, and the coming of Hamilkar was immediately brought about by a tyrant of Himera driven out by Theron. But the united power of Gelon and Theron crushed the invaders in the great battle of Himera, won, men said, on the same day as Salamis, and the victors of both were coupled as the joint deliverers of Hellas (Herod., vii. 165–167; Diod., xx. 20–25; Pind., *Pyth.*, i. 147–156; Simonides, fr. 42; Polyainos, i. 27). But, while the victory of Salamis was followed by a long war with Persia, the peace which was now granted to Carthage stayed in force for seventy years. Gelon was followed by his brother Hieron (478–467), the special subject of the songs of Pindar. Akragas meanwhile flourished under Theron; but a war between him and Hieron led to slaughter and new settlement at Himera. These transplantings from city to city began under Gelon and went on under Hieron. They made speakers in old Greece (Thuc., vi. 17) contrast the permanence of habitation there with the constant changes in Sicily. Hieron won the fame of a founder by peopling Katana with new citizens, and changing its name to Aitna.

None of these tyrannies were long-lived. The power of Theron fell to pieces under his son Thrasydaios. When the power of Hieron passed in 467 B.C. to his brother Thrasyboulos the freedom of Syracuse was won by a combined movement of Greeks and Sikels, and the Greek cities gradually settled down as they had been before the tyrannies, only with a change to democracy in their constitutions. The mercenaries who had received citizenship from the tyrants were settled at Messana. About fifty years of general prosperity followed. We have special pictures of almost incredible wealth and luxury at Akragas, chiefly founded on an

African trade. Moreover art, science, poetry, had all been encouraged by the tyrants, and they went on flourishing in the free states. To these was now added the special growth of freedom, the art of public speaking. Epicharmos (540–450), carried as a babe to Sicily, is a link between native Sikeliots and the strangers invited by Hieron; as the founder of the local Sicilian comedy, he ranks among Sikeliots. After him Sophron of Syracuse gave the Sicilian *mimes* a place among the forms of Greek poetry. But the intellect of free Sicily struck out higher paths. Empedokles of Akragas is best known from the legends of his miracles and of his death in the fires of Ætna; but he was not the less philosopher, poet, and physician, besides his political career. It is vaguely implied (Diog. Laert., viii. 2, 9) that he refused an offer of the tyranny or of authority in some shape. Gorgias of Leontinoi (*c.* 480–375) had a still more direct influence on Greek culture, as father of the technical schools of rhetoric throughout Greece. Architecture too advanced, and the Doric style gradually lost somewhat of its ancient massiveness. The temple at Syracuse which is now the metropolitan church belongs to the earlier days of this time. It is followed by the later temples at Selinous, among them the temple of Zeus, which is said to have been the greatest in Sicily, and by the wonderful series at Akragas, crowned by the Olympian temple, with its many architectural singularities. This, like its fellow at Selinous, was not fully finished at the time of the Carthaginian inroad at the end of the century.

Condition of Sikels and Sikans.

During this time of prosperity there was no dread of Carthaginian inroads. But in 454 B.C. we read of a war between Segesta and Lilybaion (Lilybæum). There was as yet no town of Lilybaion; but, if the war was waged against any Phœnician settlement, the fact is to be noticed, as hitherto Segesta has been allied with the Phœnicians against the Greeks. Far more important are our notices of the earlier inhabitants. For now comes the great Sikel movement under Douketios, who, between force and persuasion, came nearer towards uniting his people into one body than had ever been done before. From his native hill-top of Menai, rising above the lake dedicated to the Palikoi, the native deities whom Sikels and Greeks alike honored, he brought down his people to the new city of Palikai in the plain. His power grew, and Akragas could withstand him only by the help of Syracuse. Alternately victorious and defeated, spared by Syracuse (451), sent to be safe at Corinth, he came back to Sicily only to form greater plans than before. War between Akragas and Syracuse enabled him to carry out his schemes, and, with the help of another Sikel prince who bore the Greek name of Archomides, he founded Kale Akte on the northern coast. But his work was cut short by his death in 440; the hope of the Sikel people now lay in assimilation to their Hellenic neighbors. Douketios's own foundation of Kale Akte lived on, and we presently hear of Sikel towns under kings and tyrants, all marking an approach to Greek life. Roughly speaking, while the Sikels of the plain country on the east coast became subject to Syracuse, most of those in other parts of the island remained independent. Of the Sikans we hear less; but Hykkara in the northwest was an independent Sikan town on bad terms with Segesta. On the whole, setting aside the impassable barrier between Greek and Phœnician, other distinctions of race within the island were breaking down through the spread of the Hellenic element. Segesta was on familiar terms with both Greek and Phœnician neighbors, and had the right of intermarriage (Thuc., vi. 6) with Hellenic Selinous. Among the Greek cities themselves the distinction between the Dorian and the Ionian or Chalkidian settlements is still keenly felt. The Ionian is decidedly the weaker element; and it was most likely owing to the rivalry between the two great Dorian cities of Syracuse and Akragas that the Chalkidian towns were able to keep any independence at all.

Up to this time the Italiot and Sikeliot Greeks have formed part of the general Greek world, while within that world they have formed a world of their own, and Sicily has again formed a world of its own within that. Wars and conquests between Greeks and Greeks, especially on the part of Syracuse, though not wanting, have been on the whole less constant than in old Greece. It is even possible to appeal to a vein of local Sicilian patriotism, to preach a kind of Monroe doctrine by which Greeks from other lands should be shut out as strangers (ἀλλόφυλοι, Thuc., vi. 61, 74). Presently this state of Sicilian isolation was broken in upon by the great Peloponnesian War. The Sikeliot cities were drawn into alliance with one side or the other, till the main interest of Greek history gathers for a while round the Athenian attack on Syracuse. At the very beginning of the war the Lacedæmonians looked for help from the Dorian Sikeliots.

Interference of Athens.

454–413 B.C.

But the first active intervention came from the other side. Conquest in Sicily was a favorite dream at Athens (Thuc., vi. 1, cf. i. 48, and Diod., xii. 54), with a view to wider conquest or influence in the western Mediterranean. An opportunity for Athenian interference was found in 427 in a quarrel between Syracuse and Leontinoi and their allies. Leontinoi craved help from Athens on the ground of Ionian kindred. Her envoy was Gorgias; his peculiar style of rhetoric was now first heard in old Greece (Diod., xii. 53, 54), and his pleadings were successful. For several years from this time (427–422) Athens plays a part, chiefly unsuccessful, in Sicilian affairs. But the particular events are of little importance, except as leading the way to the greater events that follow. The steadiest ally of Athens was the Italiot Rhegion; Messana, with its mixed population, was repeatedly won and lost; the Sikel tributaries of Syracuse give zealous help to the Athenians. But in 424 all the Sikeliot and most of the Italiot cities, under the guidance of Hermokrates of Syracuse, who powerfully set forth the doctrine of Sikeliot, perhaps of Sicilian unity, agreed on a peace. Presently an internal disturbance at Leontinoi led to annexation by Syracuse. This gave the Athenians a pretext for another attempt in 422. Little came of it, though Athens was joined by the Doric cities of Kamarina and Akragas, clearly out of jealousy towards Syracuse. For several years the island was left to itself.

The far more memorable interference of Athens in Sicilian affairs in the year 415 was partly in answer to the cry of the exiles of Leontinoi, partly to a quite distinct appeal from the Elymian Segesta. That city, an ally of Athens, asked for Athenian help against its Greek neighbor Selinous. In a dispute, partly about boundaries, partly about the right of intermarriage between the Hellenic and the Hellenizing city, Segesta was hard pressed. She vainly asked for help at Akragas—some say at Syracuse (Diod., xii. 82)—and even at Carthage. The last appeal was to Athens. But the claims of Segesta and Leontinoi are soon forgotten in the struggle for life and death between Syracuse and Athens.

Athenian expedition.

The details of the great Athenian expedition (415–413) belong partly to the political history of Athens, partly to that of SYRACUSE (*q.v.*). But its results make it a marked epoch in Sicilian history, and the Athenian plans, if successful, would have changed the whole face of the West. If the later stages of the struggle were remarkable for the vast number of Greek cities engaged on both sides, and for the strange inversion of relations among them on which Thucydides (vii. 57, 58) comments, the whole war was yet more remarkable for the large entrance of the barbarian element into the Athenian reckonings. The war was undertaken on behalf of Segesta; the Sikels gave Athens valuable help; the greater barbarian powers out of Sicily also came into play. Some help actually came from Etruria. But Carthage was more far-sighted. If Syracuse was an object of jealousy, Athens, succeeding to her dominion, creating a power too nearly alike to her own, would have provoked far greater jealousy. So Athens found no active support save at Naxos and Katana, though Akragas, if she would not help the invaders, at least gave no help to her own rival. The war is instructive in many ways: it reminds us of the general conditions of Greek seamanship when we find that Korkyra was the meeting-place for the allied fleet, and that Syracuse was reached only by a coasting voyage along the shores of Greek Italy. We are struck also by the low military level of the Sicilian Greeks. The Syracusan heavy-armed are as far below those of Athens as those of Athens are below those of Sparta. The *quasi*-continental character of Sicily causes Syracuse, with its havens and its islands, to be looked on, in comparison with Athens, as a land power (ἠπειρῶται, Thuc., vii. 21). That is to say, the Sikeliot level represents the general Greek level as it stood before the wars in which Athens won and defended her dominion. The Greeks of Sicily had had no such military practice as the Greeks of old Greece; but an able commander could teach both Sikeliot soldiers and Sikeliot seamen to out-manœuvre Athenians. The main result of the expedition, as regards Sicily, was to bring the island more thoroughly into the thick of Greek affairs. Syracuse, threatened with destruction by Athens, was saved by the zeal of her metropolis Corinth in stirring up the Peloponnesian rivals of Athens to help her. Gylippos came; the second Athenian fleet came and perished. Syracuse was saved; all chance of Athenian dominion in Sicily or elsewhere in the West came to an end. Syracuse repaid the debt by good service to the Peloponnesian cause, and from that time the mutual influence of Sicily and old Greece upon one another is far stronger than in earlier times.

413-392 B.C.

Phœnician invasion under Hannibal.

But before the war in old Greece was over, seventy years after the great victory of Gelon (410), the Greeks of Sicily had to undergo barbarian invasion on a vaster scale than ever. The disputes between Segesta and Selinous called in these enemies also. Carthage stepped in as the ally of Segesta, the enemy of her old ally Selinous. Her leader was Hannibal, grandson and avenger of the Hamilkar who had died at Himera. In 408, at the head of a vast mercenary host, he sailed to Sicily, attacked Selinous, and stormed the town after a murderous assault of nine days, while the other Sikeliot cities, summoned to help, were still lingering. The walls and temples were overthrown; the mass of the people were massacred; the few who escaped were allowed to return to the dismantled site as tributaries of Carthage; and the city never recovered its old greatness. Thence Hannibal went on to Himera, with the special mission of avenging his grandfather. By this time the other Greek cities were stirred to help, while Sikels and Sikans joined Hannibal; the strife was distinctly a strife of Greeks and barbarians. At last Himera was stormed, and 3000 of its citizens were solemnly slaughtered on the spot where Hamilkar had died. Himera ceased to exist; but the Carthaginians founded the new town of Thermai (Termini) not far off, to which the name is sometimes laxly applied. The Phœnician possessions in Sicily now stretched across the island from Himera to Selinous. The next victim was Akragas; its defenders, natives and allies, quarrelled among themselves; the mass of the people forsook the city, and found shelter at Gela and elsewhere. The few who were left were slaughtered; the town was sacked and the walls destroyed. Akragas was presently restored, and it has lived on to this day; but it never recovered its old greatness.

Dionysios I.

Meanwhile the revolutions of Syracuse affected the history of Sicily and of the whole Greek world. Dionysios the tyrant began his reign of thirty-eight years in the first months of 405. Almost at the same moment, the new Carthaginian commander, Himilkon, attacked Gela and Kamarina. Dionysios, coming to the help of Gela, was defeated, and was charged with treachery. He now made the mass of the people of both towns find shelter at Syracuse. But now the plague led Himilkon to ask for peace. Carthage was confirmed in her possession of Selinous, Himera, and Akragas, with some Sikan districts which had opposed her. The people of Gela and Kamarina were allowed to occupy their unwalled towns as tributaries of Carthage. Leontinoi, latterly a Syracusan fort, as well as Messana and all the Sikels, were declared independent, while Dionysios was acknowledged as master of Syracuse. No war was ever more grievous to freedom and civilization. More than half Sicily was now under barbarian dominion; several of its noblest cities had perished, and a tyrant was established in the greatest. The 5th century B.C., after its central years of freedom and prosperity, ended in far deeper darkness than it had begun. The minuter account of Dionysios belongs to Syracusan history; but his position, one unlike anything that had been before seen in Sicily or elsewhere in Hellas, forms an epoch in the history of Europe. His only bright side is his championship of Hellas against the Phœnician, and this is balanced by his settlements of barbarian mercenaries in several Greek cities. Towards the native races his policy varied according to momentary interests; but on the whole his reign tended to bring the Sikels more and more within the Greek pale. His dominion is Italian as well as Sicilian; his influence, as an ally of Sparta, is important in old Greece; while, as a hirer of mercenaries everywhere, he had wider relations than any earlier Greek with the nations of western Europe. He further opened new fields for Greek settlement on both sides of the Hadriatic. In short, under him Sicily became for the first time the seat of a great European power, while Syracuse, as its head, became the greatest of European cities. His reign was unusually long for a Greek tyrant, and his career furnished a model for other rulers and invaders of Sicily. With him in truth begins that wider range of Greek warfare, policy and dominion which the Macedonian kingdoms carry on. The master of such a dominion becomes the improver of the military art. With him begins the employment of ships greater than the old triremes, of more effective engines in sieges, and that combined use of troops of various arms and nations which Alexander carried to perfection.

His wars with Carthage, etc.

The reign of Dionysios (405–367) is divided into marked periods by four wars with Carthage, in 397–396, 392, 383, and 368. In the first war his home power was all but overthrown; but he lived through the storm, and extended his dominion over Naxos, Katana, and Leontinoi. All three perished as Greek cities. Katana was the first Sikeliot city to receive a settlement of Campanian mercenaries, while others settled in non-Hellenic Entella. Naxos was settled by Sikels; Leontinoi was again merged in Syracuse. Now begin the dealings of Dionysios with Italy, where the Rhegines, kinsmen of Naxos and Katana, planned a fruitless attack on him in common with Messana. He then sought a wife at Rhegion, but was refused with scorn, while Lokroi (Locri) gladly gave him Doris. The two cities afterwards fared accordingly. In the first war with Carthage, the Greek cities under Carthaginian dominion or dependence helped him; so did Sikans and Sikels, which last had among them some stirring leaders; Elymian Segesta clave to Carthage. Dionysios took the Phœnician stronghold of Motye; but Himilkon recovered it, destroyed Messana, founded the hill-town of Tauromenion (Taormina) above Naxos for Sikels who had joined him, defeated the fleet of Dionysios, and besieged Syracuse. Between invasion and home discontent, the tyrant was all but lost; but the Spartan Pharakidas stood his friend; the Carthaginians again suffered from pestilence; and Himilkon went away defeated, taking with him his Carthaginian troops and forsaking his allies. Gela, Kamarina, Himera, Selinous, Akragas itself, now passed into the dependent alliance of Dionysios. The Carthaginian dominion was cut down to what it had been before Hannibal's invasion. The lord of Syracuse had grown at the cost of Greek and barbarian alike.

He planted mercenaries at Leontinoi, conquered some Sikel towns, central Henna among them, and made alliances with others. He restored Messana, peopling it with motley settlers, among whom were some of the old Messenians from Peloponnesos. But the Spartan masters of the old Messenian land grudged this possible beginning of a new Messenian power. Dionysios therefore moved his Messenians to a point on the north coast, where they founded Tyndaris. He clearly had a special eye to that region. He took the Sikel Kephaloidion (Cefalù), and even the old Phœnician border-fortress of Solous was betrayed to him. He beat back a Rhegine expedition; but his advance was checked by a failure to take the new Sikel settlement of Tauromenion. His enemies of all races now declared themselves. Many of the Sikels forsook him; Akragas declared herself independent; Carthage herself, stirred by the loss of Solous, again took the field.

The Punic war of 392–391 was not very memorable. Both sides failed in their chief enterprises, and the main interest of the story comes from the glimpses which we get of the Sikel states. Most of them joined the Carthaginian leader Mago; but he was successfully withstood at Agyrion by Agyris, the ally of Dionysios, who is described as a tyrant second in power to Dionysios himself. This way of speaking would imply that Agyrion had so far advanced in Greek ways as to run the usual course of a Greek commonwealth. The two tyrants drove Carthage to a peace by which she abandoned all her Sikel allies to Dionysios. This time he took Tauromenion and settled it with his mercenaries. For new colonists of this kind the established communities of all races were making way. The transportations under the older tyrants had been movements of Greeks from one Greek site to another. Now all races are confounded.

Dionysios, now free from Phœnician warfare, gave his mind to enterprises which raised his power to its greatest height. In the years 390–387 he warred against the Italiot cities in alliance with their Lucanian enemies. Rhegion Kroton (Croton), the whole toe of the boot, were conquered. Their lands were given to Lokroi; their citizens were taken to Syracuse, sometimes as slaves, sometimes as citizens. The master of barbarians fell below the lowest Hellenic level when he put the brave Rhegine general Phyton to a lingering death, and in other cases imitated the Carthaginian cruelty of crucifixion. Conqueror of southern Italy, he turned his thoughts yet further, and became the first ruler of Sicily to stretch forth his hands towards the eastern peninsula. In the Hadriatic he helped Hellenic extension. He planted directly and indirectly some settlements in Apulia, while Syracusan exiles founded the more famous Ankon or Ancona. On the east coast he founded Lissos; he helped the Parians in their settlements of Issa and Pharos; he took into his pay Illyrian warriors with Greek arms, and helped the Mollotian Alketas to win back part of his kingdom. He was even charged with plotting with his Epeirot ally to plunder Delphoi. This even Sparta would not endure; Dionysios had to content himself with sending a fleet along the west coast of Italy, to carry off the wealth of the great temple of Agylla or Cære.

In old Greece men now said that the Greek folk was hemmed in between the barbarian Artaxerxes on the one side and Dionysios, master and planter of barbarians, on the other. These feelings found expression when Dionysios sent his embassy to the Olympic games of
384, and when Lysias bade Greece rise against bot
oppressors. Dionysios vented his wrath on those
were nearest to him, banishing many, among t
his brother Leptines and his earliest friend Phili
and putting many to death. He was also once
stirred up to play the part of a Hellenic champion
made ready for yet another Punic war.

In this war (383–382) Dionysios seems for onc
have had his head turned by a first success. His
mand that Carthage should altogether withdraw
Sicily was met by a crushing defeat. Then ca
treaty by which Carthage kept Selinous and par
the land of Akragas. The Halykos became
boundary. Dionysios had also to pay 1000 tal
[$1,184,625], which caused him to be spoken o
becoming tributary to the barbarians. In the
years of his reign we hear dimly of both Syrac
and Carthaginian operations in southern Italy.
also gave help to Sparta against Thebes, sending G
ish and Iberian mercenaries to take part in G
warfare. His last war with Carthage, which was g
on at his death, was ended by a peace by which
Halykos remained the boundary.

Dionys
and

392–3

The tyranny of Dionysios fell, as usual, in the se
generation; but it was kept up for ten
years after his death by the energy of Philistos, now minister of his son Dionysios the
Younger. It fell with the coming back of the
Dion in 357. The tyranny had lasted so long th
was less easy than at the overthrow of the elder
rants to fall back on an earlier state of things. It
been a time of frightful changes throughout
Sicily, full of breaking up of old landmarks,
of confusion of races, and of movements of inhabit
But it also saw the foundation of new cities. Be
Tyndaris and Tauromenion, the foundation of A
marks another step in Sikel progress towards He
ism, while the Carthaginians founded their st
town and fortress of Lilybaion. Among these cha
the most marked is the settlement of Campanian
cenaries in Greek and Sikel towns. Yet they
could be brought under Greek influences; they
distant kinsfolk of the Sikels, and they were the
runners of Rome. They mark one stage of migra
from Italy into Sicily.

The reign of Dionysios was less brilliant in the
of art and literature than that of Hieron. Yet Di
sios himself sought fame as a poet, and his succe
Athens shows that his compositions did not de
the full scorn of his enemies. The dithyrambic
Philoxenos, by birth of Kythera, won his fam
Sicily, and other authors of lost poems are menti
in various Sikeliot cities. One of the greatest l
in all Greek history is that of the writings of Phil
(436–356), the Syracusan who had seen the Ath
siege and who died in the warfare between Dion
the younger Dionysios. Through the time of
tyrants, he was, next to the actual rulers, the
man in Sicily; but of his record of his own time
have only what filters through the recasting of
doros. But the most remarkable intellectual m
ment in Sicily at this time was the influence of
Pythagorean philosophy, which still lived o
southern Italy. It led, through Dion, to the se
visits of Plato to Sicily under both the elder and
younger Dionysios. To architecture the time wa
favorable anywhere but in Syracuse.

The time following the Dionysian tyranny wa
Syracuse a time full of the most stirring local and
sonal interest, under her two deliverers Dion
Timoleon. It is less easy to make out the exact e
on the rest of Sicily of the three years' career of D
But we may mark that, in driving out the you
Dionysios, he was helped by a general movemen
Greeks, Sikels, and Sikans. Between the deat
Dion in 354 and the coming of Timoleon in 34
hear of a time of confusion in which Hellenic
seemed likely to die out. The cities, Greek and S

Timoleon.

were occupied by tyrants. Syracuse was parted between several, Dionysios coming back to hold Ortygia. Timoleon's work was threefold—the immediate deliverance of Syracuse, the restoration of Sicily in general to freedom and Greek life, and the defence of the Greek cities against Carthage. The victory of the Krimisos in 340 led to a peace with Carthage with the old frontier; but all Greek cities were to be free, and Carthage was to give no help to any tyrant. Timoleon drove out all the tyrants, and it specially marks the fusion of the two races that the people of the Sikel Agyrion were admitted to the citizenship of free Syracuse. From some towns he drove out the Campanians, and he largely invited Greek settlement, especially from the Italiot towns, which were hard pressed by the Bruttians. The Corinthian deliverer gave, not only Syracuse, but all Greek Sicily, a new lease of life, though a short one.

337-276 B.C.

With Timoleon begins a series of leaders who came from old Greece to deliver or to conquer among the Greeks of Italy and Sicily. The enterprise of Dion most likely suggested those that followed, but Dion, as a native Syracusan, does not belong altogether to the same class. Timoleon alone was a pure republican deliverer. The Macedonian kings had established a Greek dominion in the East, and a series of princes from Sparta and Epeiros came to establish in the West a Greek dominion which should balance that of the Macedonians. Archidamos, Alexander of Epeiros, Akrotatos, Kleonymos, all unsuccessfully attempted this work in Italy; it was only Pyrrhos, the last and greatest of the series, who played any great part in Sicily. And before he came, Sicily had become the seat of a greater native power than ever. Never till the Norman came was any Sicilian dominion so famous in the world as that of the Syracusan tyrant or king Agathokles.

Agathokles.

We have unluckily no intelligible account of Sicily during the twenty years after the death of Timoleon (337–317). His deliverance is said to have been followed by great immediate prosperity, but wars and dissensions very soon began again. Agathokles won his first fame in war between Syracuse and Akragas. The Carthaginians played off one city and party against another, and Agathokles, following the same policy, became in 317, by treachery and massacre, undisputed tyrant of Syracuse, and spread his dominion over many other cities. Akragas, strengthened by Syracusan exiles, now stands out again as the rival of Syracuse. The Carthaginian Hamilkar, by conduct which contrasted with the cruelty of Agathokles, won many Greek cities to the Punic alliance. Defeated in battle, with Syracuse blockaded by a Carthaginian fleet, Agathokles formed the bold idea of carrying the war into Africa. He set the model for Regulus and Scipio, and not a few later rulers of Sicily.

For more than three years (310–307) each side carried on warfare in the land of the other. Carthage was hard pressed by Agathokles, while Syracuse was no less hard pressed by Hamilkar. The force with which Agathokles invaded Africa was far from being wholly Greek; but it was representatively European. Gauls, Samnites, Tyrrhenians, fought for him, while mercenary Greeks and Syracusan exiles fought for Carthage. He won many battles and towns; he quelled mutinies of his own troops; by inviting and murdering Ophellas lord of Kyrene (Cyrene) he doubled his army and brought Carthage near to despair. Meanwhile Syracuse, all but lost, had driven back Hamilkar, and had taken and slain him when he came again with the help of the Syracusan exile Deinokrates. Meanwhile Akragas, deeming Agathokles and the barbarians alike weakened, proclaimed freedom for the Sicilian cities under her own headship. Many towns, both Greek and Sikel, joined the confederacy. It has now become impossible to distinguish the two races; Henna and Erbessos are now the fellows of Kamarina and Leontinoi. But the hopes of Akragas were checked when Agathokles suddenly came back from Africa, landed at Selinous, and marched to Syracuse, taking one town after another. A new scheme of Sicilian union was taken up by Deinokrates, which cut short his dominion. But he now relieved Syracuse from the Carthaginian blockade; his mercenaries gained a victory over Akragas; and he sailed again for Africa, where fortune had turned against his son Archagathos, as it now did against himself. He left his sons and his army to death, bondage, or Carthaginian service, and came back to Sicily almost alone. Yet he could still gather a force which enabled him to seize Segesta, to slay or enslave the whole population, and to settle the city with new inhabitants. This change amounts to the extinction of one of the elements in the old population of Sicily. We hear no more of Elymoi; indeed Segesta has been practically Greek long before this. Deinokrates and Agathokles came to a kind of partnership, and a peace with Carthage, with the old boundary, secured Agathokles in the possession of Syracuse and eastern Sicily (301).

At some stage of his African campaigns Agathokles had taken the title of king. Earlier tyrants were well pleased to be spoken of as kings; but no earlier rulers of Sicily put either their heads or their names on the coin. Agathokles now put his name, first without, and then with, the kingly title. This was in imitation of the Macedonian leaders who divided the dominion of Alexander. The relations between the eastern and western Greek worlds are drawing closer. Agathokles in his old age took a wife of the house of Ptolemy; he gave his daughter Lanassa to Pyrrhos, and established his power east of Hadria, as the first Sicilian ruler of Korkyra. He carried on wars in the Liparæan Islands and in southern Italy, and died in 289 B.C., poisoned, some said, by his own grandson. Alike more daring and more cruel than any ruler before him, he carried the arms of Sicily further afield, and made the island the seat of a greater power than any of them.

This time was not favorable to the intellectual life of Sicily. Hitherto the island had attracted men of letters from old Greece. Now several distinguished Sicilian writers either chose or were driven to find homes elsewhere. Tinaios of Tauromenion, scorned by Polybios, but whose great Sicilian history is none the less a loss, was banished by Agathokles, and made Athens his headquarters for the last fifty years of his long life (356–*c.* 260 B.C.). Dikaiarchos (Dicæarchus) of Messana, geographer and philosopher and author of the *Life of Greece*, lived mainly in Peloponnesos till about 285 B.C. Euhemeros (Evemerus), despiser of the gods, who is claimed by more than one birthplace besides Messana, lived in the service and friendship of the Macedonian Kassandros. Philemon too, the long-lived writer of comedy (361–262 B.C.), is claimed for Syracuse, and it was only as an adopted citizen that he spent most of his life at Athens.

Period after Agathokles.

On the death of Agathokles tyrants sprang up in various cities. Akragas, under its king Phintias, won back for the moment somewhat of its old greatness. By a new depopulation of Gela, he founded the youngest of Sikeliot cities, Phintias, by the mouth of the southern Himera. And Hellas was cut short by the seizure of Messana by the disbanded Campanian mercenaries of Agathokles (*c.* 282). They slew the men, took the women as wives, and proclaimed themselves a new people in a new city by the name of Mamertines, children of Mamers or Mars. Messana became an Italian town; henceforth its formal name was "Mamertina civitas."

The Campanian occupation of Messana is the first of the chain of events which led to the Roman dominion in Sicily. As yet Rome has hardly been mentioned in Sicilian story, either for friendship or for enmity. The Mamertine settlement, the war with

Pyrrhos.

Pyrrhos, bring us on quickly. Pyrrhos came as the champion of the western Greeks against all barbarians, whether Romans in Italy or Carthaginians in Sicily. His Sicilian war (278-276) was a mere interlude between the two acts of his war with Rome. As son-in-law of Agathokles, he claimed to be specially king of Sicily, and he held the Sicilian conquest of Korkyra as the dowry of Lanassa. With such a deliverer, deliverance meant submission. Pyrrhos is said to have dreamed of kingdoms of Sicily and of Italy for his two sons, the grandsons of Agathokles, and he himself reigned for two years in Sicily as a king who came to be no less hated than the tyrants. Still as Hellenic champion in Sicily he has no peer. As European champion he has none till Roger of Hauteville. Eryx was won from the Phœnician; Panormos first became a city of Europe; if he failed before Lilybaion, that fortress and Messana were all that was left in barbarian hands through the whole island.

All this was but for a moment. The Greek king, on his way back to fight for Tarentum against Rome, had to cut his way through Carthaginians and Mamertines in Roman alliance. His saying that he left Sicily as a wrestling-ground for Romans and Carthaginians was the very truth of the matter. Very soon came the first war between Rome and Carthage, the war which is best marked by its other name of the War for Sicily. It mattered much, now that Sicily was to have a barbarian master, whether that master should be the kindred barbarian of Europe or the barbarian of Asia transplanted to the shore of Africa. That question was decided for Europe, that is for Rome, now beginning her long career as European champion. That strife too gave a large part of Sicily a last day of prosperity under a native ruler who was a king and not a tyrant.

Hieron II.

Sicily in truth never had a more hopeful champion than the second Hieron of Syracuse. The established rule of Carthage in western Sicily was now something that could be well endured alongside the robber commonwealth at Messana. The dominion of the freebooters was spreading. Besides the whole northeastern corner of the island, it reached inland to Agyrion and Kentoripa. The Mamertines leagued with other Campanian freebooters who had forsaken the service of Rome to establish themselves at Rhegion. But a new Syracusan power was growing up to meet them. Hieron, claiming descent from Gelon, pressed the Mamertines hard. He all but drove them to the surrender of Messana; he even helped Rome to chastise her own rebels at Rhegion. The wrestling-ground was thus opened for the two barbarian commonwealths. Carthaginian troops held the Messanian citadel against Hieron, while another party in Messana craved the help of the head of Italy. Rome, chastiser of the freebooters of Rhegion, saw Italian brethren in the freebooters of Messana. The War for Sicily began (264).

The exploits of Hieron had already won him the kingly title (270) at Syracuse, and he was the representative of Hellenic life and independence throughout the island. Partly in this character, partly as direct sovereign, he was virtual ruler of a large part of eastern Sicily. But he could not aspire to the dominion of earlier Syracusan rulers. The advance of Rome after the retreat of Pyrrhos kept the new king from all hope of their Italian position. And presently the new kingdom exchanged independence for safety. When Rome entered Sicily as the ally of the Mamertines, Hieron became the ally of Carthage. But in the second year of the war (263) he found it needful to change sides. His alliance with Rome marks a great epoch in the history of the Greek nation. The kingdom of Hieron was the firstfruits out of Italy of the system by which alliance with Rome grew into subjection to Rome. He was the first of Rome's kingly vassals. His only burden was to give help to the Roman side in war; within his kingdom he was free, and his dominions flourished as no part of Sicily had flourished since the days of Timoleon.

First Punic War.

During the twenty-three years of the First Punic War (264-241) the rest of the island suffered greatly. The war for Sicily was fought in and round Sicily, and the Sicilian cities were taken and retaken by the contending powers. Akragas, held by Carthage, stood a Roman siege (262); the Punic garrison escaped; the inhabitants were sold into slavery. Seven years later the repeopled city was taken and burned and its walls destroyed by a Carthaginian army. Selinous was utterly destroyed, when, towards the end of the war, Carthage gathered her whole strength again in a few points in the west. Greek Selinous and Elymian Eryx alike gave way to the new fortress of Drepanon, which, along with Lilybaion, held out till the end of the war. Segesta, subject to Carthage, still remembered its old traditions, and the sons of Æneas were welcomed as deliverers by the Trojan city. Kamarina and inland Henna passed to and fro between the two powers. But the great exploit of Rome was the second winning of Panormos for Europe, and its brilliant defence against the Semitic enemy. The highest calling of the Greek had now, in the Western lands, passed to the Roman. By the treaty which ended the war Carthage ceded to Rome all her possessions in Sicily. As that part of the island which kept a national Greek government became the first kingdom dependent on Rome, so the share of Carthage became the first Roman province. One point alone did not come under either of those heads. Messana, *Mamertina civitas*, remained an Italian ally of Rome on Sicilian soil.

276-210 B.C.

We have no picture of Sicily in the first period of Roman rule. One hundred and seventy years later, several towns within the original province enjoyed various degrees of freedom, which they had doubtless kept from the beginning. Besides the old ally Messana, Panormos, Segesta, with Kentoripa, Halesa, and Halikye, once Sikel but now Hellenized, kept the position of free cities (*liberæ et immunes*, Cic., *Verr.*, iii. 6). The rest paid tithe to the Roman people as landlord. The province was ruled by a prætor sent yearly from Rome. Within the Roman province the new state of things called forth much discontent; but Hieron remained the faithful ally of Rome through a long life. On his death (215) and the accession of his grandson Hieronymos, his dynasty was swept away by the last revolution of Greek Syracuse. The result was revolt against Rome, the great siege by Marcellus, the taking of the city, the addition of Hieron's kingdom to the Roman province. Two towns only, which had taken the Roman side, Tauromenion and Netos, were admitted to the full privileges of Roman alliance (cf. Diod. Fr., Hoeschl., lib. xxiii. p. 18; Cic., *Verr.*, iii. 6, v. 22). Tauromenion indeed was more highly favored than the children of Mamers. Rome had a right to demand ships of Messana, but not of Tauromenion. Some towns were destroyed; the people of Henna were massacred. Akragas, again held for Carthage, was for four years (214-210) the centre of an active campaign. The story of Akragas ended in plunder, slaughter, and slavery; three years later, the story of Agrigentum began.

The reign of Hieron was the last time of independent Greek culture in Sicily. His great works belong to the special history of Syracuse; but his time marks the growth of a new form of local Sicilian genius. The spread of Hellenic culture among the Sikels had in return made a Greek home for many Sikel beliefs, traditions, and customs. Bucolic poetry is the native growth of Sicily; in the hands of Theokritos it grew out of the germs supplied by Epicharmos and Sophron into a distinct and finished form of the art. The poet, himself of Syracuse, went to and fro between the courts of Hieron and Ptolemy Philadelphos; but his poetry is essentially Sicilian. So is that of his successors, both the Syracusan Moschos and Bion of Smyrna, who came to Sicily as to his natural school. The most renowned Sicilian name of this time, that of Archimedes, is hardly distinctively Sicilian. A great name in the history of science, a great name in the local history of Syracuse, he had not, like the earlier philosophers and the bucolic poets, any direct bearing on the general political or intellectual development of the island.

Sicily Roman.

210 B.C.–477 A.D.

Slave revolts.

With the incorporation of the kingdom of Hieron into the Roman province independent Sicilian history comes to an end for many ages. Of the state of Sicily under the Roman commonwealth our chief source of knowledge is the pleading of Cicero against the worst Roman oppressor of Sicily, Gaius Verres. Next in importance to this come those fragments of Diodoros which describe the two insurrections of the slaves. Between these insurrections came the legislation of Rupilius which settled the Roman system of administration in Sicily. Cicero's description comes later than all those; but the general relations between Rome and Sicily seem to have been much the same from the first occupation till the beginning of the empire. In one part of the island the Roman people stepped into the position of Carthage, in another part into that of King Hieron. The allied cities kept their several terms of alliance; the free cities kept their freedom; elsewhere the land paid to the Roman people, according to the law of Hieron, the tithe which it had paid to Hieron. But, as the tithe was let out to publicans, oppression was easy. The prætor, after the occupation of Syracuse, dwelled there in the palace of Hieron, as in the capital of the island. But, as a survival of the earlier state of things, one of his two quæstors was quartered at Lilybaion. Under the supreme dominion of Rome even the unprivileged cities kept their own laws, magistrates, and assemblies, provision being made for suits between Romans and Sicilians and between Sicilians of different cities (*Verr.*, ii. 16). In Latin the one name Siculi takes in all the inhabitants of the island; no distinction is drawn between Greek and Sikel, or even between Greek and Phœnician cities. It is assumed that all Siculi are Greeks (*Verr.*, ii. 3, 29, 49, 52, 65; iii. 37, 40, 73). Even in Greek, Σικελοὶ is now sometimes used instead of Σικελιῶται. All the persons spoken of by Cicero came to have Greek names save—a most speaking exception—Gaius Heius of *Mamertina civitas*. Inscriptions too from Sikel and Phœnician cities are commonly Greek, even when they commemorate men with Phœnician names, coupled perhaps with Greek surnames (*C. I. G.*, iii. 597, cf. 628). The process of Hellenization which had been so long going on had at last made Sicily thoroughly Greek. Roman conquest itself, which everywhere carried a Greek element with it, would help this result. The corn of the fertile island was said even then to feed the Roman people. It was this character of Sicily which led to its one frightful piece of local history. The evils of slavery and the slave trade in their worst form—the slavery of men who are their masters' equals in all but luck—reached their height in the 2d century B.C. The wars of Rome, and the systematic piracy and kidnapping that followed them, filled the Mediterranean lands with slaves of all nations. Sicily stood out before the rest as the first land to be tilled by slave-gangs, on the estates both of rich natives and of Roman settlers. The free population naturally degenerated and died out. The slaves were most harshly treated, and even encouraged by their masters to rob. The land was full of disorder, and the prætors shrank from enforcing the law against offenders, many of whom, as Roman knights, might be their own judges. Of these causes came the two great slave-revolts of the second half of the 2d century B.C. They did not stand alone in the world, but no others reached the same extent. The first outbreak was stained by some excesses, but after that we are struck with the orderly course of the rebellion. It is regular warfare. Sicily had neither native militia nor Roman army; the slaves therefore, strengthened by the poorer freemen, occupied the whole land save only the great cities; they chose kings and founded them a capital. The chosen king of one district submits to the other for the general good. They form armies which could defeat Roman generals, and they are subdued only by efforts on the same scale as the conquest of a kingdom. For most of the slaves were men used to freedom and to arms, and not a few of them Sicilian pirates. The fact that in the first war a slave named Achaios—like Davus, Geta, or Syrus—plays a chief part also tells us a good deal. The Syrian element was large, and the movement was mixed up with much of Syrian religion. But the native deities of Sicily and the holy place of the Palikoi were not forgotten. The first slave war lasted from 135 to 132, the time of Tiberius Gracchus and the fall of Numantia. The second lasted from 102 to 99, the time of the Cimbrian invasion. At other times the power of Rome might have quelled the revolt more speedily.

Later Roman rule in Sicily.

The slave wars were not the only scourge that fell on Sicily. The pirates troubled the coast, and all other evils were outdone by the three years' government of Verres (73–70 B.C.). Besides the light which the great impeachment throws on the state of the island, his administration seems really to have dealt a lasting blow to its prosperity. The slave wars had not directly touched the great cities; Verres plundered and impoverished everywhere. Another blow was the occupation of Messana by Sextus Pompeius in 42 B.C. He was master of Sicily for six years, and Strabo (vi. 2, 4) attributes to this war the decayed state of several cities. To undo this mischief Augustus planted Roman colonies at Syracuse, Tauromenion, Thermæ, Tyndaris, and Katana. The island thus received another Italian infusion; but, as elsewhere, Latin in no way displaced Greek; it was simply set up alongside of it for certain purposes. Roman tastes now came in; Roman buildings, especially amphitheatres, arose. But Sicily never became Roman like Gaul and Spain. The dictator Cæsar designed the Roman, and Marcus Antonius the Latin, franchise for all Sicily; but neither plan was carried out. Sicily remained a province, a province of the senate and people, not of the prince. Particular cities were promoted to higher privileges, and that was all. The Mamertines were Romans in Pliny's day: two free cities, Kentoripa and Segesta, had become Latin; still later, Phœnician Lilybaion received a Roman colony. All these were steps in the progress by which, in Sicily as elsewhere, political distinctions were broken down, till the edict of Antoninus bestowed at least the Roman name—no small gift—on all Roman allies and subjects. Sicily was now part of *Romania*, but it was one of its Greek members.

Till this change was made, Sicily could not be in any sense incorporated with Italy. In the division of Constantine, when the word *province* had lost its meaning, when Italy itself was mapped out into provinces, Sicily became one of these last. Along with Africa, Ræetia (Rhætia), and western Illyricum, it became part of the Italian præfecture; along with the islands of Sardinia and Corsica, it became part of the Italian diocese. It was now ruled by a corrector (see the letter of Constantine, which stands first in the *Codex Diplomaticus Siciliæ* of Johannes), afterwards by a consular under the authority of the vicar of the Roman city (*Not. Imp.*, 14, 5). Few emperors visited Sicily; Hadrian was there, as everywhere, and Julian also (*C. D.*, 10). In its provincial state Sicily fell back more than some other provinces. Ausonius could still reckon Catina and fourfold Syracuse ("quadruplices Syracusas") among noble cities; but Sicily is not, like Gaul, rich in relics of later Roman life, and it is now Egypt rather than Sicily that feeds Rome. The island has no internal history beyond a very characteristic fact, a third slave war in the days of Gallienus. External history there could be none in the central island, with no frontier open to Germans or Persians. Sicilian history begins again when the wandering of the nations planted new powers, not on the frontier of the empire, but at its heart.

Teutonic masters.

The powers between which Sicily now passes to and fro are Teutonic powers. The earlier stages of Teutonic advance could not touch Sicily. Alaric thought of a Sicilian expedition, but a storm hindered him. Sicily was to be reached only by a Teutonic power which made its way through Gaul, Spain, and Africa. The Vandal now dwells at Carthage instead of the Canaanite. Gaiseric (Genseric) (429–477) subdued the great islands for which Roman and Phœnician had striven. Along with Sardinia, Corsica, and the Balearic Isles, Sicily is again in possession of a naval power at Carthage. Gaiseric, at Rome more than a Hannibal, makes a treaty with Odowakar (Odoacer) almost like that which ended the First Punic War. He gave up (Victor Vitensis, i. 4) the island on condition of a tribute, which was hardly paid by Theodoric. Sicily was now ruled by a Gothic count, and the Goths claimed to have treated the land with special tenderness (Procopius, *Bell. Goth.*, iii. 16). The island, like the rest of Theodoric's dominions, was certainly well looked after by the great king and his minister; yet we hear darkly of disaffection to Gothic rule (Cass., *Var.*, i. 3). Theodoric gave back Lilybaion to the Vandal king Thrasamund as the dowry of his sister Analafrida (Proc., *Bell. Vand.*, i. 8). Yet Lilybaion was a Gothic possession when Belisarius, conquerer of Africa, demanded it in vain as part of the Vandal possessions (Proc., *Bell. Vand.*, ii. 5; *Bell. Goth.*, i. 3). In the Gothic war Sicily was the first land to be recovered for the empire, and that with the good will of its people (535). Panormus alone was stoutly defended by its Gothic garrison. In 550 Totila took some fortresses, but the great cities all withstood him and the Goths were driven out the next year.

Sicily under the Eastern empire.

Sicily was thus won back to the Roman dominion, but the seat of the Roman dominion was now at Constantinople. Belisarius was Pyrrhos and Marcellus in one. For 430 years some part of Sicily, for 282 years the whole of it, again remained a Roman province. To the Gothic count again succeeded, under Justinian, a Roman *prætor*, in Greek στρατηγός. That was the official title; we often hear of a *patrician* of Sicily, but patrician was in strictness a personal rank. In the later mapping out of the empire into purely military divisions, the *theme* (θέμα) of Sicily took in both the island and the nearest peninsula of the mainland, the oldest Italy. The island itself was divided for financial purposes, almost as in the older times, into the two divisions of Syracuse and Lilybaion. The revolutions of Italy hardly touched a land which looked steadily to the eastern Rome as its head. The Lombard and Frankish masters of the peninsula never fixed themselves in the island. When the Frank took the imperial crown of the West, Sicily still kept its allegiance to the Augustus who reigned at Constantinople, and was only torn away piecemeal from the empire by the next race of conquerors.

Ecclesiastical relations with Italy.

This connection of Sicily with the eastern division of the empire no doubt largely helped to keep up Greek life in the island. This was of course strengthened by union with a power which had already a Greek side, and where the Greek side soon became dominant. Still the connection with Italy was close, especially the ecclesiastical connection. Some things tend to make Sicily look less Greek than it really was. The great source of our knowledge of Sicily in the century which followed the reconquest by Belisarius is the *Letters* of Pope Gregory the Great, and they naturally show the most Latin side of things. The merely official use of Latin was, it must be remembered, common to Sicily with Constantinople. Gregory's *Letters* are largely occupied with the affairs of the great Sicilian estates held by the Roman Church, as by the churches of Milan and Ravenna. But they deal with many other matters (see the collection in Johannes, *C.D.*, where the letters bearing on Sicily are brought together, or the usual collection of his letters). Saint Paul's visit to Syracuse naturally gave rise to many legends; but the Christian Church undoubtedly took early root in Sicily. We hear of Manichæans (*C.D.*, 163); Jews were plentiful, and Gregory causes compensation to be made for the unlawful destruction of synagogues. Of paganism we find no trace, save that pagan slaves, doubtless not natives of the island, were held by Jews (*C.D.*, 127). Herein is a contrast between Sicily and Sardinia, where, according to a letter from Gregory to the empress Constantina, wife of Maurice (594–595), praying for a lightening of taxation in both islands, paganism still lingered (*C.D.*, 121). Sicily belonged to the Latin patriarchate; but we already (*C.D.*, 103) see glimmerings of the coming disputes between the Eastern and Western Churches. Things were changed when, in the early days of the iconoclast controversy, Leo the Isaurian confiscated the Sicilian and Calabrian estates of the Roman Church (Theoph., i. 631).

477–828.

In the 9th, 10th, and 11th centuries the old drama of Sicily was acted again. The island is again disputed between Europe and Asia, transplanted to Africa between Greek and Semitic dwellers on her own soil. Panormus and Syracuse are again the headquarters of races and creeds, of creeds yet more than of races. The older religious differences—not small certainly when the choice lay between Zeus and Moloch—were small compared with the strife for life and death between Christendom and Islam. Gregory and Mahomet were contemporaries, and, though Saracen occupation did not begin in Sicily till more than two centuries after Gregory's death, Saracen inroads began much sooner. In 655 (Theoph., i. 532) part of Sicily was plundered, and its inhabitants carried to Damascus. Then came the strange episode of the visit of Constans the Second (641–668), the first emperor, it would seem, who had set foot in Sicily since Julian. After a war with the Lombards, after twelve days' plunder of Rome, he came on to Syracuse, where his oppressions led to his murder in 668. Sicily now saw for the first time the setting up of a tyrant in the later sense. Meketios, commander of the Eastern army of Constans, revolted, but Sicily and Roman Italy kept their allegiance to the new emperor Constantine Pogonatos, who came in person to destroy him. Then came another Saracen inroad from Alexandria, in which Syracuse was sacked (Paul. Diac., v. 13). Others followed, but there was as yet no lasting settlement. Towards the end of the 8th century, though Sicily itself was untouched, its patricians and their forces play a part in the affairs of southern Italy as enemies of the Frankish power. Charles himself was believed (Theoph., i. 736) to have designs on Sicily; but, when it came to Saracen invasion, the sympathies of both pope and Cæsar lay with the invaded Christian land (*Mon. Car.*, 323, 328).

Early Saracen inroads.

Saracen conquest.

In 813 a peace for ten years was made between the Saracens and the patrician Gregory. A few years after it expired Saracen settlement in the island begins. This was a special time of Saracen inroad on the islands belonging to the Eastern empire. Almost at the same moment Crete was seized by a band of adventurers from Spain. But the first Saracen settlers in Sicily were the African neighbors of Sicily, and they were called to the work by a home treason. The story has been tricked out with many romantic details (*Chron. Salern.*, 60, ap. Pertz, iii. 498; Theoph. Cont., ii. 272; George Kedrenos, ii. 97); but it seems plain that Euphemios or

Euthymios of Syracuse, supported by his own citizens, revolted against Michael the Stammerer (820–829), and, when defeated by an imperial army, asked help of Ziyádet Allah, the Aghlabite prince of Kairawán, and offered to hold the island of him. The struggle of 138 years now began. Euphemios, a puppet emperor, was led about by his Saracen allies much as earlier puppet emperors had been led about by Alaric and Ataulf, till he was slain in one of the many sieges. The second Semitic conquest of Sicily began in 827 at Mazzara on the old border of Greek and Phœnician. But the land had a brave defender in the patrician Theodotos, and the invaders met with a stout resistance both in the island and from armies both from Constantinople and from Byzantine Italy. The advance of the invaders was slow. In two years all that was done was to occupy Mazzara and Mineum—the old Menai of Douketios—strange points certainly to begin with, and seemingly to destroy Agrigentum, well used to destruction. Attacks on Syracuse failed; so did attacks on Henna—*Castrum Ennæ*, now changing into *Castrum Johannis* (perhaps Καστροιάννη), Castrogiovanni. The actual gain was small; but the invaders took seizin alike of the coast and of the island.

829-1060.

A far greater conquest followed when new invaders came from Spain and when Theodotos was killed in 830. The next year Panormus passed away forever from Roman, for 230 years from Christian, rule. Syracuse was for fifty years, not only as of old, the bulwark of Europe, but the bulwark of Christendom. By the conquest of Panormus the Saracens were firmly rooted in the island. We hear dimly of treasonable dealings with them on the part of the *strategos* Alexios, son-in-law of the emperor Theophilos; but we see more clearly that Saracen advance was largely hindered by dissensions between the African and Spanish settlers. In the end the Moslem conquests in Sicily became an Aghlabite principality owning at best a formal superiority in the princes of Kairawán. With the Saracen occupation begins a new division of the island, which becomes convenient in tracing the progress of Saracen conquest. This is into three valleys, known in later forms of language as Val di Mazzara or Mazza in the northwest, Val di Noto in the southeast, and Val Demone (a name of uncertain origin) in the northeast (see Amari, *Musulmani in Sicilia*, i. 465). The first Saracen settlement of Val di Mazzara answers roughly to the old Carthaginian possessions. From Panormus the emir or lord of Sicily, Mohammed ibn Abdallah, sent forth his plunderers throughout Sicily and even into southern Italy. There, though they made no lasting settlements, they often occupied particular points. A consul or duke of Naples in 836 even asked for Saracen help against the Lombards, which he is said to have repaid by help against his fellow-subjects in Sicily (Johan. Diac., 57; Amari, i. 314).

The chief work of the next ten years was the conquest of the Val di Noto, but the first great advance was made elsewhere. In 843 the Saracens won the Mamertine city, Messana, and thus stood in the path between Italy and Sicily. Then the work of conquest, as described by the Arabic writers, went on, but slowly. At last, in 859, the very centre of the island, the stronghold of Henna, was taken, and the main part of Val di Noto followed. But the divisions among the Moslems helped the Christians; they won back several towns, and beat off all attacks on Syracuse and Tauromenium. It is strange that the reign of Basil the Macedonian (867), a time of such renewed vigor in the empire, was the time of the greatest of all losses in Sicily. In Italy the imperial frontier largely advanced; in Sicily imperial fleets threatened Panormus. But in 875 the accession of Ibráhím ibn Ahmed in Africa changed the face of things. The emir in Sicily, Ja'far ibn Ahmed, received strict orders to act vigorously against the eastern towns. In 877 began the only successful Semitic siege of Syracuse. The next year the city, which for 1600 years had been the seat of Greek, Roman and Christian life, passed for the first time under the yoke of strangers to the fellowship of Europe.

Thus in fifty-one years the imperial and Christian territory in Sicily was cut down to a few points on or near the eastern coast, to the Val Demone in short without Messana. But between Moslem dissension and Christian valor the struggle had still to be waged for eighty-seven years. Henna had been the chief centre of Christian resistance a generation earlier; its place was now taken by the small fort of Rametta not far from Messina. The Moslems of Sicily were busy in civil wars; Arabs fought against Berbers, both against the African overlord. In 900 Panormus had to be won by a son of Ibráhím from Moslem rebels provoked by his father's cruelty. But when Ibráhím himself came into Sicily, renewed efforts against the Christians led to the first taking of Tauromenium (908), of Rametta, and of other points. The civil war that followed his death, the endless revolutions of Agrigentum, where the weaker side did not scruple to call in Christian help, hindered any real Saracen occupation of eastern Sicily. The emperors never gave up their claims to Sicily or their hopes of recovering it. Besides the struggle with the Christians in the island, there was often direct warfare between the empire and the Saracens; but such warfare was more active in Italy than in Sicily. In 956 a peace or truce was made by the emperor Constantine Porphyrogenitus. A few years later, Otho the Great, the restorer of the Western empire, looked to Sicily as a land to be won back for Christendom. It had not yet wholly passed away; but the day soon came. Strange to say, as Syracuse fell in the reign of Basil the Macedonian, the Saracen occupation was completed in the reign of Nikephoros Phokas (Nicephorus Phocas), the deliverer of Crete. In the very year of his accession (963) Tauromenium was taken for the second time, and became for a hundred years a Mohammedan possession. Rametta alone held out. A fleet and army from Constantinople went in vain to its help: the last stronghold of Christendom was taken (965), and for a season all was over.

Reconquest by Eastern empire.

Thus in 138 years the Arab did what the Canaanite had never done. The whole island was a Semitic, that is now a Mohammedan, possession. The Greek-speaking Roman of Sicily was a bondman in his own land, like the Latin-speaking Roman of Spain. Yet, the complete Saracen possession of Sicily may seem a thing of a moment. Its first and longest period lasted only 73 years. In that time Mohammedan Sicily was threatened by a Western emperor; the Arabic writers claim the Saracen army by which Otho the Second was beaten back in 982 as a Sicilian army. A mightier enemy was threatening in the East. Basil the Second planned the recovery of Sicily in good earnest. In 1027 he sent a great army; but his death stopped their progress before they reached the island. But the great conqueror had left behind him men trained in his school, and eleven years later the eagles of the new Rome again marched to Sicilian victories. The ravages of the Sicilian Saracens in the Greek islands were more frightful than ever, and George Maniakes, the first captain of his time, was sent to win back the lost land. He too was helped by Saracen dissensions. The emir Abul-afar became a Roman vassal, and, like Alaric of old, became *magister militum* in the Roman army. His brother and rival Abu-hafas brought help from Africa; and finally all joined against the Christians. Four years of Christian victory (1038–1042) followed. In the host of Maniakes were men of all races,—Normans, who had already begun to show themselves in south Italy, and the Warangian guard, the best soldiers of the empire, among whom Harold Hardrada himself is said to have held a place. Town after town was delivered, first Messana, then Syracuse, then a crowd of others. The exact extent of the reconquest is uncertain; Byzantine writers claim the deliverance of the whole island; but it is certain that the Saracens never lost Panormus. But court influence spoiled everything: Maniakes was recalled; under his successor Stephen, brother-in-law of the emperor Michael, the Saracens won back what they had lost. Messana alone held out, for how long a time is uncertain. But it could not have been again under the yoke for many years when a conqueror came who had no empresses to thwart him. The second Saracen occupation of all Sicily was short indeed. In 1060 began the thirty years' work of the first Roger.

Sicily under Saracen rule.

Thus for 263 years the Christian people of some part or other of Sicily were in subjection to Moslem masters. But that subjection differed widely in different times and places. The land was won bit by bit. One town was taken by storm; another submitted on terms harsher or more favorable. The condition of the Christians varied from that of personal slaves to that of communities left free on the payment of tribute. The great mass were in the intermediate state usual among the non-Mohammedan subjects of a Mohammedan power. The *dhimmí* of Sicily were in essentially the same case as the *rayahs* of the Turk. While the conquest was going on, the towns that remained unconquered gained in point of local freedom. They became allies rather than subjects of the distant emperor. So did the tributary districts, as long as the original terms were kept. But, as ever, the condition of the subject race grew worse. After the complete conquest of the island, while the mere slaves had turned Mohammedans, there is nothing more heard of tributary districts. At the coming of the Normans the whole Christian population was in the state of *rayahs*. Still Christianity and the Greek tongue never died out; churches and monasteries received and held property; there still are saints and men of learning. Panormus was specially Saracen; yet a Christian religious guild could be founded there in 1048 (*Tabularium Regiæ Cap. Panorm.*, p. 1). We have its Greek foundation deed. It would be rash to deny that traces of other dialects may not have lingered on; but Greek and Arabic were the two written tongues of Sicily when the Normans came. The Sicilian Saracens were hindered by their internal feuds from ever becoming a great power; but they stood high among Mohammedan nations. Their advance in civilization is shown by their position under the Normans, and above all by their admirable style of architecture (see PALERMO). Saracens are always called in for any special work of building or engineering. They had a literature which Norman kings studied and promoted. The Normans in short came into the inheritance of the two most civilized nations of the time, and they allowed the two to flourish side by side.

Norman conquest.

The most brilliant time for Sicily as a power in the world begins with the coming of the Normans. Never before or after was the island so united or so independent. Some of the old tyrants had ruled out of Sicily; none had ruled over all Sicily. The Normans held all Sicily as the centre of a dominion which stretched far beyond it. The conquest was the work of one man, Count Roger of the house of Hauteville, brother of the more famous Robert Wiscard (Guiscard). That it took him thirty years was doubtless owing to his being often called off to help his brother in Italy and beyond Hadria. The conquests of the Normans in Italy and Sicily form part of one enterprise; but they altogether differ in character. In Italy they overthrew the Byzantine dominion; their own rule was perhaps not worse; but they were not deliverers. In Sicily they were everywhere welcomed by the Christians as deliverers from infidel bondage.

As in the Saracen conquest of Sicily, as in the Byzantine recovery, so in the Norman conquest, the immediate occasion was given by a home traitor. Count Roger had already made a plundering attack, when Becumen of Catania, driven out by his brother, urged him to serious invasion. Messina was taken in 1060, and became for awhile the Norman capital. The Christians everywhere welcomed the conqueror. But at Traina they presently changed their minds, and joined with the Saracens to besiege the count in their citadel. At Catania Becumen was set up again as Roger's vassal, and he did good service till he was killed. Roger soon began to fix his eye on the Saracen capital. Against that city he had Pisan help, as the inscription on the Pisan *duomo* witnesses (cf. Geoff. Mal., ii. 34). But Palermo was not taken until 1071, and then only by the help of Duke Robert, who kept the prize to himself. Still its capture was the turning-point in the struggle. Taormina (Tauromenium) was won in 1078. Syracuse, under its emir Benarvet, held out stoutly. He won back Catania by the help of a Saracen to whom Roger had trusted the city, and whom he himself punished. Catania was won back by the count's son Jordan. But progress was delayed by Jordan's rebellion and by the absence of Roger in his brother's wars. At last, in 1085, Syracuse was won. Next year followed Girgenti and Castrogiovanni, whose chief became a Christian. Noto, the Saracen Rametta, held out till 1090. Then the whole island was won, and Roger completed his conquest by a successful expedition to Malta.

1060-1090.

Saracens under Norman rule.

Like the condition of the Greeks under the Saracens, so the condition of the Saracens under the Normans differed in different places, according to the circumstances of each conquest. The Mohammedan religion was everywhere tolerated, in many places much more. But it would seem that, just as under the Moslem rule, conversions from Christianity to Islam were forbidden. On the other hand, conversions from Islam to Christianity were not always encouraged; Saracen troops were employed from the beginning, and Count Roger seems to have thought them more trustworthy when unconverted. At Palermo the capitulation secured to the Saracens the full enjoyment of their own laws; Girgenti was long mainly Saracen; in Val di Noto the Saracens kept towns and castles of their own. On the other hand, at Messina there were few or none, and we hear of both Saracen and Greek villains, the latter doubtless abiding as they were in Saracen times. But men of both races were trusted and favored according to their deserts. The ecclesiastical relations between Greeks and Latins are harder to trace. At the taking of Palermo the Greek bishop was restored; but his successors were Latins, and Latin prelates were placed in the bishoprics which Count Roger founded. Urban the Second visited Sicily to promote the union of the church, and he granted to the count those special ecclesiastical powers held by the counts and kings of Sicily as hereditary legates of the Holy See which grew into the famous Sicilian monarchy (Geoff. Mal., iv. 29). But Greek worship went on; at Messina it lingered till the 14th and 15th centuries (Pirro, *Sicilia Sacra*, i. 420, 431, 449), as it has been since brought back by the Albanian colonists. But the Greeks of Sicily have long been united Greeks, admitting the authority of the see of Rome.

Linguistic elements in Sicily.

In its results the Norman conquest of Sicily was a Latin conquest far more thorough than that which had been made by the Roman commonwealth. The Norman princes protected all the races, creeds, and tongues of the island, Greek, Saracen, and Jew. But new races came to settle alongside of them, all of whom were Latin as far as their official speech was concerned. The Normans brought the French tongue with them; it remained the court speech during the 12th century, and Sicily was thrown open to all speakers of French, many of whom came from England. There was con-

1090-1197.

stant intercourse between the two great islands, both ruled by Norman kings, and many natives of England filled high places in Sicily. But French was only a language of society, not of business or literature. The languages of inscriptions and documents are Greek, Arabic, and Latin, in private writings sometimes Hebrew. The kings understood Greek and Arabic, and their deeds and works were commemorated in both tongues. Hence comes the fact, at first sight so strange, that Greek, Arabic, and French have all given way to a dialect of Italian. But the cause is not far to seek. The Norman conquest opened Sicily to settlers from Italy, above all from the Norman possessions in Italy. Under the name of Lombards they became an important, in some parts a dominant, element. Thus at Messina where we hear nothing of Saracens, we hear much of the disputes between Greeks and Lombards. The Lombards had hardly a distinct language to bring with them, At the time of the conquest, it was already found out that French had become a distinct speech from Latin; Italian hardly was such. The Lombard element, during the Norman reign, shows itself, not in whole documents or inscriptions, but in occasional words and forms, as in some of the mosaics at Monreale. And if any element, Latin or akin to Latin, had lingered on through Byzantine or Saracen rule, it would of course be attracted to the new Latin element, and would help to strengthen it. It was this Lombard element that had the future before it. Greek and Arabic were antiquated, or at least isolated, in a land which Norman conquest had made part of Western Europe and Latin Christendom. They could grow only within the island; they could gain no strength from outside. Even the French element was in some sort isolated, and later events made it more so. But the Lombard element was constantly strengthened by settlement from outside. In the older Latin conquest, the Latin carried Greek with him, and the Greek element absorbed the Latin. Latin now held in western Europe the place which Greek had held there. Thus, in the face of Italian, both Greek and Arabic died out. Step by step, Christian Sicily became Latin in speech and in worship. But this was not till the Norman reigns were over. Till the end of the 12th century Sicily was the one land where men of divers creeds and tongues could live side by side, each in his own way.

Hence came both the short-lived brilliancy of Sicily and its later decay. In Sicily there were many nations all protected by the Sicilian king; but there was no Sicilian nation. Greek, Saracen, Norman, Lombard, and Jew could not be fused into one people; it was the boast of Sicily that each kept his laws and tongue undisturbed. Such a state of things could live on only under an enlightened despotism; the discordant elements could not join to work out really free and national institutions. Sicily had parliaments, and some constitutional principles were well understood. But they were assemblies of barons, or at most of barons and citizens; they could only have represented the Latin elements, Norman and Lombard in the island. The elder races, Greek and Saracen, stand outside the relations between the Latin king and his Latin subjects. Still, as long as Greek and Saracen were protected and favored, so long was Sicily the most brilliant of European kingdoms. But its greatness had no ground-work of national life; for lack of it the most brilliant of kingdoms presently sank below the level of other lands.

Roger I.

Four generations only span the time from the birth of Count Roger, about 1030, to the death of the emperor Frederick the Second in 1250. Roger, great count of Sicily, was, at his death in 1101, succeeded by his young son Simon, and he in 1105 by the second Roger, the first king. He inherited all Sicily, save half Palermo—the other half had been given up—and part of Calabria. The rest of Palermo was soon granted; the Semitic capital became the abiding head of Sicily. On the death of Duke William of Apulia, Roger gradually founded (1127–40) a great Italian dominion. To the Apulian duchy he added (1136) the Norman principality of Capua, Naples (1138), the last dependency of the Eastern empire in Italy, and (1140) the Abruzzi, an undoubted land of the Western empire. He thus formed a dominion which has been divided, united, and handed over from one prince to another, oftener than any other state in Europe, but whose frontier has hardly changed at all. In 1130 Roger was crowned at Palermo, by authority of the antipope Anacletus, taking the strange title of "king of Sicily and Italy." This, on his reconciliation with Pope Innocent the Second, he exchanged for "king of Sicily and of the duchy of Apulia and of the principality of Capua." By virtue of the old relations between the popes and the Normans of Apulia, he held his kingdom in fief of the Holy See, a position which on the whole strengthened the royal power. But his power, like that of Dionysios and Agathokles, was felt in more distant regions. His admiral, George of Antioch, Greek by birth and creed, warred against the Eastern empire, won Corfu (Korypho; the name of Korkyra is forgotten) for a season, and carried off the silk-workers from Thebes and Peloponnesos to Sicily. But Manuel Komnenos (Comnenus) ruled in the East, and if Roger threatened Constantinople, Manuel threatened Sicily. In Africa the work of Agathokles was more than renewed; Mahadia and other points were won and kept as long as Roger lived. These exploits won him the name of the terror of Greeks and Saracens. To the Greeks and still more to the Saracens of his own island he was a protector and something more.

William I. and II.

Roger's son William, surnamed the Bad, was crowned in his father's lifetime in 1151. Roger died in 1154, and William's sole reign lasted till 1166. It was a time of domestic rebellions, chiefly against the king's unpopular ministers, and it is further marked by the loss of Roger's African conquests. After William the Bad came (1166–1189) his son William the Good. Unlike as were the two men in themselves, in their foreign policy they are hardly to be distinguished. The Bad William has a short quarrel with the pope; otherwise Bad and Good alike appear as zealous supporters of Alexander the Third and as enemies of both empires. The Eastern warfare of the Good is stained by the frightful sack of Thessalonica; it is marked also by the formation of an Eastern state under Sicilian supremacy (1186). Corfu, the possession of Agathokles and Roger, with Durazzo, Cephalonia, and Zante, was granted by William to his admiral Margarito with the strange title of king of the Epeirots. He founded a dynasty, though not of kings, in Cephalonia and Zante. Corfu and Durazzo were to be more closely connected with the Sicilian crown.

Tancred.

William III.

The brightest days of Sicily ended with William the Good. His marriage with Joanna, daughter of Henry of Anjou and England, was childless, and William tried to procure the succession of his aunt Constance and her husband, King Henry the Sixth of Germany, son of the emperor Frederick the First. But the prospect of German rule was unpopular, and on William's death the crown passed to Tancred, an illegitimate grandson of King Roger who figures in English histories in the story of Richard's crusade. In 1191 Henry, now emperor, asserted his claims; but, while Tancred lived he did little, in Sicily nothing, to enforce them. On the death of Tancred (1194) and the accession of his young son William the Third, the emperor came and conquered Sicily and the Italian possessions, with an amount of cruelty which outdid any earlier war or revolution. First of four Western emperors who wore the Sicilian crown, Henry died in 1197, leaving the kingdom to his young son Frederick, heir of the Norman kings through his mother.

The great days of the Norman conquest and the Norman reigns have been worthily recorded by contemporary historians. For few times have we richer materials. The oldest is Aimé or Amato of Monte Cassino, who exists only in an Old-French translation. We have also for the Norman conquest the halting hexameters of William of Apulia, and for the German conquest the lively and partial verses of Peter of Eboli. Of prose writers we have Geoffrey Malaterra, Alexander abbot of Telesia, Romuald archbishop of Salerno, Falco of Benevento, above all Hugo Falcandus, one of the very foremost of mediæval writers. Not one of these Latin writers was a native of the island, and we have no record from any native Greek. Occasional notices we of course have in the Byzantine writers, and Archbishop Eustathios's account of the taking of Thessalonica is more than occasional. And the close connection between Sicily and England leads to many occasional references to Sicilian matters in English writers.

The relations between the various races of the islands are most instructive. The strong rule of Roger kept all in order. He called himself the defender of Christians; others, on account of his favor to the Saracens, spoke of him as a pagan. He certainly encouraged Saracen art and literature in every shape. His court was full of eunuchs, of whom we hear still more under William the Bad. Under William the Good the Saracens, without any actual oppression, seem to be losing their position. Hitherto they had been one element in the land, keeping their own civilization alongside of others. By a general outbreak on the death of William the Good, the Saracens, especially those of Palermo, were driven to take shelter in the mountains, where they sank into a wild people, sometimes holding points of the island against all rulers, sometimes taking military service under them. The Jews too begin to sink into bondmen. Sicily is ceasing to be the land of many nations living side by side on equal terms.

Emperor Frederick II.

The Germans who helped Henry to win the Sicilian crown did not become a new element in the island, but only a source of confusion during the minority of his son. Frederick—presently to be the renowned emperor Frederick the Second, "Fridericus stupor mundi et immutator mirabilis"—was crowned at Palermo in 1198; but the child, deprived of both parents, was held to be under the protection of his lord Pope Innocent the Third. During his minority the land was torn in pieces by turbulent nobles, revolted Saracens, German captains seeking settlements, the maritime cities of Italy and professed French deliverers. In 1210 the emperor Otho the Fourth, who had overrun the continental dominions, threatened the island. In 1212, just when Frederick was reaching an age to be of use in his own kingdom, he was called away to dispute the crown of Germany and Rome with Otho. Eight years more of disorder followed; in 1220 the emperor-king came back. He brought the Saracens of the mountains back again to a life in plains and cities, and presently planted a colony of them on the mainland at Nocera, when they became his most trusty soldiers. His necessary absences from Sicily led to revolts. He came back in 1233 from his crusade to suppress a revolt of the eastern cities, which seem, like those of Italy, to have been aiming at republican independence. A Saracen revolt in 1243 is said to have been followed by a removal of the whole remnant to Nocera. Some however certainly stayed or came back; but their day was over.

Under Frederick the Italian or Lombard element finally prevailed in Sicily. Of all his kingdoms Sicily was the best beloved. He spoke all its tongues; he protected, as far as circumstances would allow, all its races. He legislated for all in the spirit of an enlightened and equal despotism, jealous of all special privileges, whether of nobles, churches or cities. The heretic alone was persecuted; he was the domestic rebel of the church; Saracen and Jew were entitled to the rights of foreigners. Yet Frederick, patron of Arabic learning, suspected even of Moslem belief, fails to check the decline of the Saracen element in Sicily. The Greek element has no such forces brought against it. It is still a chief tongue of the island, in which Frederick's laws are put forth as well as in Latin. But it is clearly a declining element. Greek and Saracen were both becoming survivals in an island which was but one of the many kingdoms of its king. No wonder that the Italian element advanced at the cost of all others. Frederick chose it as the court speech of Sicily, and he made it more than a court speech, the speech of a new-born literature. Sicily, strangely enough, became the cradle of Italian song.

1197-1282.

Two emperors had now held the Sicilian crown. On Frederick's death in 1250 the crown passed to his son Conrad, not emperor indeed, but king of the Romans. He was nominally succeeded by his son Conradin. The real ruler under both was Frederick's natural son Manfred. In 1258, on a false rumor of the death of Conradin, Manfred was himself crowned king at Palermo. He had to found the kingdom afresh. Pope Innocent the Fourth had crossed into Sicily to take advantage of the general discontent. The cities, whose growing liberties had been checked by Frederick's legislation, strove for practical, if not formal, independence, sometimes for dominion over their fellows. The 5th century B.C. seemed to have come back. Messina laid waste the lands of Taormina, because Taormina would not obey the bidding of Messina. Yet, among these and other elements of confusion, Manfred succeeded in setting up again the kingly power, first for his kinsmen and then for himself. His reign continued that of his father, so far as a mere king could continue the reign of such an emperor. The king of Sicily was the first potentate of Italy, and came nearer than any prince since Louis the Second to the union of Italy under Italian rule. He sought dominion too beyond Hadria; Corfu, Durazzo and a strip of the Albanian coast became Sicilian possessions as the dowry of Manfred's Greek wife. But papal enmity was too much for him. His overlord claimed to dispose of his crown, and hawked it about among the princes of the West. Edmund of England bore the Sicilian title for a moment. More came of the grant of Urban the Fourth (1264) to Charles, count of Anjou, and through his wife sovereign count of Provence. Charles, crowned by the pope in 1266, marched to take possession of his lord's grant. Manfred was defeated and slain at Benevento. The whole Sicilian kingdom became the spoil of a stranger who was no deliverer to any class of its people. The island sank yet lower. Naples, not Palermo, was the head of the new power; Sicily was again a province. But a province Sicily had no mind to be. In the continental lands Charles founded a dynasty; the island he lost after sixteen years. His rule was not merely the rule of a stranger king surrounded by stranger followers; the degradation of the island was aggravated by gross oppression, grosser than in the continental lands. The continental lands submitted, with a few slight efforts at resistance. The final result of the Angevin conquest of Sicily was its separation from the mainland.

Manfred.

Charles of Anjou.

Sicilian feeling was first shown in the support given to the luckless expedition of Conradin in 1268. Frightful executions in the island followed his fall. The rights of the Swabian house were now held to pass to Peter (Pedro), king of Aragon, husband of Manfred's daughter Constance. The connection with Spain, which has so deeply affected the whole later history of Sicily, now begins. Charles held the Greek possessions of Manfred and had designs both on Epeiros and on Constantinople. The emperor Michael Palaiologos and Peter of Aragon became allies against Charles; the famous John of Procida acted as an agent between them; the costs of Charles's Eastern warfare caused great discontent, especially in an island where some might still look to the Greek emperor as a natural deliverer. Peter and Michael were doubtless watching the turn of things in Sicily; but the tale of a long-hidden conspiracy between them and the whole Sicilian people has been set aside by Amari. The actual outbreak of 1282, the famous Sicilian Vespers, was stirred up by the wrongs of the moment. A gross case of insult offered by a Frenchman to a Sicilian woman led to the massacre at Palermo, and the like scenes followed elsewhere. The strangers were cut off; Sicily was left to its own people. The towns and districts left without a ruler by no means designed to throw off the authority of the overlord; they sought the good will of Pope Martin. But papal interests were on the side of Charles; and he went forth with the blessing of the church to win back his lost kingdom.

1282-1735.

Angevin oppression had brought together all Sicily in a common cause. There was at last a Sicilian nation, a nation for a while capable of great deeds. Sicily now stands out as a main centre of European politics. But the land has lost its character; it is becoming the plaything of powers, instead of the meeting place of nations. The tale, true or false, that Frenchmen and Provençals were known from the natives by being unable to frame the Italian sound of *c* shows how thoroughly the Lombard tongue had overcome the other tongues of the island. In Palermo, once a city of threefold speech, a Greek, a Saracen, a Norman, who clave to his own tongue must have died with the strangers.

Peter of Aragon.

Charles was now besieging Messina; Sicily seems to have put on some approach to the form of a federal commonwealth. Meanwhile Peter of Aragon was watching and preparing. He now declared himself. To all, except the citizens of the great cities, a king would be acceptable; Peter was chosen with little opposition in a parliament at Palermo, and a struggle of twenty-one years began, of which Charles and Peter saw only the first stage. In fact, after Peter had helped the Sicilians to relieve Messina, he was very little in Sicily; he had to defend his kingdom of Aragon, which Pope Martin had granted to another French Charles. He was represented by Queen Constance, and his great admiral Roger de Loria kept the war away from Sicily, waging it wholly in Italy, and making Charles, the son of King Charles, prisoner. In 1285 both the rival kings died. Charles had before his death been driven to make large legislative concessions to his subjects to stop the tendency shown, especially in Naples, to join the revolted Sicilians. By Peter's death Aragon and Sicily were separated; his eldest son Alphonso took Aragon, and his second son James took Sicily, which was to pass to the third son Frederick, if James died childless. James was crowned, and held his reforming parliament also. With the popes no terms could be made. Charles, released in 1288 under a deceptive negotiation, was crowned king of Sicily by Honorius; but he had much ado to defend his continental dominions against James and Roger. In 1291 James succeeded Alphonso in the kingdom of Aragon, and left Frederick not king, according to the entail, but only his lieutenant in Sicily.

James.

Frederick.

Frederick was the real restorer of Sicilian independence. He had come to the island so young that he felt as a native. He defended the land stoutly, even against his brother. For James presently played Sicily false. In 1295 he was reconciled to the church and released from all French claims on Aragon, and he bound himself to restore Sicily to Charles. But the Sicilians, with Frederick at their head, disowned the agreement, and in 1296 Frederick was crowned king. He had to defend Sicily against his brother and Roger de Loria, who forsook the cause, as did John of Procida. Hitherto the war had been waged on the mainland; now it was transferred to Sicily. King James besieged Syracuse as admiral of the Roman Church; Charles sent his son Robert in 1299 as his lieutenant in Sicily, where he gained some successes. But in the same year the one great land battle of the war, that of Falconaria, was won for Sicily. The war, chiefly marked by another great siege of Messina, went on till 1302, when both sides were thoroughly weakened and eager for peace. By a treaty, confirmed by Pope Boniface the next year, Frederick was acknowledged as king of Trinacria for life. He was to marry the daughter of the king of Sicily, to whom the island kingdom was to revert at his death. The terms were never meant to be carried out. Frederick again took up the title of king of Sicily, and at his death in 1337 he was succeeded by his son Peter. There were thus two Sicilian kingdoms and two kings of Sicily. The king of the mainland is often spoken of for convenience as king of Naples, but that description was never borne as a formal title save in the 16th century by Philip, king of England and Naples, and in the 19th by Joseph Bonaparte and Joachim Murat. The strict distinction was between Sicily on this side the Pharos (of Messina) and Sicily beyond it.

Peter.

Thus the great island of the Mediterranean again became an independent power. And, as far as legislation could make it, Sicily became one of the freest countries in Europe. By the laws of Frederick parliaments were to be regularly held, and without their consent the king could not make war, peace, or alliance. The treaty of 1302 was not confirmed by parliament, and in 1337 parliament called Peter to the crown. But Sicily never rose to the greatness of its Greek or its Norman days, and its old character had passed away. Of Greeks and Saracens we now hear only as a degraded remnant, to be won over, if it may be, to the Western Church. The kingdom had no foreign possessions; yet faint survivals of the days of Agathokles and Roger lingered on. The isle of Gerba off the African coast was held for a short time, and traces of the connection with Greece went on in various shapes. If the kings of Sicily on this side the Pharos kept Corfu down to 1386, those beyond the Pharos became in 1311 overlords of Athens, when that duchy was seized by Catalan adventurers, disbanded after the wars of Sicily. In 1530 the Sicilian island of Malta became the shelter of the Knights of Saint John driven by the Turk from Rhodes, and Sicily has received several colonies of Christian Albanians, who have replaced Greek and Arabic by yet another tongue.

Subsequent history.

There is no need to dwell at length on the Sicilian history of the last five hundred years. The descendants of Frederick did not form a great dynasty. Under him and after him Sicily played a part in Italian affairs, invading and being invaded on behalf of the Ghibelline cause. But it was torn by dissensions between Spanish and Italian factions, and handed to and fro between one Spanish king and another. At last Ferdinand the Catholic (1479–1516), king by inheritance of Aragon and of Sicily beyond the pharos, conquered the continental Sicily, and called himself king of the Two Sicilies. Both were now ruled by Spanish viceroys. In Charles the First[1] (1516–1555)—Charles of Anjou is not reckoned—Sicily had a third imperial king, and once more became the starting-point for African warfare. Philip, already king of Naples, became king of the Two Sicilies at the abdication of his father, and the two crowns passed along with Castile and Aragon till the division of the Spanish dominions. Under the foreign rule the old laws were trampled under foot. Three risings took place, that of Messina in 1672, with pretended French help, which led to deeper subjection. At the death of Charles the Second in 1700, Sicily acknowledged the French claimant Philip; but the peace

[1] [Charles I. of Spain, fifth emperor and, excluding Charles of Anjou, the third king of Naples bearing the name.—Am. Ed.]

of Utrecht made it the kingdom of Victor Amadeus of Savoy (1713–1720). He was crowned at Palermo; but he had to withstand Spanish invasion, and to exchange Sicily for the other insular crown of Sardinia. Both Sicilies now passed to the emperor Charles the Sixth, the fourth imperial king, who also is passed by in Sicilian reckoning. Charles the Third is the Spanish prince of the house of Bourbon who won both Sicilies from the Austrian and who was the last king crowned at Palermo (1735).

The wars of the French Revolution again parted the Two Sicilies. In 1798 Ferdinand the Fourth (1759–1825) withdrew to the island before the French armies. In 1805 he withdrew again, while Joseph Buonaparte and Joachim Murat reigned on the mainland as kings of Naples. Under the Bourbon rule, besides the common grievances of both kingdoms, Sicily had specially to complain of being treated as subordinate to Naples. But from 1806 to 1815 Sicily, practically a separate kingdom under British protection, enjoyed a measure of well being such as it had not had for some ages, and in 1812 a constitution was established. The European settlement of 1815 brought back the Bourbon to his continental kingdom. Ferdinand the First became a constitutional king over the United Kingdom of the Two Sicilies. This was equivalent to the suppression of the separate constitution of the island, and before long all constitutional order was trodden under foot. In 1820, and also in 1836, under Ferdinands I. and II., Sicily rose for freedom and separation. This last time the island was bound yet more firmly to continental rule. In the general stir of 1848 Sicily again proclaimed her independence, and sought for herself a king in the house of Savoy. Again were the liberties of Sicily trodden under foot; and, in the last change of all, the deliverance wrought by Garibaldi in 1860, if not her liberties, her ancient memories were forgotten. Sicily became part of a free kingdom; but her king does not bear her style, and he has not taken the crown of Roger. The very name of Sicily[1] has been wiped out; and the great island now counts only as seven provinces of an Italian kingdom.

The literature bearing on Sicily, old and new, is endless. It is something for a land to have had part of its story told by Thucydides and another by Hugo Falcandus. Of modern books Holm's *Geschichte Siciliens im Alterthum* (down to the accession of the second Hieron) is of great value. So are the works of Michele Amari for the Moslem occupation and the War of the Vespers. The old local historian Fazzello must not be passed by, nor the collections of Carusio, Pirro, and Giovanni. But a history of Sicily and the cycles of its history from the beginning is still lacking. The writers on particular branches of the subject are infinite. Gally Knight's *Normans in Sicily* has probably led many to their first thoughts on the subject; and, as a guide for the traveller, that of Gsel-fels can hardly be outdone.

(E. A. F.)

PART II.—GEOGRAPHY AND STATISTICS.

Plate II.

The island of Sicily (Ital. *Sicilia*) belongs to the kingdom of Italy, being separated from the mainland only by the narrow (about 2 miles wide) but deep Straits of Messina. It is nearly bisected by the meridian of 14° E., and by far the greater part lies to the south of 38° N. Its southernmost point, however, in 36° 40′ N. is 40′ to the north of Point Tarifa, the southernmost point of Spain and of the continent of Europe. In shape it is triangular, whence the ancient poetical name of *Trinacria*, referring to its three promontories of Pelorum (now Faro) in the northeast, Pachynum (now Passaro) in the southeast, and Lilybæum (now Boeo) in the west. Its area, exclusive of the adjacent small islands belonging to the *compartimento*, is, according to the recent planimetrical calculation of the Military Geographical Institute of Italy, 9860 square miles,—considerably less than one-third of that of Ireland; that of the whole *compartimento* is 9935 square miles.

Geographical position.

The island occupies that part of the Mediterranean in which the shallowing of the waters divides that sea into two basins, and in which there are numerous indications of frequent changes in a recent geological period. The channel between Cape Bon in Tunis and the southwest of Sicily (a distance of 80 miles) is, on the whole, shallower than the Straits of Messina, being for the most part under 100 fathoms in depth, and exceeding 200 fathoms only for a very short interval, while the Straits of Messina, which are at their narrowest part less than 2 miles in width, have almost everywhere a depth exceeding 150 fathoms. The geological structure in the neighborhood of this strait shows that the island must originally have been formed by a rupture between it and the mainland, but that this rupture must have taken place at a period long antecedent to the advent of man, so that the name Rhegium cannot be based even on the tradition of any such catastrophe. The mountain range that runs out towards the northeast of Sicily is composed of crystalline rocks precisely similar to those forming the parallel range of Aspromonte in Calabria, but both of these are girt about by sedimentary strata belonging in part to an early Tertiary epoch. That a subsequent land connection took place, however, by the elevation of the sea-bed there is abundant evidence to show; and the occurrence of the remains of African Quaternary mammals, such as *Elephas meridionalis*, *E. antiquus*, *Hippopotamus pentlandi*, as well as of those of still living African forms, such as *Elephas africanus* and *Hyæna crocuta*, makes it probable that there was a direct post-Tertiary connection also with the African continent.

Coasts.

The north coast is generally steep and cliffy and abundantly provided with good harbors, of which that of Palermo is the finest. In the west and south the coast is for the most part flat, more regular in outline, and less favorable to shipping, while in the east, where the sea-bottom sinks rapidly down towards the eastern basin of the Mediterranean, steep rocky coasts prevail, except opposite the plain of Catania. In the northern half of this coast the lava streams of Mount Etna stand out for a distance of about 20 miles in a line of bold cliffs and promontories. At various points on the east, north and west coasts there are evidences of a rise of the land having taken place within historical times, at Trapani on the west coast even within the 19th century. As in the rest of the Mediterranean tides are scarcely observable; but at several points on the west and south coasts a curious oscillation in the level of the waters, known to the natives as the *marrobbio* (or *marobia*), is sometimes noticed, and is said to be always preceded by certain atmospheric signs. This consists in a sudden rise of the sea-level, occasionally to the height of 3 feet, sometimes occurring only once, sometimes repeated at intervals of a minute for two hours, or even, at Mazzara, where it is most frequently observed, for twenty-four hours together.

Surface.

The surface of Sicily lies for the most part more than 500 feet above the level of the sea. Caltanissetta, which occupies the middle point in elevation as well as in respect of geographical situation, stands 1900 feet above sea-level. Considerable mountains occur only in the north, where the lower slopes of all the heights form one continuous series of olive-yards and orangeries. Of the rest of the island the greater part forms a plateau varying in elevation and mostly covered with wheat-fields. The only plain of any great extent is that of Catania, watered by the Simeto, in the east; to the north of this plain the active volcano of ETNA (*q.v.*) rises with an exceedingly gentle slope to the height of 10,868 feet from a base 400 square miles in extent. This is the highest elevation of the island. The steep and narrow crystalline ridge which trends northeastwards, and is known to geographers by the name of the Peloritan Mountains, does not reach 4000 feet. The Nebrodian Mountains, a limestone range connected with the Peloritan range and having an east and west trend, rise to a somewhat greater height, and farther west, about the middle of the north coast, the Madonie (the only one of the groups mentioned which has a native name) culminate at the height of nearly 6500 feet. From the western end of the Nebrodian Mountains a lower range (in some places under 1500 feet in height) winds on the whole southeastwards in the direction of Cape Passaro. With the exception of the Simeto, the principal perennial streams—the Salso, the Platani and the Belici—enter the sea on the south coast.

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[1] [For *compartimento* of Sicily, or official retention of the name, see p. 36 below.—AM. ED.]

Geology.

Of the sedimentary rocks of Sicily none are earlier than the Secondary period, and of the older Secondary rocks there are only comparatively small patches of Triassic and Jurassic age—most abundant in the west but also occurring on the flanks of the mountains in the northeast. Cretaceous rocks are very sparingly represented (in the southeast), and by far the greater part of the island is occupied by Tertiary (mainly Eocene and Miocene) limestones. The Nebrodian Mountains are mainly composed of compact limestones of Oligocene date, but are flanked by Eocene rocks including the nummulitic limestone. Quaternary deposits border many of the bays, and the plain of Catania is wholly covered with recent alluvium. Basalts and basaltic tufas border this plain on the south, as the ancient and modern lavas of Etna do on the north.

Climate.

The climate of Sicily resembles that of the other lands in the extreme south of Europe. As regards temperature, it has the warm and equable character which belongs to most of the Mediterranean region. At Palermo (where continuous observations have been made since 1791) the range of temperature between the mean of the coldest and that of the hottest month is little greater than at Greenwich. The mean temperature of January (51½° Fahr.) is nearly as high as that of October in the south of England, that of July (77° Fahr.) about 13° warmer than the corresponding month at Greenwich. During the whole period for which observations have been made the thermometer has never been observed to sink at Palermo below the freezing-point; still frost does occur in the islands even on the low grounds, though never for more than a few hours. On the coast snow is seldom seen, but it does fall occasionally. On the Madonie it lies till June, on Etna till July. The annual rainfall except on the higher mountains does not reach 30 inches, and, as in other parts of the extreme south of Europe, it occurs chiefly in the winter months, while the three summer months (June, July, and August) are almost quite dry. During these months the whole rainfall does not exceed 2 inches, except on the slopes of the mountains in the northeast. Hence most of the streams dry up in summer. The chief scourge is the sirocco, which is experienced in its most characteristic form on the north coast, as an oppressive, parching, hot, dry wind, blowing strongly and steadily from the south, the atmosphere remaining through the whole period of its duration leaden-colored and hazy in consequence of the presence of immense quantities of reddish dust. It occurs most frequently in April, and then in May and September, but no month is entirely free from it. Three days are the longest period for which it lasts. The same name is sometimes applied to a moist, and not very hot, but yet oppressive, southeast wind which blows from time to time on the east coast. Locally the salubrity of the climate is seriously affected by the occurrence of malaria, regarding which important evidence was furnished to a Government commission of inquiry by officials of the Sicilian railways. From this it appears that the whole of the northeast coast from Catania to Messina is perfectly free from malaria, and so also is the line on the north coast from Palermo to Termini; and, singularly enough, while these parts of the low ground are free, malarial regions are entered upon in certain places as soon as the railway begins to ascend to higher levels. Such is the case with the line which crosses the island from Termini to Girgenti; and on the line which ascends from Catania to Castrogiovanni it is found that the stations become more and more unhealthy as the line ascends to Leonforte, and at that station so unhealthy are the nights that it is necessary to convey the employés by a special train every evening to Castrogiovanni (at the height of more than 3000 feet), and to bring them back by another train in the morning.

Flora.

The flora of Sicily is remarkable for its wealth of species; but, comparing Sicily with other islands that have been long separated from the mainland, the number of endemic species is not great. The orders most abundantly represented are the *Compositæ*, *Cruciferæ*, *Labiatæ*, *Caryophyllaceæ*, and *Scrophulariaceæ*. The *Rosaceæ* are also abundantly represented, and among them are numerous species of the rose. The general aspect of the vegetation of Sicily, however, has been greatly affected, as in other parts of the Mediterranean, by the introduction of plants within historical times. Being more densely populated than any other large Mediterranean island, and having its population dependent chiefly on the products of the soil, it is necessarily more extensively cultivated than any other of the larger islands referred to, and many of the objects of cultivation are not originally natives of the island. Not to mention the olive, which must have been introduced at a remote period, all the members of the orange tribe, the agave, and the prickly pear, as well as other plants highly characteristic of Sicilian scenery, have been introduced since the beginning of the Christian era. With respect to vegetation and cultivation three zones may be distinguished. The first reaches to about 1600 feet above sea-level, the upper limit of the members of the orange tribe; the second ascends to about 3300 feet, the limit of the growth of wheat, the vine, and the hardier evergreens; and the third, that of forests, reaches from about 3300 feet upwards. But it is not merely height that determines the general character of the vegetation. The cultivated trees of Sicily mostly demand such an amount of moisture as can be obtained only on the mountain slopes, and it is worthy of notice that the structure of the mountains is peculiarly favorable to the supply of this want. The limestones of which they are mostly composed act like a sponge, absorbing the rain-water through their innumerable pores and fissures, and thus storing it up in the interior, afterwards to allow it to well forth in springs at various elevations lower down. In this way the irrigation which is absolutely indispensable for the members of the orange tribe during the dry season is greatly facilitated, and even those trees for which irrigation is not so indispensable receive a more ample supply of moisture during the rainy season. Hence it is that, while the plain of Catania is almost treeless and tree-cultivation is comparatively limited in the west and south, where the extent of land under 1600 feet is considerable, the whole of the north and northeast coast from the Bay of Castellamare round to Catania is an endless succession of orchards, in which oranges, citrons, and lemons alternate with olives, almonds, pomegranates, figs, carob trees, pistachios, mulberries, and vines. Oranges are specially important as an export crop, and the value of this product has enormously increased since steamers began to traverse the Mediterranean. Olives are even more extensively cultivated, but more for home consumption. The limit in height of the olive is about 2700 feet, and that of the vine about 3500. A considerable silk production depends on the cultivation of the mulberry in the neighborhood of Messina and Catania. One of the most striking features in the commerce of the island is the very large proportion of southern fruits sent to the United States, whence petroleum is chiefly imported. Among other trees and shrubs of importance may be mentioned the deep-rooted sumach, which is adapted to the driest regions, the manna ash (*Fraxinus ornus*), the American *Opuntia vulgaris* or prickly pear and the agave—the former of which yields a favorite article of diet with the natives, and both of which thrive on the driest soil—the date-palm, the plantain, various bamboos, cycads, and the dwarf-palm, the last of which grows in some parts of Sicily more profusely than anywhere else, and in the desolate region in the southwest yields almost the only vegetable product of importance. The *Arundo Donax*, the tallest of European grasses, is largely grown for vine-stakes. The forests on the higher slopes of the mountains are chiefly of oak, with which are associated large numbers of the fruit-trees of central Europe, and on Etna and the Madonie chestnuts.

Cereals.

Outside of the tree region wheat is by far the most important product. At the present day Sicily is still a rich granary, as it was in ancient times when Greek colonies flourished in the south and east, and later under the supremacy of Rome. In all three-fourths of the cultivated surface are estimated to be covered with cereals, and it is the cultivation of wheat more particularly which determines in most places the character of the Sicilian landscape throughout the year. The *maquis*, or thick-leaved stunted evergreens, which on the other Mediterranean islands withstand this summer drought, have been almost banished from Sicily by the extent of the wheat cultivation. Oats and barley are also grown, but maize scarcely at all, for, being a summer crop, it is almost entirely excluded from cultivation by the extreme drought of that season. Beans form in spring the chief food of the entire population. Flax is grown for its seed (linseed), and the *Crocus sativus* for the production of saffron. On the plain of Catania cotton is grown along with wheat, and among other sub-tropical products sugar (probably introduced by the Arabs about the 10th century) and tobacco are still of some importance; but the cultivation of rice has greatly declined, in consequence of its tendency to produce malaria.

The native fauna of Sicily is similar to that of Southern Italy. Among domestic animals mules and asses are very important as beasts of burden. At the enumeration of 10th January, 1876, mules numbered in Sicily 112,115, out of a total of 293,868 belonging to the kingdom of Italy; the number of asses at the same date was 82,702 out of a total of 674,246 in the kingdom. The horses, sheep, and cattle are all of indifferent quality. Tunny and sardine fisheries are carried on round the coasts.

Industry and mining.

Manufacturing industry is little developed in the island, and besides agriculture mining is the only important occupation of the people. The chief mineral is sulphur, Sicilian sulphur being indeed the most valuable mineral product of Italy. There are about 300 mines in operation in the provinces of Girgenti, Caltanissetta, Catania, and Palermo, employing about 27,000 people. The sulphur is found in a particular formation of the Upper Miocene, and is separated from the ore by fusion in a primitive kind of furnace called *calcaroni*, in most of which part of the sulphur is used as fuel. With the exception of a small quantity, which is used in the island for the vineyards, all the sulphur is exported, chiefly to England, France, Belgium, and the United States, and the production goes on increasing, notwithstanding the lowering of the price, due to the extraction of sulphur from iron pyrites obtained elsewhere. Before 1860 the annual production did not exceed 150,000 tons, while in 1880 it exceeded 300,000 tons, and in 1884 almost reached 400,000 tons. It is estimated that at least 50,000,000 tons are still available in the island. Besides sulphur, rock salt, the annual production of which is about 3000 tons, is the only important mineral product of the island; but not less than 170,000 tons of bay salt are made in the salt-pans of Trapani and other parts of the west coast. The rock salt is principally excavated near Racalmuto, Casteltermini, and Trabona.

Administrative divisions.

The *compartimento* of Sicily is divided into seven provinces, the area and population of which are given in the following table:

Provinces.	Area in sq. miles.	No. of Communes.	Pop. 1881.	Pop. per sq. mile.
Caltanissetta.	1270	28	266,379	210
Catania.........	1924	63	563,457	292
Girgenti........	1165	41	312,487	268
Messina........	1246	97	460,924	370
Palermo	1985	76	699,151	352
Syracuse.......	1439	32	341,526	237
Trapani	929	20	283,977	305
	9958	357	2,927,901	294

The areas here given are those of Strelbitsky for 1881, these giving a total which agrees better than the old official figures with the total calculated by the Military Geographical Institute, which has not yet made any calculations for the individual provinces. The volcanic Lipari or Æolian Islands to the north of Sicily are included in the province of Messina; the island of Ustica to the northwest in that of Palermo; the Ægadic group (Lat. *Insulæ Ægates*), consisting of a number of limestone islands in the west, in that of Trapani, from which the nearest is separated by a channel not more than nine fathoms in depth; and to the same province belongs also Pantelleria, midway between Sicily and Africa.

Population.

The prosperity of the island, due chiefly to the stimulation of the cultivation of southern fruits by the extension of commerce in recent years, is shown by the fact that since 1861 the population has increased more rapidly than that of any other part of the kingdom. In 1861 the total population was 2,392,414, and in 1871 2,584,099. Thus the annual rate of increase was 7.74 per thousand as against 6.91 for the whole kingdom while between 1871 and 1881 the annual increase was at the rate of 12.62 per thousand for Sicily as against 6.02 for the whole kingdom. The number of emigrants is small. In 1882 the number of emigrants proper (those who declared their intention of remaining out of the country for more than one year) was 2261 out of 65,748 for the whole kingdom, that of the temporary emigrants 954 as compared with 95,814.

The population, which in consequence of the chequered history of the island is necessarily a very mixed one, is said to be on the whole well disposed and industrious. The lawlessness indicated by the continued existence of the secret society called the *Mafia*, which, like the *Camorra* of the Neapolitan provinces of the mainland, overrides the law in taking vengeance on those who have rendered themselves obnoxious to it, is a relic of former misrule, and is diminishing under the present Government. The condition of the peasantry still shows some of the injurious results of Spanish rule, under which the feudal system was introduced in its worst form. The nobles, who then acquired large landed properties, collected their serfs or retainers round their own castles, so that a number of considerable towns grew up, and the country districts were to a large extent deserted. The cultivators of the soil had often to walk 10 or 12 miles from their homes to their fields. It is chiefly from this cause that even at the present day the people of the island are mainly congregated in towns containing not less than 5000 inhabitants each. The three principal towns of Sicily and the chief seats of its foreign commerce are Palermo (population, with suburbs, 244,991 in 1881), Catania, (100,417), and Messina (81,049), and the next in size are Marsala (40,251), Acireale (38,547), Trapani (38,231; the headquarters of the coral-fishers of Italy), Caltanissetta (25,027), Syracuse (23,507), Sciacca (22,195), Girgenti (20,008; the centre of the trade in sulphur), Castrogiovanni (18,961), Licata (17,565), Terranova (17,173).

Education.

The backward state of education is another consequence of former misrule. In 1881 61.59 per cent of the inhabitants above twelve years of age were still unable to read and write (*analfabeti*), and in 1880–81 the number of pupils in the elementary public schools was only 101,724, or nearly 1 in 29 of the whole population, as against about 1 in 15 for the whole kingdom. Here, however, as in other parts of Italy, improvement is going on in this respect, for the percentage of the people of Sicily above twelve years old unable to read and write was 67.59 in 1871 and 73.12 in 1861.

Communication.

The system of roads and railways is still defective. One line of railway proceeds along the east coast from Messina to Syracuse, and a branch ascends from it to join one of the lines which cross the middle of the island from north to south. Of these there are two,—one from Licata and one from Porto Empedocle, both on the south coast; these lines meet before touching the north coast a little to the east of Termini; thence the railway proceeds along the north coast to Palermo and Castellamare, whence it recrosses the island again to Mazzara, and afterwards follows the west coast northwards to Trapani. A project is now (1886) entertained for the connection of the railways of Sicily with those of the mainland by a tunnel under the Straits of Messina.

See W. H. Smyth, *Sicily and its Islands*, London, 1824; Theo. Fischer, *Beitr. z. Phys. Geogr., d. Mittelmeerländer, besonders Siciliens*, Leipsic, 1877; Id., "Das Klima der Mittelmeerländer," in Ergänzungsband xiii. of *Petermann's Mittheilungen*, Gotha, 1879. A complete account of Etna is given in Arnold von Lasaulx's edition of *Der Aetna*, by W. Sartorius von Waltershausen, Leipsic, 2 vols. 1880. The best topographical map of Sicily is that based on Government surveys on the scale of 1 : 50,000; and on a small scale (1 : 800,000) that in Baedeker's *Italy* is of peculiar excellence. The geology of the island is shown in a single sheet in the *Carta Geologica della Sicilia nella Scala di* 1 : 500,000, and in more detail on the scale of 1 : 100,000 in twenty-seven sheets (not yet completed). See also for the geology and currents of the Straits of Messina the "Schizzo Geologico dello Stretto di Messina colla Indicazione delle Correnti Marine," in the *Bolletino del R. Comitato Geologico d' Italia*, 13th year, Rome, 1882. Regarding the minerals, see the third vol. of *I Tesori sotterranei dell' Italia* by W. Jervis, Turin, 1881.

(G. G. C.)

SICKINGEN, **Franz von** (1481–1523) a powerful German baron, was born at Sickingen, Baden, the castle of his family, on 1st March, 1481. He was the greatest of those Rhenish knights who held their lands immediately of the emperor, and was much esteemed by Maximilian I. and by Charles V., to both of whom he rendered good service in war. He held the position of imperial councillor and chamberlain, and won great fame as a protector of the poor and the oppressed. In 1517 he was put under the ban of the empire in consequence of a war with the imperial city of Worms. Afterwards he carried on wars with the duke of Lorraine, the imperial city of Metz, the landgrave Philip of Hesse, and Duke Ulrich, of Würtemberg. For a short time he was disposed to serve Francis I. of France, from whom he received a pension; but in the imperial election of 1519 Sickingen exercised his influence on behalf of Charles V., and in 1521 he took a prominent part, with the count of Nassau, in the war with France. In 1522 an assembly at Landau elected him head of the confederation of Rhenish and Swabian barons. He was an enthusiastic adherent of the Humanists and Reformers, and when Luther seemed to be in danger offered to provide for him a place of safety. Through the influence of Ulrich von Hutten, Sickingen formed a vast scheme for the overthrow of the spiritual and temporal princes, his intention being that all Germany should be brought into immediate subjection to the emperor. He was so popular among the landsknechte or mercenary foot soldiers of the time that he had no difficulty in bringing together a powerful army; and in September, 1522, he began the war by attacking the archbishop of Treves. Much alarm was excited by this sudden movement, and the landgrave Philip and the palsgrave Louis hastened to the aid of the besieged prelate, and compelled Sickingen to withdraw from Treves. He had hoped that the barons, the peasantry, and the cities would rise in support of his designs, but in this expectation he was disappointed. Fortress after fortress was taken from him, and at last, in April, 1523, he was besieged in the tower of Landstuhl near Kaiserslautern. During the bombardment he was mortally wounded, and on 7th May, 1523, he died, having capitulated almost immediately before. With his defeat and death the Barons' War came to an end. His son was made a baron of the empire (*Reichsfreiherr*) by Maximilian II., and a descendant was raised in 1773 by Joseph II. to the rank of *Reichsgraf*. One line of the family continued to possess immediate estates in the lordship of Landstuhl down to 1803.

SICKLE. See SCYTHE.

SICYON was a city in the east of Achaia, Greece, about 2 miles inland from the Corinthian Gulf, situated on and below a hill in the angle formed by the confluence of the rivers Asopus and Helisson; the site is now occupied by the village of Vasilika. It possessed a harbor on the coast round which was a well-fortified town, which was almost a suburb of the main city (*Σικυωνίων λιμήν*). The ancient and native form of the name was *Σεκυών*. The earliest inhabitants were Ionians; but it was conquered by the Dorian invaders of Argolis, who extended their dominion over Corinth, Sicyon, and the whole valley of the Asopus. Phalces, son of the first Dorian king of Argos, Temenus, was said to have been the conqueror of Sicyon and founder (*οἰκιστής*) of the Dorian city, which, like Corinth, probably continued for a long time subject to the powerful kings of Argos. The population of the Dorian Sicyon was divided into four tribes; the Dorian conquerors constituted three—viz., the usual Dorian tribes Hylleis, Dymanes, and Pamphyli—and a part of the pre-Dorian population constituted the fourth tribe, which was called Ægialeis. (Previous to the Dorian conquest the city bore, according to Strabo, the name Ægiali, or according to Pausanias, Ægialeia.) The rest of the ancient population were reduced to the state of serfs, called *κατωνακοφόροι* or *κορυνηφόροι*, whose position was similar to that of the Helots in Sparta. As in most of the cities of Greece, the conflict between the aristocracy and the commons, who were superior in number but inferior in organization, in education, and in power, resulted in the rise of a dynasty of tyrants, the Orthagoridæ, who destroyed the rule of the Dorian oligarchy and reigned in Sicyon for a century, from about 665 B.C. Under the strong hand of these dynasts Sicyon attained great wealth. Lying near the great commercial centre Corinth, and possessing a harbor, it shared in the immense development of trade with the Italian peninsula which took place in the 8th and 7th centuries. Its marine was considerable, though apparently never of the first rank; at a later time it sent fifteen triremes to fight against the Persians at Salamis. The bronze work of Sicyon was renowned, as Strabo mentions; and we may gain some conception of its style from some of the bronzes found at Olympia, which have probably been fabricated either at Sicyon or in the closely connected workshops of Argos. The Dædalid sculptors Dipœnus and Scyllis from Crete settled in Sicyon about the beginning of the 6th century, and gave the first impulse to a school of art, working mainly in bronze or in wood covered with bronze, which lasted for some generations at Sicyon, Corinth, and Argos, and played a very prominent part in the development of Greek art. The early bronze work of the Sicyo-Argive workshops in all probability formed the model after which the Hesiodic description of the Shield of Hercules was composed by a poet of the 7th century. The fame of Sicyonian bronze work gave rise to the epithet *Τελχινία*, which was sometimes applied to the city. Terra-cotta vases which have been fabricated at Sicyon are found in Etruria, whither they were exported in the Italian trade. They closely resemble in style the vases of Corinth, from which they are distinguished by the peculiar form of the letter *epsilon* in the inscriptions painted on them, and they usually belong to the 6th century. The market-gardens of the fertile Asopus valley supplied the populous Corinth with fruit and vegetables. At least in later times the fine shoes made in Sicyon were widely used in Greece. In the 4th century Sicyon continued to be one of the foremost states in an artistic point of view. The Sicyonian school of painting was founded by Eupompus, and some of the greatest foreign artists, such as Pamphilus and Apelles, studied in it. Lysippus also, who gave a new impulse and tone to Greek sculpture, was a native of Sicyon.

In the dynasty of the Orthagoridæ Andreas began to reign about 665, his son Myron before 648; of Aristonymus, son of Myron, nothing is known; Myron II., son of Aristonymus, reigned seven years; Isodamus, brother and murderer of Myron II., reigned a short time, and about 596 was replaced by his younger brother Clisthenes, who ruled till about 565. The dynasty ended with Clisthenes, who had no son; but his institutions continued in force for sixty years longer, until Sicyon came under the influence of the Peloponnesian confederacy, in which the Dorian Sparta was the chief power. The policy of the Orthagoridæ had always been strongly anti-Dorian, and under the Dorian reaction the most unfavorable color was given to their actions; hence grew the extremely unpleasant picture of them in the pages of Herodotus, who gives the current Peloponnesian accounts of the 5th century. These accounts are contradicted by the long rule of the dynasty and the permanence of their policy after their extinction. Myron I. won a chariot-race at Olympia in 648, and dedicated a bronze *θάλαμος* (probably a large chest or *ναΐσκος* covered with bronze), with an inscription, which Pausanias saw in the Olympian treasury of the Sicyonians. The building of this treasury is ascribed to him by Pausanias, but excavation has shown that the building is not earlier than 500; it consists of a simple cella with a pronaos *in antis*, and is built of Sicyonian stones, cut and numbered at Sicyon, and thence transported by water to Olympia. Clisthenes was the most powerful and famous of the Sicyonian despots, and he continued the anti-Dorian policy of his predecessors; but, as we have seen, it is impossible to trust the details of his action as given by Herodotus (v. 67). He is said to have forbidden the rhapsodists to recite the epics in which the fame of Dorian heroes was sung, and to have encouraged the worship of Dionysus, a non-Dorian deity. Another object of his policy was to secure the favor of the Delphian oracle, and he used all his power in the Sacred War on the side of Delphi against Crissa (590 B.C.). He won a victory in the chariot-race at Delphi in 582. Clisthenes had no son, and he desired to obtain the noblest of the Greeks as a husband for his daughter Agariste. The story of the wooing of Agariste as it was current in Athens, probably in poetic form, has been preserved by Herodotus. Clisthenes, when declared victor at the Olympian games (572 or 568), invited the best of the Greeks to Sicyon. Twelve representatives from all parts of Greece (whose names are chosen by the poet with little regard to chronological possibility) assembled there and spent a year as guests of Clisthenes. First among them all were two Athenians, one of whom, Megacles the Alcmæonid, was at last preferred to his rival Hippoclides; and the careless remark of the latter, "Hippoclides cares not," became proverbial. Megacles and Agariste were parents of Clisthenes, who became famous after 510 as the second founder of the Athenian democracy, and their granddaughter Agariste was mother of the still more famous Pericles. When Sicyon again came under the Dorian influence shortly before 500, the oligarchical form of government was reintroduced and lasted till about 369, when the democracy was again established; but its form was used by Euphron to exercise his own power, and after him a series of tyrants ruled the city, till in 251 Aratus reintroduced the democratic government and Sicyon joined the Achæan league. Under the Roman rule Sicyon profited by the destruction of Corinth in 146 B.C.; it received part of the Corinthian territory together with the presidency of the Isthmian games. But it sank into decay as Corinth revived, and was almost depopulated when Pausanias visited it in the 2d century after Christ. Among the bishoprics of the Byzantine time New Sicyon occurs regularly; it is probable that this was a town on a new site near the old city. (W. M. RA.)

SIDDONS, Sarah (1755–1831), English actress' was the eldest of twelve children of Roger Kemble' the manager of a company of strolling players, and his wife Sarah Ward, and was born in the "Shoulder of Mutton" public-house, Brecon, Wales, 5th July, 1755. Through the special care of her mother in sending her to the schools in the towns where the company played she received a remarkably good education, although she was accustomed to make her appearance on the stage while still a mere child. She became attached to William Siddons, an actor of the company; but this was discountenanced by her parents, who wished her to accept the offer of a squire. Siddons was dismissed from the company, and she was sent to a situation as lady's maid in Warwickshire; at last, however, the necessary consent was obtained and the marriage took place at Trinity Church, Coventry, on 26th November, 1773. It was while playing at Cheltenham in the following year that Mrs. Siddons met with the earliest decided recognition of her great powers as an actress, when by her representation of Belvidera in *Venice Preserved* she moved to tears a party of "people of quality" who had come to "scoff." Her merits were made known by them to Garrick, who sent his deputy to Cheltenham to report regarding her abilities, the result being that she was engaged to appear at Drury Lane at a salary of £5 [$24.30] a week. Owing to inexperience as well as other circumstances, her first appearances as Portia and in other parts were unfortunate, and when, after playing with success in Birmingham, she was about to return to town she received a note from the manager of Drury Lane stating that her services would not be required. Thus, in her own words, "banished from Drury Lane as a worthless candidate for fame and fortune," she again in the beginning of 1777 went "on the circuit" in the provinces. After a very successful engagement at Bath from 1778 to 1782, she again accepted an offer from Drury Lane, when her appearance in Southerne's *Isabella* was one continued triumph, only equalled in the history of the English stage by that of Garrick's first night at Drury Lane in 1741 and that of Edmund Kean's in 1814. In her earlier years it was in scenes of a tender and melting character that she exercised the strongest sway over an audience; but in the performance of Lady Macbeth, in which she appeared February, 1785, it was the grandeur of her exhibition of the more terrible passions as related to one awful purpose that held them spellbound. In Lady Macbeth she found the highest and best scope for her gifts. It fitted her as no other character did, and as perhaps it will never fit another actress. Her extraordinary and peculiar physical endowments—tall and striking figure, brilliant beauty, powerfully expressive eyes, and solemn dignity of demeanor—enabled her to confer a weird majesty on the character which inexpressibly heightened the tragic awe surrounding her fate. After Lady Macbeth she played Desdemona, Rosalind, and Ophelia, all with great success; but it was in Queen Catherine—which she first played on her brother's spectacular revival of *Henry VIII.* in 1788—that she discovered a part almost as well adapted to her peculiar powers as that of Lady Macbeth. In her early life she had attempted comedy, but her gifts in this respect were very limited. It was of course inevitable that comparisons should be made between her and her only compeer Rachel, who undoubtedly excelled her in intensity and the portrayal of fierce passion, but was a less finished artist and lacked Mrs. Siddons's dignity and pathos. Though Mrs. Siddons's minute and systematic study perhaps gave a certain amount of stiffness to her representations, it conferred on them a symmetry and proportion to which Rachel never attained. Mrs. Siddons formally retired from the stage 29th June, 1812, but occasionally appeared on special occasions even when advanced in years. In private life she enjoyed the friendship and respect of a wide circle, including many of the most eminent persons of her time. She died at London on 8th June, 1831.

See Thomas Campbell, *Life of Mrs. Siddons* (2 vols., 1834); Fitzgerald, *The Kembles* (3 vols., 1871); and Frances Ann Kemble, *Records of a Girlhood* (3 vols., 1878).

SIDI-BEL-ABBÈS, chief town of an arrondissement in the department of Oran, Algeria, lies 48 miles by rail to the south of that town, at an elevation of 1552 feet above sea-level, on the right bank of the Mekerra (afterwards the Sig), and surrounded by a plain which is dominated by the escarpments of Mount Tessala. The town, encircled by a crenellated and bastioned wall with a fosse, is traversed from east to west and from north to south by two wide streets shaded by plane trees; the gates are four in number, named from Oran, Daia, Mascara, and Tlemcen respectively. There are numerous fountains fed from the Mekerra. The civil and military quarters of the town are quite distinct from one another. The population of Sidi-bel-Abbès in 1881 was 13,298, or, including the commune, 16,840; the Spanish considerably preponderates over the French element. The town, which is of quite recent origin, derives its name from a chapel, near which a redoubt was constructed by General Bedeau in 1843. The surrounding country is healthy, fertile, and populous.

SIDMOUTH, Viscount. See Addington, Henry.

SIDNEY, or Sydney, Algernon (1622–1683), was the second son of Robert, second earl of Leicester, and of Dorothy Percy, daughter of Henry, earl of Northumberland, and was born at Penshurst, Kent, in 1622. As a boy he showed much talent, which was carefully trained under his father's eye. In 1632 with his elder brother he accompanied his father on his mission as ambassador extraordinary to Christian IV. of Denmark, whom he saw at Rendsburg. In May, 1636, Sidney went with his father to Paris, where he became a general favorite, and from there to Rome. In October, 1641, he was given a troop in his father's regiment in Ireland, of which his brother, Lord Lisle, was in command. In August, 1643, the brothers returned to England. At Chester their horses were taken by the Royalists, whereupon they again put out to sea and landed at Liverpool. Here they were detained by the Parliamentary commissioners, and by them sent up to London for safe custody. Whether this was intended by Sidney or no, it is certain that from this time he ardently attached himself to the Parliamentary cause. On 10th May, 1644, he was made captain of horse in Manchester's army, under the Eastern Association. He was shortly afterwards made lieutenant-colonel, and charged at the head of his regiment at Marston Moor (2d July), where he was wounded and rescued with difficulty.

On 2d April, 1645, he was given the command of a cavalry regiment in Cromwell's division of Fairfax's army, was appointed governor of Chichester on 10th May, and in December was returned to parliament for Cardiff. In July, 1646, his regiment was ordered to Ireland, and he was made lieutenant-general of horse in that kingdom and governor of Dublin. Leaving London on 1st February, 1647, Sidney arrived at Cork on the 22d. He was soon (8th April), however, recalled by a resolution of the House passed through the interest of Lord Inchiquin. On 7th May he received the thanks of the House of Commons. On 13th October, 1648, he was made lieutenant of Dover castle, of which he had previously been appointed governor. He was at this time identified with the Independents as opposed to the Presbyterian party. He was nominated one of the commissioners to try Charles I., but took no part in the trial, retiring to Penshurst until sentence was pronounced. That Sidney approved of the trial, though not of the sentence, there can, however, be little doubt, for in Copenhagen he publicly and vigorously expressed his concurrence. On 15th May, 1649, he was a member of the committee for settling the succession and for regulating the election of future parliaments. Sidney lost the governorship of Dover, however, in March, 1651, in consequence, apparently, of a quarrel with his officers. He then went to The Hague, where he quarrelled with Lord Oxford at play, and a duel was only prevented by their friends. He returned to England in the autumn, and henceforward took an active share in parliamentary work. On 25th November Sidney was elected on the council of state and was evidently greatly considered. In the usurpation of Cromwell, however, he utterly refused all concurrence, nor would he leave his place in parliament except by force when Cromwell dispersed it on 19th[1] April, 1653. He immediately retired to Penshurst, where he was concerned chiefly with family affairs. In 1654 he again went to The Hague, and there became closely acquainted with De Witt. On his return he kept entirely aloof from public affairs, and it is to this period that the *Essay on Love* is ascribed.

Upon the restoration of the Long Parliament, 7th May, 1659, Sydney again took his seat, and was placed on the council of state. He showed himself in this office especially anxious that the military power should be duly subordinated to the civil. On 5th June he was appointed one of three commissioners to mediate for a peace between Denmark supported by Holland and Sweden. He was probably intended to watch the conduct of Montague, who was in command of the Baltic squadron. Of his character we have an interesting notice from Whitelocke, who refused to accompany him on the ground of his "overruling temper and height." Upon the conclusion of the treaty he went to Stockholm as plenipotentiary; and in both capacities he behaved with resolution and address. When the restoration of Charles II. took place Sidney left Sweden, 28th June, 1660, bringing with him from the king of Sweden a rich present in testimony of the estimation in which he was held. Sidney went first to Copenhagen, and then, being doubtful of his reception by the English court, settled at Hamburg. From there he wrote a celebrated letter vindicating his conduct, which will be found in the Somers *Tracts*. He shortly afterwards left Hamburg, and passed through Germany by way of Venice to Rome. His stay there, however, was embittered by misunderstandings with his father and consequent straits for money. Five shillings a day, he says, served him and two men very well for meat, drink, and firing. He devoted himself to the study of books, birds, and trees, and speaks of his natural delight in solitude being largely increased. In 1663 he left Italy, passed through Switzerland, where he visited Ludlow, and came to Brussels in September, where his portrait was painted by Van Egmondt; it is now at Penshurst. He had thoughts of joining the imperial service, and offered to transport from England a body of the old Commonwealth men; but this was refused by the English court. It is stated that the enmity against him was so great that now, as on other occasions, attempts were made to assassinate him. On the breaking out of the Dutch war Sidney, who was at The Hague, urged an invasion of England, and shortly afterwards went to Paris, where he offered to raise a rebellion in England on receipt of 100,000 crowns [$121,500]. Unable, however, to come to terms with the French Government, he once more went into retirement in 1666,—this time to the south of France. In August, 1670, he was again in Paris, and Arlington proposed that he should receive a pension from Louis; Charles II. agreed, but insisted that Sidney should return to Languedoc. In illustration of his austere principles it is related that, Louis having taken a fancy to a horse belonging to him and insisting on possessing it, Sidney shot the animal, which, he said, "was born a free creature, had served a free man, and should not be mastered by a king of slaves." His father was now very ill, and after much difficulty Sidney obtained leave to come to England in the autumn of 1677. Lord Leicester died in November; and legal business connected with other portions of the succession detained Sidney from returning to France as he had intended. He soon became involved in political intrigue, joining, in general, the country party, and holding close communication with Barillon, the French ambassador. In the beginning of 1679 he stood for Guildford, and was warmly supported by William Penn, with whom he had long been intimate, and to whom he afforded assistance in drawing up the constitution of Pennsylvania. He was defeated by court influence, and his petition to the House, complaining of an undue return, never came to a decision. His *Letters to Henry Savile*, written at this period, are of great interest. He was in Paris, apparently only for a short while, in November, 1679. Into the prosecution of the Popish Plot Sidney threw himself warmly, and was among those who looked to Monmouth, rather than to Orange, to take the place of James in the succession, though he afterwards disclaimed all interest in such a question. He now stood for Bramber (Sussex), again with Penn's support, and a double return was made. He is reported on 10th August, 1679, as being elected for Amersham (Buckingham) with Sir Roger Hill. When parliament met, however, in October, 1680, his election was declared void. But now, under the idea that an alliance between Charles and Orange would be more hostile to English liberty than would the progress of the French arms, he acted with Barillon in influencing members of parliament in this sense, and is twice mentioned as receiving the sum of 500 guineas [$2,551.50] from the ambassador. Of this there is no actual proof, and it is quite possible that Barillon entered sums in his accounts with Louis which he never paid away. In any case it is to be remembered that Sidney is not charged with receiving money for advocating opinions which he did not enthusiastically hold.

Upon the dissolution of the last of Charles's parliaments the king issued a justificatory declaration. This was at once answered by a paper entitled *A Just and Modest Vindication, etc.*, the first sketch of which is imputed to Sidney. It was then, too, that his most celebrated production, the *Discourses concerning Government*, was concluded, in which he upholds the doctrine of the mutual compact and traverses the High Tory positions from end to end. In especial he vindicates the propriety of resistance to kingly oppression or misrule, upholds the existence of an hereditary nobility interested in their country's good as the firmest barrier against such oppression, and maintains the authority of parliaments. In each point the English constitution, which he ardently admires, is, he says, suffering: the prerogatives of the crown are disproportionately great; the peerage has been degraded by new creations; and parliaments are slighted.

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[1] [Cromwell expelled the Parliament on the 20th April; v. vol. vi. p. 582.—AM. ED.]

For a long while Sidney kept himself aloof from the duke of Monmouth, to whom he was introduced by Lord Howard. After the death of Shaftesbury, however, in November, 1682, he entered into the conferences held between Monmouth, Russell, Essex, Hampden, and others. That treasonable talk went on seems certain, but it is probable that matters went no further. The watchfulness of the court was, however, aroused, and on the discovery of the Rye House Plot, Sidney, who had always been regarded in a vague way as dangerous, was arrested while at dinner on 26th June, 1683. His papers were carried off, and he was sent at once to the Tower on a charge of high treason. For a considerable while no evidence could be found on which to establish a charge. Jeffreys, however, was made lord chief-justice in September; a jury was packed; and, after consultations between the judge and the crown lawyers, Sidney was brought to listen to the indictment on 7th November. The trial, which began on 21st November, was conducted with a shameless absence of equity; Sidney was refused a copy of the indictment, in direct violation of law, and—more shameful still—he was refused the assistance of counsel. Hearsay evidence and the testimony of the perjured informer Lord Howard, whom Sidney had been instrumental in introducing to his friends, were first produced. This being insufficient, partial extracts from papers found in Sidney's study, and supposed only to be in his handwriting, in which the lawfulness of resistance to oppression was upheld, were next relied on. He was indicted for "conspiring and compassing the death of the king." Sidney conducted his case throughout with great skill; he pointed especially to the fact that Lord Howard, whose character he easily tore to shreds, was the only witness against him as to treason, whereas the law required two, that the treason was not accurately defined, that no proof had been given that the papers produced were his, and that, even if that were proved, these papers were in no way connected with the charge. Against the determination to secure a conviction, however, his courage, eloquence, coolness, and skill were of no avail, and the verdict of "guilty" was given. On 25th November Sidney presented a petition to the king, praying for an audience, which, however, under the influence of James and Jeffreys, Charles refused. On the 26th he was brought up for judgment, and again insisted on the illegality of his conviction. Upon hearing his sentence he gave vent to his feelings in a few noble and beautiful words. Jeffreys having suggested that his mind was disordered, he held out his hand and bade the chief-justice feel how calm and steady his pulse was. By the advice of his friends he presented a second petition, offering, if released, to leave the kingdom at once and forever. The supposed necessity, however, of checking the hopes of Monmouth's partisans, caused the king to be inexorable. The last days of Sidney's life were spent in drawing up his *Apology* and in discourse with Independent ministers. He was beheaded on the morning of 7th December, 1683. His remains were buried at Penshurst.

(O. A.)

SIDNEY, SIR PHILIP (1554-1586), although killed at the early age of thirty-two, was one of the most conspicuous figures at the court of Elizabeth, was known to the leading statesmen of Europe as a soldier and statesman of the highest promise, took a permanent place in history and legend as a romantic hero, and in literature is distinguished as the author of the first important body of English sonnets and a writer whose works mark a distinct advance in English prose. He was born at Penshurst in Kent on 29th November, 1554. His father was Sir Henry Sidney, famous in his time as an administrator of Ireland, his mother a Dudley, sister of Elizabeth's favorite, the earl of Leicester, and daughter of the earl of Northumberland executed for high treason in the reign of Mary. Thus Sidney was of notable kindred on both sides:

> "Others, because of both sides I do take
> My blood from them who did excel in this,
> Think Nature me a man-at-arms did make."[1]

He received his scholastic education at Shrewsbury school and at Christ Church, Oxford. He was entered at Shrewsbury on the same day with his lifelong friend and biographer Fulke Greville, afterwards Lord Brooke. In 1572 he set out with three years' leave of absence to complete his education by Continental travel; he was in Paris at the house of the English ambassador on the night of the massacre of St. Bartholomew, and went thence to Frankfort, Vienna, and the chief cities of Italy. During these travels he associated with scholars and statesmen, making an earnest study of European politics, winning golden opinions for his youthful gravity and sagacity. From that time Hubert Languet, the Reformer, whom he met at Frankfort, maintained a constant correspondence with him. On his return he was introduced at court, won the favor of Elizabeth, who considered him "one of the jewels of her crown," and, in proof of the versatility which made him one of the wonders of his age, wrote a masque, *The Lady of the May*, for Leicester's great reception of the queen at Kenilworth,[a] and distinguished himself in the tournament upon the same occasion. In 1577, at the age of twenty-two, being sent as ambassador in great state to congratulate and sound Rudolph II., the new emperor of Germany, he met William the Silent, who pronounced him one of the ripest statesmen in Europe. He returned in the following year, and from that time till the expedition to the Netherlands, in which he lost his life, he had no public employment, but lived partly at court, partly at his country seat at Penshurst in Kent. In 1583 he married the daughter of Sir Francis Walsingham, who after his death became countess of Essex. His most memorable interference in state affairs was a bold letter of remonstrance to Elizabeth against her suspected policy of marrying the duke of Anjou. The queen's anger at his boldness drove him for a time into retirement. He was a strong advocate of intervention on the Protestant side, and in 1585 accompanied Leicester in his expedition to the Netherlands, and was appointed governor of Flushing, one of the towns held by the queen as security. The historical truth of the famous incident at the battle of Zutphen (22d September, 1586), when the wounded hero passed a cup of water to a dying soldier, has been questioned; but it is matter of fact that he owed his death to an impulse of romantic generosity. The lord marshal happening to enter the field of Zutphen without greaves, Sidney cast off his also, to put his life in the same peril, and thus exposed himself to the fatal shot. His death took place fifteen days later, on 7th October,[2] 1586, at Arnheim.

No poet's death was ever so lamented by poets as Sidney's. Pastoral elegy was in fashion, and all the numerous poets and rhymesters of the time from Spenser to Davison hastened to lay their tribute of verse on the bier of this the darling of all the shepherds:

> "With whom all joy and jolly-merriment
> Is also deaded and in dolour drent."

That there was much more than the worship of his rank and his bright eager personality in this is shown by the lasting reputation of what he wrote during the two years of retirement, 1580-81, which he seems to have given mainly to literature. The truth is that Sidney transferred his own strong, radiant, graceful, and lovable character to his writings with a freshness and fidelity such as few finished artists have achieved, so that he really and literally lives in them to charm forever. None of his writings were published during his lifetime, and the dates of composition are uncertain. But it would seem that Sidney's first attempt at verse was a metrical version of the Psalms, written in conjunction with his sister, the countess of Pembroke,—"Sidney's sister, Pembroke's mother." The worth of these paraphrases, which have all Sidney's qualities of sincerity, directness, and sweetness of rhythm, has recently been recognized by Mr. Ruskin, who has edited them under the title of *Rock Honeycomb* in the second volume of his *Bibliotheca Pastorum* (1877). Sidney's famous prose romance, *The Countess of Pembroke's Arcadia*, the "vain amatorious poem" with which Charles I. solaced his imprisonment, was also begun in 1580. It was published in 1590, and kept its popularity as long as that kind of high-flown sentiment and intricate adventure found readers. The buoyancy and freshness of Sidney's style give a certain air of reality even to the artificial scenes of the *Arcadia*, and many pretty songs are interspersed through the work. Sidney's greatest poetic achievement, however, was the series of sonnets entitled *Astrophel and Stella*, the first important body of sonnets in the English language. The sonnets, 108 in number, are a chronicle of the poet's love for Penelope Devereux, sister of the earl of Essex, afterwards Lady Rich.[1] He first met the lady when she was a child of twelve at one of the stages in Elizabeth's progress to Kenilworth in 1575. A match was apparently arranged between them by their families, but upon Leicester's disgrace it was broken off and Penelope was given to Lord Rich. Sidney seems then to have discovered that he was in love with her. Whether the passion was real or feigned for artistic purposes is of little consequence, although the reality of it has been hotly maintained; he writes as if it were real, and the verisimilitude of the story recorded in the sonnets, which express his varying moods towards her throughout the incidents of subsequent intercourse and the distractions of his public life, adds greatly to their interest. Very few of the sonnets will bear separation from the context, though there is hardly one that does not contain some sweet ingenuity of fancy or casual felicity of phrase. Some of them were special favorites with Charles Lamb. Sidney's other work during this busy literary passage in his short life, the *Apologie for Poetrie*, has also established itself as a classic.

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[1] *Astrophel and Stella*, sonnet 41.

[2] [J. A. Symonds, in *Sir Philip Sydney*, pp. 171-173 (New York, 1886), says he lingered twenty-five days after being wounded, and died on 17th October.—AM. ED.]

[a] [Arber, in his edition of the *Apologie*, says it was written when the Court went to Wanstead in 1578.—AM. ED.]

The best of the sonnets are selected by Mrs. Ward in Ward's *English Poets*; Mr. Main also makes a good selection in his *Treasury of English Sonnets*. The sonnets were probably written in 1581; they were not published till 1591, when they formed the first in a brilliant series of volumes of sonnet literature (see "Elizabethan Sonneteers," in Minto's *Characteristics of English Poets*). The *Apologie* is included in Arber's reprints.

SIDON (Arab. *Saida*), long the principal city of Phœnicia (*q.v.*), and even in the Middle Ages a place of importance, but now little more than a mere village, is situated on the Syrian coast in 33° 36′ N. lat. and 35° 20′ 9′′ E. long., about midway between Sur (Tyre) and Beirut (Beyrout). The ancient city extended some 800 yards farther inland, over ground now occupied by luxuriant fruit-gardens, on the produce of which the inhabitants of the town live. In front of the flat promontory to which the modern Sidon is confined there stretches northwards and southwards a rocky peninsula; at the northern extremity of this begins a series of small rocks enclosing the harbor, which at present is a very bad one, having been, to some extent at least, purposely filled up. The port was formerly protected on the north by the Ḳal'at el-Baḥr ("Sea Castle"), a building of the 13th century, situated upon an island still connected with the mainland by a bridge. On the south side of the town lay the so-called Egyptian harbor, now quite useless. The wall by which Sidon is at present surrounded is pierced by two gates, those of Beirut and Akko (Acre); at the southeastern angle, upon a heap of rubbish, stand the remains of the citadel. The streets are very narrow, and the buildings of any interest are few; most prominent are some large caravanserais belonging to the period of Sidon's modern prosperity, and the large mosque, formerly a church of the Knights of St. John. Sidon looks best from the north. Of its 9000 inhabitants 7000 are Mohammedans; there are a number of institutions conducted by Catholic and Protestant Christians. In the neighborhood are large Phœnician burial-places, which have been partially explored by Renan; the natives also engage in the search for antiquities. The principal finds are sarcophagi, and next to these sculptures and paintings. The most important discovery hitherto made has been that of the sarcophagus of Eshmunazar with a long inscription; it is now (1886) in the Louvre.

In 637–638 Sidon was taken by the Arabs. During the crusades it was alternately in possession of the Franks and the Mohammedans, but finally fell into the hands of the latter in 1291. As the residence of the Druse emir Fakhr ed-Dîn, it rose to some prosperity about the beginning of the 17th century, but towards the close of the 18th its commerce again passed away, principally to Beirut (Beyrout), and the prosperity of Sidon has ever since been steadily declining.

See Renan, *Mission de Phénicie*, Paris, 1865.

SIDONIUS APOLLINARIS. See Apollinaris Sidonius.

SIEBENBÜRGEN. See Transylvania.

SIEBOLD, Carl Theodor Ernst von (1804–1885), physiologist and zoologist, the son of a physician and a descendant of what Oken called the "Asclepiad family of Siebolds," was born at Würzburg on 16th February, 1804. Educated in medicine and science chiefly at the university of Berlin, he became successively professor of zoology, physiology, and comparative anatomy in Königsberg, Erlangen, Freiburg, Breslau, and Munich. In conjunction with Stannius he published (1845–48) a *Manual of Comparative Anatomy*, which is still of solid value; and along with Kölliker he founded in 1848 a journal which soon took and still retains a leading place in biological literature, *Zeitschrift für wissenschaftliche Zoologie*. He was also a laborious and successful helminthologist (see Parasitism) and entomologist, in both capacities contributing many valuable papers to his journal, which he continued to edit until his death in 1885. In these ways, without being a man of marked genius, but rather an industrious and critical observer, he came to fill a peculiarly distinguished position in science, and was long reckoned, what his biographer justly calls him, the Nestor of German zoology. See Ehlers, *Zeitschr. f. wiss. Zool.*, 1885.

SIEBOLD, Philipp Franz von (1796–1866), scientific explorer of Japan and elder brother of the physiologist noticed above, was born at Würzburg, Germany, on 17th February, 1796. He studied medicine and natural science at Würzburg, and obtained his doctor's diploma in 1820. In 1822 he entered the service of the king of the Netherlands as medical officer to the East Indian army. On his arrival at Batavia he was attached to a new mission to Japan, sent by the Dutch with a view to improve their trading relations with that country. Siebold was well equipped with scientific apparatus, and he remained in Japan for six years, with headquarters at the Dutch settlement on the little island of Deshima. His medical qualifications enabled him to find favor with the Japanese, and he gathered a vast amount of information concerning a country then almost as little known as Corea, especially concerning its natural history and ethnography. He had comparatively free access to the interior, and his reputation spreading far and wide brought him visitors from all parts of the country. His valuable stores of information were added to by trained natives whom he sent to collect for him in the interior. In 1824 he published *De Historiæ Naturalis in Japonia Statu* and in 1832 his splendid *Fauna Japonica*. His knowledge of the language enabled him also in 1826 to issue from Batavia his *Epitome Linguæ Japonicæ*. In Deshima he also laid the foundation of his *Catalogus Librorum Japonicorum* and *Isagoge in Bibliothecam Japonicam*, published after his return to Europe, as also his *Bibliotheca Japonica*, which, with the co-operation of J. Hoffmann, appeared at Leyden in 1833. During the visit which he was permitted to make to Yedo (Tokio), Siebold made the best of the rare opportunity; his zeal, indeed, outran his discretion, since, for obtaining a native map of the country, he was thrown into prison and compelled to quit Japan on 1st January, 1830. On his return to Holland he was raised to the rank of major, and in 1842 to that of colonel. After his arrival in Europe he began to give to the world the fruits of his researches and observations in Japan.

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[1] [Some of the sonnets were written after her marriage, after the manner of Petrarch. She was unhappy with Rich, bore children to the Earl of Devon, to whom Laud eventually married her.—Am. Ed.]

His *Nippon; Archiv zur Beschreibung von Japan und dessen Neben- und Schutz-Ländern* was issued in five quarto volumes of text, with six folio volumes of atlas and engravings. He also issued many fragmentary papers on various aspects of Japan. In 1854 he published at Leyden *Urkundliche Darstellung der Bestrebungen Niederlands und Russlands zur Eröffnung Japans*. In 1859 Siebold undertook a second journey to Japan, and was invited by the emperor to his court. In 1861 he obtained permission from the Dutch Government to enter the Japanese service as negotiator between Japan and the powers of Europe, and in the same year his eldest son was made interpreter to the English embassy at Yedo. Siebold was, however, soon obliged by various intrigues to retire from his post, and ultimately from Japan. Returning by Java to Europe in 1862, he set up his ethnographical collections, which were ultimately secured by the Government of Bavaria and removed to Munich. He continued to publish papers on various Japanese subjects, and received honors from many of the learned societies of Europe. He died at Munich on 18th October, 1866. Siebold until recent years was our great authority on Japan, and even now his writings on the natural history of that country have not been superseded.

See biography by Moritz Wagner, in *Allgemeine Zeitung*, 13th to 16th November, 1866.

SIEDLCE (Russ. *Syedlets*), a government of Russian Poland, between the Vistula and the Bug, having Warsaw on the N.W., Łomża on the N., Grodno and Volhynia on the E., Lublin and Radom on the S. Its area is 5535 square miles. The surface is mostly flat, only a few hilly tracts appearing in the middle, around Biała, and in the east on the banks of the Bug. Extensive marshes prevail in the north and southeast. Chalk, Jurassic and Tertiary deposits cover the surface, and are overlain in their turn with widely spread Glacial deposits. The valley of the Vistula is mostly wide, with several terraces covered with sand-dunes or peat-bog. Siedlce is watered by the Vistula, which borders it for 50 miles on the west; the Bug, which is navigable from Opalin and flows for 170 miles on the east and northeast borders of the province; the Wieprż, a tributary of the Vistula, which is also navigable, and flows for 25 miles along the southern boundary; and the Liwiec, a tributary of the Bug, which is navigable for some 30 miles below Wengroff.

Of the total surface of the government only 184,760 acres are unproductive; 695,420 acres are covered with forests; 1,703,100 are under crops, and 611,260 under meadows and pasture land. The population only increases at the rate of 0.75 per cent. a year, and in 1884 numbered 630,240; of these Poles constituted 39.7 per cent., Little Russians 43.1, Jews 15.1, and Germans about 2. According to religious belief they were distributed as follows: Out of 616,649 inhabitants in 1882 there were 367,187 Catholics, 142,945 Orthodox Greeks, 96,764 Jews, 8892 Protestants, 505 Baptists, and 356 Mohammedan Tatars. Agriculture is the chief occupation; in 1881 the crops yielded 1,531,400 quarters of corn and 10,988,400 bushels of potatoes. Cattle-breeding is in a relatively flourishing state, there being (1881) 57,500 horses, 292,670 horned cattle, 461,700 sheep, and 194,100 pigs. Manufactures are insignificant (2270 workmen); their aggregate production, chiefly from distilleries and breweries, was valued at £394,820 [$1,198,825.20] in 1881. Trade also is insignificant, although Siedlce has four railways, one of which, from Warsaw to Brest-Litovsk, crosses it from west to east. There are two gymnasia for boys (at Siedlce and Biała), one gymnasium for girls, one seminary for teachers (at Biała), and about 240 primary schools with 11,260 scholars. The government is divided into nine districts, the chief towns of which, with their populations in 1882, are—Siedlce (see below), Biała (19,435), Constantinoff (3200), Garvolin (14,620), Łukoff (11,030), Radzyn (4440), Sokołoff (6300), Wengroff (8140), and Włodawa (17,985). Janoff (3030), where a state stud is kept, has also municipal institutions.

SIEDLCE, capital of the above government, is situated 57 miles east-southeast of Warsaw, on the Brest-Litovsk Railway. It received municipal institutions in 1547. The Oginskis, to whom it belonged, have embellished it with a palace and gardens; but it is still nothing more than a large village, where the provincial authorities have their seat. Its population was 12,950 in 1882.

SIEGE. See FORTIFICATION.

SIEGEN, an ancient mining and manufacturing town of Prussia, in the province of Westphalia, is situated 47 miles to the east of Cologne on the Sieg, a tributary entering the Rhine opposite Bonn. The surrounding district, to which it gives its name, abounds in iron-mines, so that iron founding and smelting are important branches of industry in and near the town. Large tanneries and leather works, and factories for cloth paper, and machinery, are among the other industrial establishments. The population in 1880 was 15,024, of whom 3632 were Roman Catholics and 111 Jews.

Siegen was the capital of an early principality belonging to the house of Nassau; and from 1606 onwards it gave name to the junior branch of Nassau-Siegen. Napoleon incorporated Siegen in the grand-duchy of Berg in 1806; and in 1815 the congress of Vienna assigned it to Prussia, under whose rule it has nearly quintupled its population. Rubens is said to have been born here in 1577.

SIEGFRIED. See NIBELUNGENLIED, vol. xvii, p. 488–9.

SIEMENS, SIR WILLIAM (1823–1883), christened Carl Wilhelm, an eminent inventor, engineer, and natural philosopher, was born at Lenthe in Hanover, on 4th April, 1823. After being educated in the polytechnic school of Magdeburg and the university of Göttingen he visited England at the age of nineteen in the hope of introducing a process in electro-plating invented by himself and his brother Werner. The invention was adopted by Messrs. Elkington, and Siemens returned to Germany to enter as a pupil the engineering works of Count Stolberg at Magdeburg. In 1844 he was again in England with another invention, the "chronometric" or differential governor for steam-engines (see STEAM-ENGINE). Finding that British patent laws afforded the inventor a protection which was then wanting in Germany, he thenceforth made England his home; but it was not till 1859 that he formally became a naturalized British subject. After some years spent in active invention and experiment at mechanical works near Birmingham, he went into practice as an engineer in 1851. He labored mainly in two distinct fields, the applications of heat and the applications of electricity, and was characterized in a very rare degree by a combination of scientific comprehension with practical instinct. In both fields he played a part which would have been great in either alone; and, in addition to this, he produced from time to time miscellaneous inventions and scientific papers sufficient in themselves to have established a reputation. His position was recognized by his election in 1862 to the Royal Society, and later to the presidency of the Institute of Mechanical Engineers, the Society of Telegraph Engineers, the Iron and Steel Institute, and the British Association; by honorary degrees from the universities of Oxford, Glasgow, Dublin, and Würzburg; and by knighthood. He died in London on the 19th of November, 1883.

In the application of heat Siemen's work began just after Joule's experiments had placed the doctrine of the conservation of energy on a sure basis. While Rankine, Clausius, and Thomson were developing the dynamical theory of heat as a matter of physical and engineering theory, Siemens, in the light of the new ideas, made a bold attempt to improve the efficiency of the steam-engine as a converter of heat into mechanical work. Taking up the regenerator—a device invented by Stirling twenty years before, the importance of which had meanwhile been ignored—he applied it to the steam engine in the form of a regenerative condenser with some success. This was in 1847, and in 1855 engines constructed on Siemen's plan were worked at the Paris exhibition. Later he made many attempts to apply the regenerator to internal-combustion or gas engines; but neither in steam-engines nor in gas-engines were his inventions directly and permanently fruitful, though the direction they followed is that in which improvement is still looked for. The regenerative principle, however, as a means of economizing heat soon received at his hands another and far wider application. In 1856 he introduced the regenerative furnace, the idea of his brother Friedrich, with whom William associated himself in directing its applications. In an ordinary furnace a very large part of the heat of combustion is lost by being carried off in the hot gases which pass up the chimney. In the regenerative furnace the hot gases pass through a regenerator, or chamber stacked with loose bricks, which absorb the heat. When the bricks are well heated the hot gases are diverted so as to pass through another similar chamber, while the air necessary for combustion, before it enters the furnace, is made to traverse the heated chamber, taking up as it goes the heat which has been stored in the bricks. After a suitable interval the air currents are again reversed. The process is repeated periodically, with the result that the products of combustion escape only after being cooled, the heat which they take from the furnace being in great part carried back in the heated air. But another invention was required before the regenerative furnace could be thoroughly successful. This was the use of gaseous fuel, produced by the crude distillation and incomplete combustion of coal in a distinct furnace, now known as Siemens's gas-producer. From this the gaseous fuel passes by a flue to the regenerative furnace, and it, as well as the entering air, is heated by the regenerative method, four brick-stacked chambers being used instead of two. The complete invention was applied at Chance's glass-works in Birmingham in 1861, and furnished the subject of Faraday's farewell lecture to the Royal Institution. It was soon applied to many industrial processes, but it found its greatest development a few years later at the hands of Siemens himself in the manufacture of steel. To produce steel directly from the ore, or by melting together wrought-iron scrap with cast-iron upon the open hearth, had been in his mind from the first, but it was not till 1867, after two years of experiment in "sample steel works" erected by himself for the purpose, that he achieved success. The modern forms of the Siemens steel process are described in the article IRON (vol. xiii. p. 346 sq.). The product is a mild steel of exceptionally trustworthy quality, the use of which for boiler-plates has done much to make possible the high steam-pressures that are now common, and has consequently contributed, indirectly, to that improvement in the thermodynamic efficiency of heat engines which Siemens had so much at heart. Just before his death he was again at work upon the same subject, his plan being to use gaseous fuel from a Siemens producer in place of solid fuel beneath the boiler, and to apply the regenerative principle to boiler furnaces. His faith in gaseous fuel led him to anticipate that its use would in time supersede that of solid coal for domestic and industrial purposes, cheap gas being supplied either from special works or direct from the pit; and among his last inventions was a house grate to burn gas along with coke, which he regarded as a possible cure for city smoke.

In electricity Siemens's name is closely associated with the growth of land and submarine telegraphs, the invention and development of the dynamo, and the application of electricity to lighting and to locomotion. In 1860, with his brother Werner, he invented the earliest form of what is now known as the Siemens armature; and in 1867 he communicated a paper to the Royal Society "On the Conversion of Dynamical into Electrical Force without the Aid of Permanent Magnetism," in which he announced the invention by Werner Siemens of the dynamo-electric machine, an invention which was also reached independently and almost simultaneously by Wheatstone and by S. A. Varley. The Siemens-Alteneck or multiple-coil armature followed in 1873, and became the basis of the modern Siemens dynamo as developed, with great labor, by the firm of Siemens Brothers themselves, and (with later modifications) by Edison, Hopkinson, and others. While engaged in constructing a trans-Atlantic cable for the Direct United States Telegraph Company, Siemens designed the very original and successful ship "Faraday," by which that and other cables were laid. One of the last of his works was the Portrush and Bushmills electric tramway, in the north of Ireland, opened in 1883, where the water power of the river Bush drives a Siemens dynamo, from which the electric energy is conducted to another dynamo serving as a motor on the car. In the Siemens electric furnace the intensely hot atmosphere of the electric arc between carbon points is employed to melt refractory metals. Another of the uses to which he turned electricity was to employ light from arc lamps as a substitute for sunlight in hastening the growth and fructification of plants. Among his miscellaneous inventions were the differential governor already alluded to, and a highly scientific modification of it, described to the Royal Society in 1866; a water-meter which acts on the principle of counting the number of turns made by a small reaction turbine through which the supply of water flows; an electric thermometer and pyrometer, in which temperature is determined by its effect on the electrical conductivity of metals; an attraction meter for determining very slight variations in the intensity of a gravity; and the bathometer, by which he applied this idea to the problem of finding the depth of the sea without a sounding-line. In a paper read before the Royal Society in 1882 "On the Conservation of Solar Energy," he suggested a bold but unsatisfactory theory of the sun's heat, in which he sought to trace on a cosmic scale an action similar to that of the regenerative furnace. His fame, however, does not rest on his contributions to pure science, valuable as some of these were. His strength lay in his grasp of scientific principles, in his skill to perceive where and how they could be applied to practical affairs, in his zealous and instant pursuit of thought with action, and in the indomitable persistence with which he clung to any basis of effort that seemed to him theoretically sound.

Siemens's writings consist for the most part of lectures and papers scattered through the scientific journals and the publications of the Royal Society, the Institution of Civil Engineers, the Institute of Mechanical Engineers, the Iron and Steel Institute, the British Association, etc. A biography by Dr. William Pole is now (1886) in preparation. (J. A. E.)

SIENA, a city of Italy, and one of the most characteristic of Tuscany, stands (43° 19′ N. lat., 11° 19′ E. long.) on a hill near the mountainous region of Chianti, the Maremma, and Val di Chiana. It is 60 miles by rail south of Florence and 160 northwest of Rome. The area of the city within the walls is about 2¼ square miles and its population in 1881 was 25,204. The province of Siena, comprising about 1467 square miles, with 37 communes, and a total population of 207,000, by the political redistribution of 1882 forms a single electoral college and returns four members to parliament. The diocese of Siena, an archbishopric dating from 1459, includes 18 city and 95 rural parishes divided into 12 vicariates.

Public institutions.

The city possesses a university, founded in 1203 and limited to the faculties of law and medicine. Among the other public institutions the following are the more important: the town library, first open to students in the 17th century; the Archivio, a record office, instituted in 1858, containing a valuable and splendidly arranged collection of documents; the Fine Arts Institution, founded in 1816; and the natural history museum of the Royal Academy of the Physiocritics, inaugurated in the same year. There are also many flourishing charities, including an excellent hospital and a school for the deaf and dumb.

Festivals.

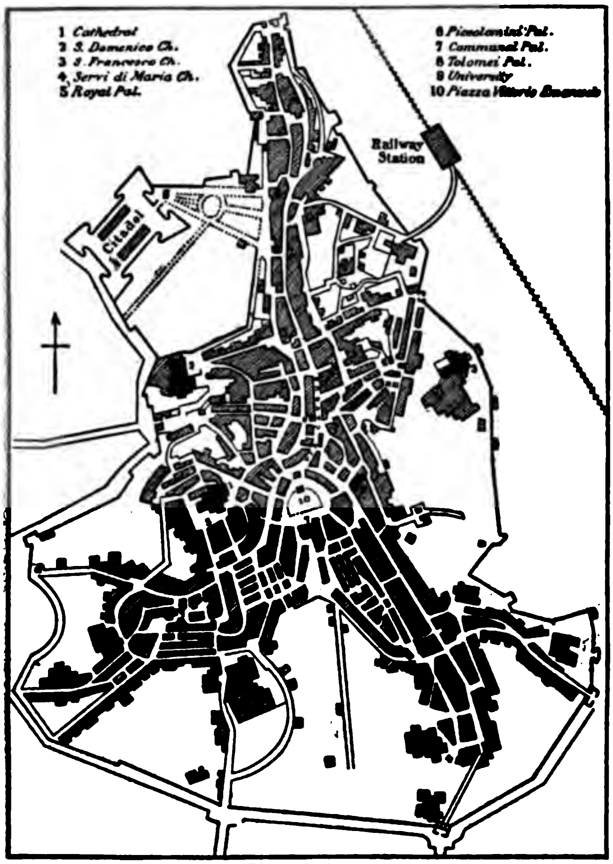
The public festivals of Siena known as the "Palio delle Contrade" have a European celebrity. They are held in the public square, the curious and historic Piazza del Campo (now Piazza di Vittorio Emanuele), on 2d July and 16th August of each year; they date from the Middle Ages and were instituted in commemoration of victories and in honor of the Virgin Mary (the old title of Siena, as shown by seals and medals, having been "Sena vetus civitas Virginis"). In the 15th and 16th centuries the celebrations consisted of bull-fights. At the close of the 16th century these were replaced by races with mounted buffaloes, and since 1650 by (ridden) horses. Siena is divided into seventeen *contrade* (wards), each with a distinct appellation and a chapel and flag of its own; and every year ten of these *contrade*, chosen by lot, send each one horse to compete for the prize *palio* or banner. The aspect of Siena during these meetings is very characteristic, and the whole festivity bears a mediæval stamp in harmony with the architecture and history of the town.

Cathedral.

Among the noblest fruits of Sienese art are the public buildings adorning the city. The cathedral, one of the finest examples of Italian Gothic architecture, was begun in the early years of the 13th century, and in 1317 its walls were extended to the baptistery of San Giovanni; a further enlargement was

Churches.

begun in 1339 but never carried out, and a few ruined walls and arches alone remain to show the magnificence of the uncompleted design. The splendid west front, of tricuspidal form, enriched with a multitude of columns, statues, and inlaid marbles, was finished in 1380. Space fails for the enumeration of the art treasures of the interior, but conspicuous among them is the well-known octagonal pulpit by Niccolò Pisano, dating from about 1274. The cathedral pavement is almost unique. It is inlaid with designs in color and black and white, representing Biblical and legendary subjects, and is supposed to have been begun by Duccio della Buoninsegna. But the finest portions beneath the domes, with scenes from the history of Abraham, Moses, and Elijah, are by Domenico Beccafumi and are executed with marvellous boldness and effect. The choir stalls also deserve mention; the older ones (remains of the original choir) are in *tarsia* work; the others, dating from the 16th century, are carved from Riccio's designs. The Piccolomini Library, adjoining the *duomo*, was founded by Cardinal Francesco Piccolomini-Todeschini (afterwards Pius III.) in honor of his uncle, Pius II. Here are Pinturicchio's famous frescos of scenes from the life of the latter pontiff and the collection of choir books (supported on sculptured desks) with splendid illuminations by Sienese and other artists. The church of San Giovanni, the ancient baptistery, beneath the cathedral is approached by an outer flight of marble steps built in 1451. It has a beautiful façade designed by Giovanni di Mino del Pellicciaio in 1382, and a marvellous font with bas-reliefs by Donatello, Ghiberti, Giacomo della Quercia, and other 15th-century sculptors. The other churches are—the Collegiata di Provenzano, a vast building of some elegance, designed by Schifardini (1594); Sant' Agostino, rebuilt by Vanvitelli in 1755, containing a crucifixion and Saints by Perugino, a Massacre of the Innocents by Matteo di Giovanni, the Coming of the Magi by Sodoma, and a St. Antony by Spagnoletto or his school; the beautiful church of the Servites (15th century), which contains another Massacre of the Innocents by Matteo di Giovanni and other good examples of the Sienese school; San Francesco, designed by Agostino and Agnolo about 1326, and now (1887), being restored, which once possessed many fine paintings by Duccio Buoninsegna, Lorenzetti, Sodoma, and Beccafumi, but some of these perished in the great fire of 1655, and the rest were removed to the Institute of Fine Arts after 1862 during the temporary desecration of the church; San Domenico, a fine 13th-century building with a single nave and transept, containing Sodoma's splendid fresco the Swoon of St. Catherine, the Madonna of Guido da Siena, and a crucifix by Sano di Pietro. This church crowns the Fontebranda hill above the famous fountain of that name immortalized by Dante, and in a steep lane below stands the house of St. Catherine, now converted into a church and oratory, and maintained at the expense of the inhabitants of the Contrada dell' Oca. It contains some good pictures by Pacchia and other works of art, but is chiefly visited for its historic interest and as a striking memorial of the characteristic piety of the Sienese.



Plan of Siena.

Municipal buildings.

The communal palace in the Piazza del Campo was begun in 1288 and finished in 1309. It is built of brick, is a fine specimen of Pointed Gothic, and was designed by Agostino and Agnolo. The light and elegant tower (Torre del Mangia) soaring from one side of the palace was begun in 1325, and the chapel standing at its foot, raised at the expense of the Opera del Duomo as a public thank-offering after the plague of 1348, dates from 1352. This grand old palace has other attractions besides the beauty of its architecture, for its interior is lined with works of art. The atrium has a fresco by Bartolo di Fredi and the two ground-floor halls contain a Coronation of the Virgin by Sano di Pietro and a splendid Resurrection by Sodoma. In the Sala dei Nove or della Pace above are the noble allegorical frescos of Ambrogio Lorenzetti representing the effects of just and unjust government; the Sala delle Balestre or del Mappamondo is painted by Simone di Martino (Memmi) and others, the Cappella della Signoria by Taddeo di Bartolo, and the Sala del Concistorio by Beccafumi. Another hall is now being prepared in memory of Victor Emmanuel II., and its frescos and decorations are to be entrusted exclusively to Sienese artists. The former hall of the grand council, built in 1327, was converted into the chief theatre of Siena by Riccio in 1560, and, after being twice burned, was rebuilt in 1753 from Bibbiena's designs. Another Sienese theatre, the Rozzi, in Piazza San Pellegrino, designed by A. Doveri and erected in 1816, although modern, has an historic interest as the work of an academy dating from the 16th century, called the Congrega de' Rozzi, that played an important part in the history of the Italian comic stage.

Palaces, etc.

The city is adorned by many other noble edifices both public and private, of which we will mention the following palaces—the Tolomei (1205); Buonsignori, formerly Tegliacci, an elegant 14th-century construction, restored in 1848; Grottanelli, formerly Pecci and anciently the residence of the captain of war, recently restored in its original style; Sansedoni; Marsilii; Piccolomini, now belonging to the Government and containing the state archives; Piccolomini delle Papesse, like the other Piccolomini mansion, designed by Bernardo Rossellino, and now the national bank; the enormous block of the Monte de' Paschi, enlarged and partly rebuilt in the original style between 1877 and 1881, and including the old Dogana and Spannocchi palaces; the Loggia di Mercanzia (15th century), now a club; the Loggia del Papa, erected by Pius II.; and other fine buildings. We must also mention the two celebrated fountains, Fonte Gaia and Fontebranda; the Fonte Nuova, near Porta Ovile, by Camaino di Crescentino also deserves notice. Thanks to all these architectural treasures, the narrow Sienese streets with their many windings and steep ascents are full of picturesque charm, and, together with the collections of excellent paintings, foster the local pride of the inhabitants and preserve their taste and feeling for art.

History.—The origin of Siena, like that of other Italian cities, is lost in a mist of legendary tradition. It was probably founded by the Etruscans, and then falling under the Roman rule became a colony in the reign of Augustus, or a little earlier, and was distinguished by the name of *Sæna Julia.* Few memorials of the Roman era or of the first centuries of Christianity have been preserved, and none at all of the interval preceding the Lombard period. We have documentary evidence that during this epoch, in the reign of Rotaris (or Rotari), there was a bishop of

Siena named Mouro. Attempts to trace earlier bishops as far back as the 5th century have yielded only vague and contradictory results. Under the Lombards the civil government was in the hands of a *gastaldo*, under the Carolingians of a count, whose authority, by slow degrees and a course of events similar to what took place in other Italian communes, gave way to that of the bishop, whose power in turn gradually diminished and was superseded by that of the consuls and the commonwealth.

Struggle between nobles and popolani.

We have written evidence of the consular government of Siena from 1125 to 1212; the number of consuls varied from three to twelve. This government, formed of *gentiluomini* or nobles, did not remain unchanged throughout the whole period, but was gradually forced to accept the participation of the *popolani* or lower classes, whose efforts to rise to power were continuous and determined. Thus in 1137 they obtained a third part of the government by the reconstitution of the general council with 100 nobles and 50 *popolani*. In 1199 the institution of a foreign *podestà* gave a severe blow to the consular magistracy, which was soon extinguished; and in 1233 the people again rose against the nobles in the hope of ousting them entirely from office. The attempt was not completely successful; but the Government was now equally divided between the two estates by the creation of a supreme magistracy of twenty-four citizens, —twelve nobles and twelve *popolani*. During the rule of the nobles and the mixed rule of nobles and *popolani* the commune of Siena was enlarged by fortunate acquisitions of neighboring lands and by the submission of feudal lords, such as the Scialenghi, Aldobrandeschi, Pannocchieschi, Visconti di Campiglia, etc. Before long the reciprocal need of fresh territory and frontier disputes, especially concerning Poggibonsi and Montepulciano, led to an outbreak of hostilities between Florence and Siena. Thereupon, to spite the rival republic, the Sienese took the Ghibelline side, and the German emperors, beginning with Frederick Barbarossa, rewarded their fidelity by the grant of various privileges.

War with Florence.

During the 12th and 13th centuries there were continued disturbances, petty wars, and hasty reconciliations between Florence and Siena, until in 1254–55 a more binding peace and alliance was concluded. But this treaty, in spite of its apparent stability, led in a few years to a fiercer struggle; for in 1258 the Florentines complained that Siena had infringed its terms by giving refuge to the Ghibellines they had expelled, and on the refusal of the Sienese to yield to these just remonstrances both states made extensive preparations for war. Siena applied to Manfred, obtained from him a strong body of German horse, under the command of Count Giordano, and likewise sought the aid of its Ghibelline allies. Florence equipped a powerful citizen army, of which the original registers are still preserved in the volume entitled *Il Libro di Montaperti* in the Florence archives. This army, led by the podestà of Florence and twelve burgher captains, set forth gayly on its march towards the enemy's territories in the middle of April, 1260, and during its first campaign, ending 18th May, won an insignificant victory at Santa Petronilla, outside the walls of Siena. But in a second and more important campaign, in which the militia of the other Guelf towns of Tuscany took part, the Florentines were signally defeated at Montaperti on 4th September, 1260. This defeat crushed the power of Florence for many years, reduced the city to desolation, and apparently annihilated the Florentine Guelfs. But the battle of Benevento (1266) and the establishment of the dynasty of Charles of Anjou on the Neapolitan throne put an end to the Ghibelline predominance in Tuscany. Ghibelline Siena soon felt the effects of the change in the defeat of its army at Colle di Valdelsa (1269) by the united forces of the Guelf exiles, Florentines, and French, and the death in that battle of her powerful citizen Provenzano Salvani (mentioned by Dante), who had been the leading spirit of the Government at the time of the victory of Montaperti. For some time Siena remained faithful to the Ghibelline cause; nevertheless Guelf and democratic sentiments began to make head. The Ghibellines were on several occasions expelled from the city, and, even when a temporary reconciliation of the two parties allowed them to return, they failed to regain their former influence.

Success of popular party.

Meanwhile the popular party acquired increasing power in the state. Exasperated by the tyranny of the Salimbeni and other patrician families allied to the Ghibellines, it decreed in 1277 the exclusion of all nobles from the supreme magistracy (consisting since 1270 of thirty-six instead of twenty-four members), and insisted that this council should be formed solely of Guelf traders and men of the middle class. This constitution was confirmed in 1280 by the reduction of the supreme magistracy to fifteen members, all of the humbler classes, and was definitively sanctioned in 1285 (and 1287) by the institution of the magistracy of nine. This council of nine, composed only of burghers, carried on the government for about seventy years, and its rule was sagacious and peaceful. The territories of the state were enlarged; a friendly alliance was maintained with Florence; trade flourished; in 1321 the university was founded, or rather revived, by the introduction of Bolognese scholars; the principal buildings now adorning the town were begun; and the charitable institutions, which are the pride of modern Siena, increased and prospered. But meanwhile the exclusiveness of the single class of citizens from whose ranks the chief magistrates were drawn had converted the government into a close oligarchy and excited the hatred of every other class. Nobles, judges, notaries, and populace rose in frequent revolt, while the nine defended their state (1295–1309) by a strong body of citizen militia divided into *terzieri* (sections) and *contrade* (wards), and violently repressed these attempts. But in 1355 the arrival of Charles IV. in Siena gave fresh courage to the malcontents, who, backed by the imperial authority, overthrew the government of the nine and substituted a magistracy of twelve drawn from the lowest class. These new rulers were to some extent under the influence of the nobles who had fomented the rebellion, but the latter were again soon excluded from all share in the government. This was the beginning of a determined struggle for supremacy, carried on for many years, between the different classes of citizens, locally termed *ordini* or *monti*,—the lower classes striving to grasp the reins of government, the higher classes already in office striving to keep all power in their own hands, or to divide it in proportion to the relative strength of each *monte*. As this struggle is of too complex a nature to be described in detail, we must limit ourselves to a summary of its leading episodes.

Council of nine.

Rule of the twelve.

The twelve who replaced the council of nine (as these had previously replaced the council of the nobles) consisted—both as individuals and as a party—of ignorant, incapable, turbulent men, who could neither rule the state with firmness nor confer prosperity on the republic. They speedily broke with the nobles, for whose manœuvres they had at first been useful tools, and then split into two factions, one siding with the Tolomei, the other, the more restless and violent, with the Salimbeni and the *noveschi* (partisans of the nine), who, having still some influence in the city, probably fomented these dissensions, and, as we shall see later on, skilfully availed themselves of every chance likely to restore them to power. In 1368 the adversaries of the twelve succeeded in driving them by force from the public palace, and substituting a government of thirteen,—

ten nobles and three *noveschi*. This government lasted only twenty-two days, from 2d to 24th September, and was easily overturned by the dominant faction of the *dodicini* (partisans of the twelve), aided by the Salimbeni and the populace, and favored by the emperor Charles IV. The nobles were worsted, being driven from the city as well as from power; but the absolute rule of the twelve was brought to an end, and right of participation in the government was extended to another class of citizens. For, on the expulsion of the thirteen from the palace, a council of 124 plebeians created a new magistracy of twelve *difensori* (defenders), no longer drawn exclusively from the order of the twelve, but composed of five of the *popolo minuto*, or lowest populace (now first admitted to the government), four of the twelve, and three of the nine. But it was of short duration, for the *dodicini* were ill satisfied with their share, and in December of the same year (1368) joined with the *popolo minuto* in an attempt to expel the three *noveschi* from the palace. But the new popular order, which had already asserted its predominance in the council of the *riformatori*, now drove out the *dodicini*, and for five days (11th to 16th December) kept the government in its own hands. Then, however, moved by fear of the emperor, who had passed through Siena two months before on his way to Rome, and who was about to halt there on his return, it tried to conciliate its foes by creating a fresh council of 150 *riformatori*, who replaced the twelve defenders by a new supreme magistracy of fifteen, consisting of eight *popolani*, four *dodicini*, and three *noveschi*, entitled respectively "people of the greater number," "people of the middle number," and "people of the less number." From this renewal dates the formation of the new order of *monte dei riformatori*, the title henceforth bestowed on all citizens, of both the less and the greater people, who had reformed the government and begun to participate in it in 1368. The turbulent faction of the twelve and the Salimbeni, being dissatisfied with these changes, speedily rose against the new Government. This time they were actively aided by Charles IV., who, having returned from Rome, sent his militia, commanded by the imperial vicar Malatesta da Rimini, to attack the public palace. But the Sienese people, being called to arms by the council of fifteen, made a most determined resistance, routed the imperial troops, captured the standard and confined the emperor in the Salimbeni palace. Thereupon Charles came to terms with the Government, granted it an imperial patent, and left the city, consoled for his humiliation by the gift of a large sum of money.

Riformatori and council of fifteen.

In spite of its wide basis and great energy, the *monte dei riformatori*, the heart of the new Government, could not satisfactorily cope with the attacks of adverse factions and treacherous allies. So, the better to repress them, it created in 1369 a chief of the police, with the title of *esecutore*, and a numerous association of *popolani*—the company or *casata grande* of the people—as bulwarks against the nobles, who had been recalled from banishment, and who, though fettered by strict regulations, were now eligible for offices of the state. But the appetite for power of the "less people" and the dregs of the populace was whetted rather than satisfied by the installation of the *riformatori* in the principal posts of authority. Among the wool-carders—men of the lowest class, dwelling in the precipitous lanes about the Porta Ovile—there was an association styling itself the "company of the worm." During the famine of 1371 this company rose in revolt, sacked the houses of the rich, invaded the public palace, drove from the council of fifteen the four members of the twelve and the three of the nine, and replaced them by seven tatterdemalions. Then, having withdrawn to its own quarter, it was suddenly attacked by the infuriated citizens (*noveschi* and *dodicini*), who broke into houses and workshops and put numbers of the inhabitants to the sword without regard for age or sex. Thereupon the popular rulers avenged these misdeeds by many summary executions in the piazza. These disorders were only checked by fresh changes in the council of fifteen. It was now formed of twelve of the greater people and three *noveschi*, to the total exclusion of the *dodicini*, who, on account of their growing turbulence, were likewise banished from the city.

Contention for Arezzo.

Magistracy of the ten priors.

Meanwhile the Government had also to contend with difficulties outside the walls. The neighboring lords attacked and ravaged the municipal territories; grave injuries were inflicted by the mercenary bands, especially by the Bretons and Gascons. The rival claims to the Neapolitan kingdom of Carlo di Durazzo and Louis of Anjou caused fresh disturbances in Tuscany. The Sienese Government conceived hopes of gaining possession of the city of Arezzo, which was first occupied by Durazzo's men, and then by Enguerrand de Coucy for Louis of Anjou; but while the Sienese were nourishing dreams of conquest the French general unexpectedly sold the city to the Florentines, whose negotiations had been conducted with marvellous ability and despatch (1384). The gathering exasperation of the Sienese, and notably of the middle class, against their rulers was brought to a climax by this cruel disappointment. Their discontent had been gradually swelled by various acts of home and foreign policy during the sixteen years' rule of the *riformatori*, nor had the concessions granted to the partisans of the twelve and the latter's recall and renewed eligibility to office availed to conciliate them. At last the revolt broke out and gained the upper hand, in March, 1385. The *riformatori* were ousted from power and expelled the city, and the trade of Siena suffered no little injury by the exile of so many artisan families. The fifteen were replaced by a new supreme magistracy of ten priors, chosen in the following proportions,—four of the twelve, four of the nine, and two of the people proper, or people of the greater number, but to the exclusion of all who had shared in the government or sat in council under the *riformatori*. Thus began a new order or *monte del popolo*, composed of families of the same class as the *riformatori*, but having had no part in the government during the latter's rule. But, though now admitted to power through the burgher reaction, as a concession to democratic ideas, and to cause a split among the greater people, they enjoyed very limited privileges.[1]

Subjection to Milan.

In 1387 fresh quarrels with Florence on the subject of Montepulciano led to an open war, that was further aggravated by the interference in Tuscan affairs of the ambitious duke of Milan, Gian Galeazzo Visconti. With him the Sienese concluded an alliance in 1389 and ten years later accepted his suzerainty and resigned the liberties of their state. But in 1402 the death of Gian Galeazzo lightened their yoke. In that year the first plot against the Viscontian rule, hatched by the twelve and the Salimbeni and fomented by the Florentines, was violently repressed, and caused the twelve to be again driven from office; but in the following year a special *balìa*, created in consequence of that riot, annulled the ducal suzerainty and restored the liberties of Siena. During the interval the supreme magistracy had assumed a more popular form. By the partial readmission of the *riformatori* and exclusion of the twelve, the permanent *balìa* was now composed of nine priors (three of the nine, three of the people, and three of the *riformatori*) and of a captain of the people to be chosen from each of the three *monti* in turn. On 11th April peace was made with the Florentines and Siena enjoyed several years of tranquil prosperity.

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[1] The following are the *ordini* or *monti* that held power in Siena for any considerable time—*gentiluomini*, from the origin of the republic; *nove*, from about 1285; *dodici*, from 1355; *riformatori*, from 1368; *popolo*, from 1385.

Quarrels with Florence.

Institution of the balìa.

But the great Western schism then agitating the Christian world again brought disturbance to Siena. In consequence of the decisions of the council of Pisa, Florence and Siena had declared against Gregory XII. (1409); Ladislaus of Naples, therefore, as a supporter of the pope, seized the opportunity to make incursions on Sienese territory, laying it waste and threatening the city. The Sienese maintained a vigorous resistance till the death of this monarch in 1414 freed them from his attacks. In 1431 a fresh war with Florence broke out, caused by the latter's attempt upon Lucca, and continued in consequence of the Florentines' alliance with Venice and Pope Eugenius IV., and that of the Sienese with the duke of Milan and Sigismund, king of the Romans. This monarch halted at Siena on his way to Rome to be crowned, and received a most princely welcome. In 1433 the opposing leagues signed a treaty of peace, and, although it was disadvantageous to the Sienese and temptations to break it were frequently urged upon them, they faithfully adhered to its terms. During this period of comparative tranquillity Siena was honored by the visit of Pope Eugenius IV. (1443) and by that of the emperor Frederick III., who came there to receive his bride, Eleanor of Portugal, from the hands of Bishop Æneas Sylvius Piccolomini, his secretary and historian (1452). This meeting is recorded by the memorial column still to be seen outside the Camollia gate. In 1453 hostilities against Florence were again resumed, on account of the invasions and ravages of Sienese territory committed by Florentine troops in their conflicts with Alphonso of Naples, who since 1447 had made Tuscany his battle-ground. Peace was once more patched up with Florence in 1454. Siena was next at war for several years with Aldobrandino Orsini, count of Pitigliano, and with Jacopo Piccinini, and suffered many disasters from the treachery of its generals. About the same time the republic was exposed to still graver danger by the conspiracy of some of its leading citizens to seize the reins of power and place the city under the suzerainty of Alphonso, as it had once been under that of the duke of Milan. But the plot came to light; its chief ringleaders were beheaded, and many others sent into exile (1456); and the death of Alphonso at last ended all danger from that source. During those critical times the government of the state was strengthened by a new executive magistracy called the *balìa*, which from 1455 began to act independently of the priors or consistory. Until then it had been merely a provisional committee annexed to the latter. But henceforward the *balìa* had supreme jurisdiction in all affairs of the state, although always, down to the fall of the republic, nominally preserving the character of a magistracy extraordinary. The election of Æneas Sylvius Piccolomini to the papal chair in 1458 caused the utmost joy to the Sienese; and in compliment to their illustrious fellow-citizen they granted the request of the nobles and readmitted them to a share in the government. But this concession, grudgingly made, only remained in force for a few years, and on the death of the pope (1464) was revoked altogether, save in the case of members of the Piccolomini house, who were decreed to be *popolani* and were allowed to retain all their privileges. Meanwhile fresh discords were brewing among the plebeians at the head of affairs.

Revolution of 1480.

The conspiracy of the Pazzi in 1478 led to a war in which Florence and Milan were opposed to the pope and the king of Naples, and which was put an end to by the peace of 13th March, 1480. Thereupon Alphonso, duke of Calabria, who was fighting in Tuscany on the side of his father Ferdinand, came to an agreement with Siena and, in the same way as his grandfather Alphonso, tried to obtain the lordship of the city and the recall of the exiled rebels of 1456. The *noveschi* (to whose order most of the rebels belonged) favored his pretensions, but the *riformatori* were against him. Many of the people sided with the *noveschi*, rose in revolt on 22d June, 1480, and, aided by the duke's soldiery, reorganized the government to their own advantage. Dividing the power between their two orders of the nine and the people, they excluded the *riformatori* and replaced them by a new and heterogeneous order styled the *aggregati*, composed of nobles, exiles of 1456, and citizens of other orders who had never before been in office. But this violent and perilous upset of the internal liberties of the republic did not last long. A decree issued by the Neapolitan king (1482) depriving the Sienese of certain territories in favor of Florence entirely alienated their affections from that monarch. Meanwhile the *monte* of the nine, the chief promoters of the revolution of 1480, were exposed to the growing hatred and envy of their former allies, the *monte del popolo*, who, conscious of their superior strength and numbers, now sought to crush the *noveschi* and rise to power in their stead. This change of affairs was accomplished by a series of riots between 7th June, 1482, and 20th February, 1483. The *monte del popolo* seized the lion's share of the government; the *riformatori* were recalled, the *aggregati* abolished, and the *noveschi* condemned to perpetual banishment from the government and the city. But "in perpetuo" was an empty form of words in those turbulent Italian republics. The *noveschi*, being "fat burghers" with powerful connections, abilities, and traditions, gained increased strength and influence in exile; and five years later, on 22d July, 1487, they returned triumphantly to Siena, dispersed the few adherents of the *popolo* who offered resistance, murdered the captain of the people, reorganized the state, and placed it under the protection of the Virgin Mary. And, their own predominance being assured by their numerical strength and influence, they accorded equal shares of power to the other *monti*.

Pandolfo Petrucci.

Among the returned exiles was Pandolfo Petrucci, chief of the *noveschi* and soon to be at the head of the Government. During the domination of this man (who, like Lorenzo de' Medici, was surnamed "the Magnificent") Siena enjoyed many years of splendor and prosperity. We use the term "domination" rather than "signory" inasmuch as, strictly speaking, Petrucci was never lord of the state, and left its established form of government intact; but he exercised despotic authority in virtue of his strength of character and the continued increase of his personal power. He based his foreign policy on alliance with Florence and France, and directed the internal affairs of the state by means of the council (*collegio*) of the *balìa*, which, although occasionally reorganized for the purpose of conciliating rival factions, was always subject to his will. He likewise added to his power by assuming the captainship of the city guard (1495), and later by the purchase from the impoverished commune of several outlying castles (1507). Nor did he shrink from deeds of bloodshed and revenge; the assassination of his father-in-law, Niccolò Borghesi (1500), is an indelible blot upon his name. He successfully withstood all opposition within the state, until he was at last worsted in his struggle with Cesare Borgia, who caused his expulsion from Siena in 1502. But through the friendly mediation of the Florentines and the French king he was recalled from banishment on 29th March, 1503. He maintained his power until his death at the age of sixty on 21st May, 1512, and was interred with princely ceremonials at the public expense. The predominance of his family in Siena did not last long after his decease. Pandolfo had not the qualities required to found a dynasty such as that of the Medici. He lacked the lofty intellect of a Cosimo or a Lorenzo, and the at-

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mosphere of liberty-loving Siena with its ever-changing factions was in no way suited to his purpose. His eldest son Borghese Petrucci, was incapable, haughty, and exceedingly corrupt; he only remained three years at the head of affairs and fled ignominiously in 1515. Through the favor of Leo X. he was succeeded by his cousin Raffaello Petrucci, previously governor of St. Angelo and afterwards a cardinal.

Under the protection of the emperor.

This Petrucci was a bitter enemy to Pandolfo's children. He caused Borghese and a younger son named Fabio to be proclaimed as rebels, while a third son, Cardinal Alphonso, was strangled by order of Leo X. in 1518. He was a tyrannical ruler, and died suddenly in 1522. In the following year Clement VII. insisted on the recall of Fabio Petrucci; but two years later a fresh popular outbreak drove him from Siena forever. The city then placed itself under the protection of the emperor Charles V., created a magistracy of "ten conservators of the liberties of the state" (December, 1524), united the different *monti* in one named the "*monte* of the reigning nobles," and rejoicing to be rid of the last of the Petrucci, dated their public books, *ab instaurata libertate* year I., II., and so on.

The so-called free government subject to the empire lasted for twenty-seven years; and the desired protection of Spain weighed more and more heavily until it became a tyranny. The imperial legates and the captains of the Spanish guard in Siena crushed both Government and people by continual extortions and by undue interference with the functions of the *balìa*. Charles V. passed through Siena in 1535, and, as in all the other cities of enslaved Italy, was received with the greatest pomp; but he left neither peace nor liberty behind him. From 1527 to 1545 the city was torn by faction fights and violent revolts against the *noveschi*, and was the scene of frequent bloodshed. The *balìa* was reconstituted several times by the imperial agents,—in 1530 by Don Lopez di Soria and Alphonso Piccolomini, duke of Amalfi, in 1540 by Granvella (or Granvelle), and in 1548 by Don Diego di Mendoza; but government was carried on as badly as before, and there was increased hatred of the Spanish rule. When in 1549 Don Diego announced the emperor's purpose of erecting a fortress in Siena to keep the citizens in order, the general hatred found vent in indignant remonstrance. The historian Orlando Malavolti and other special envoys were sent to the emperor in 1550 with a petition signed by more than a thousand citizens praying him to spare them so terrible a danger; but their mission failed: they returned unheard. Meanwhile Don Diego had laid the foundation of the citadel and was carrying on the work with activity. Thereupon certain Sienese citizens in Rome, headed by Æneas Piccolomini (a kinsman of Pius II.), entered into negotiations with the agents of the French king and, having with their help collected men and money, marched on Siena and forced their way in by the new gate (now Porta Romana) on 26th July, 1552. The townspeople, encouraged and reinforced by this aid from without, at once rose in revolt, and attacking the Spanish troops, disarmed them and drove them to take refuge in the citadel (28th July). And finally by an agreement with Cosimo de' Medici, duke of Florence, the Spaniards were sent away on the 5th August, 1552, and the Sienese took possession of their fortress.

Contest between empire and France for Siena.

The Government was now reconstituted under the protection of the French agents; the *balìa* was abolished, its very name having been rendered odious by the tyranny of Spain, and was replaced by a similar magistracy styled *capitani del popolo e reggimento*. Siena exulted in her recovered freedom; but her sunshine was soon clouded. First, the emperor's wrath was stirred by the influence of France in the counsels of the republic; then Cosimo, who was no less jealous of the French, conceived the design of annexing Siena to his own dominions. The first hostilities of the imperial forces in Val di Chiana (1552–53) did little damage; but when Cosimo took the field with an army commanded by the marquis of Marignano the ruin of Siena was at hand. On 26th January Marignano captured the forts of Porta Camollia (which the whole population of Siena, including the women, had helped to construct) and invested the city. On 2d August of the same year, at Marciano in Val di Chiana, he won a complete victory over the Sienese and French troops under Piero Strozzi, the Florentine exile and marshal of France. Meanwhile Siena was vigorously besieged, and its inhabitants, sacrificing everything for their beloved city, maintained a most heroic defence. A glorious record of their sufferings is to be found in the *Diary* of Sozzini, the Sienese historian, and in the *Commentaries* of Blaise de Monluc, the French representative in Siena. But in April, 1555, the town was reduced to extremity and was forced to capitulate to the emperor and the duke. On 21st April the Spanish troops entered the gates; thereupon many patriots abandoned the city and, taking refuge at Montalcino, maintained there a shadowy form of republic until 1559.

Incorporation of Siena with Tuscany.

Cosimo I. de' Medici being granted the investiture of the Sienese state by the patent of Philip II. of Spain, dated 3d July, 1557, took formal possession of the city on the 19th of the same month. A lieutenant-general was appointed as representative of his authority; the council of the *balìa* was reconstituted with twenty members chosen by the duke; the consistory and the general council were left in existence but deprived of their political autonomy. Thus Siena was annexed to the Florentine state under the same ruler and became an integral part of the grand-duchy of Tuscany. Nevertheless it retained a separate administration for more than two centuries, until the general reforms of the grand-duke Pietro Leopoldo, the French domination, and finally the restoration swept away all differences between the Sienese and Florentine systems of government. In 1859 Siena was the first Tuscan city that voted for annexation to Piedmont and the monarchy of Victor Emmanuel II., this decision (voted 26th June) being the initial step towards the unity of Italy.

Literary History.—The literary history of Siena, while recording no gifts to the world equal to those bequeathed by Florence, and without the power and originality by which the latter became the centre of Italian culture, can nevertheless boast of some illustrious names. Of these a brief summary, beginning with the department of general literature and passing on to history and science, is subjoined. Many of them are also dealt with in separate articles, to which the reader is referred.

Literary history.

As early as the 13th century the vulgar tongue was already well established at Siena, being used in public documents, commercial records, and private correspondence. The poets flourishing at that period were Folcacchiero, Cecco Angiolieri—a humorist of a very high order—and Bindo Bonichi, who belonged also to the following century. The chief glory of the 14th century was St. Catherine Benincasa. The year of her death (1380) was that of the birth of St. Bernardino Albizzeschi, a popular preacher whose sermons in the vulgar tongue are models of style and diction. To the 15th century belongs Æneas Sylvius Piccolomini (Pius II.), humanist, historian, and political writer. In the 16th century we find another Piccolomini (Alexander), bishop of Patras, author of a curious dialogue, *Della bella Creanza delle Donne;* another bishop, Claudio Tolomei, diplomatist, poet, and philologist, who revived the use of ancient Latin metres; and Luca Contile, a writer of narratives, plays, and poems. Prose fiction had two representatives in this century,—Scipione Bargagli, a writer of some merit, and Pietro Fortini, whose productions were trivial and indecent. In the 17th century we find Ludovico Sergardi (Quinto Settano), a Latinist and satirical writer of much talent and culture; but the most original and brilliant figure in Sienese literature is that of Girolamo Gigli (1660–1722), author of the *Gazzettino*, *La Sorrellina di Don Pilone*, *Il Vocabolario Cateriniano*, and the *Diario Ecclesiastico*. As humorist, scholar, and philologist Gigli would take a high place in the literature of any land.

His resolute opposition to all hypocrisy—whether religious or literary—exposed him to merciless persecution from the Jesuits and the Della Cruscan Academy.

Historians.

In the domain of history we have first the old Sienese chronicles, which down to the 14th century are so confused that it is almost impossible to disentangle truth from fiction or even to decide the personality of the various authors. Three 14th century chronicles, attributed to Andrea Dei, Agnolo di Tura, called Il Grasso, and Neri di Donati, are published in Muratori, vol. xv. To the 15th century belongs the chronicle of Allegretto Allegretti, also in Muratori (vol. xxiii.); and during the same period flourished Sigismondo Tizio (a priest of Siena, though born at Castiglione Aretino), whose voluminous history written in Latin and never printed (now among the MSS. of the Chigi Library in Rome), though devoid of literary merit, contains much valuable material. The best Sienese historians belong to the 16th century. They are Orlando Malavolti (1515–1596), a man of noble birth, the most trustworthy of all; Antonio Bellarmati; Alessandro Sozzini di Girolamo, the sympathetic author of the *Diario dell' ultima Guerra Senese;* and Giugurta Tommasi, of whose tedious history ten books, down to 1354, have been published, the rest being still in manuscript. Together with these historians we must mention the learned scholars Celso Cittadini (d. 1627), Ulberto Benvoglienti (d. 1733), one of Muratori's correspondents, and Gio. Antonio Picci (d. 1768), author of histories of Pandolfo Petrucci and the bishopric of Siena. In the same category may be classed the librarian C. F. Carpellini (d. 1872), author of several monographs on the origin of Siena and the constitution of the republic, and Scipione Borghesi (d. 1877), who has left a precious store of historical, biographical, and bibliographical studies and documents.

Scientific writers.

In theology and philosophy the most distinguished names are—Bernardino Ochino and Lelio and Fausto Soccini (16th century); in jurisprudence, three Soccini—Mariano senior, Bartolommeo, and Mariano junior (15th and 16th centuries); and in political economy, Sallustio Bandini (1677–1760), author of the *Discorso sulla Maremma.* In physical science the names most worthy of mention are those of the botanist Pier Antonio Mattioli (1501–1572), of Pirro Maria Gabrielli (1643–1705), founder of the academy of the Physiocritics, and of the anatomist Paolo Mascagni (d. 1825).

Painters.

Art.—The history of Sienese art is a fair and luminous record. Lanzi happily designates Sienese painting as "Lieta scuola fra lieto popolo" ("the blithe school of a blithe people"). The special characteristics of its masters are freshness of color, vivacity of expression, and distinct originality. The Sienese school of painting owes its origin to the influence of Byzantine art; but it improved that art, impressed it with a special stamp, and was for long independent of all other influences. Consequently Sienese art seemed almost stationary amid the general progress and development of the other Italian schools, and preserved its mediæval character down to the end of the 15th century. When the Florentine Giotesques and their few followers were on the wane, this mystic Sienese school still showed continued fertility and improvement. At the close of the 15th century the influence of the Umbrian and—to a slighter degree—of the Florentine schools began to penetrate into Siena, followed a little later by that of the Lombard, and these grafts gave fresh vigor to the old stock without destroying its special characteristics. Of this new phase of Sienese art it has been well said that Sodoma was its Leonardo, Baldassare Peruzzi its Raphael, and Beccafumi its Michelangelo. In every age Siena has produced many painters of different degrees of merit. It is impossible to mention all, so we will only cite the names of the more celebrated. In the 13th century we find Guido (da Siena), painter of the well-known Madonna in the church of S. Domenico in Siena. The 14th century gives us Ugolino, who painted the Madonna del Tabernacolo in Or San Michele, Florence; Duccio di Buoninsegna, whose chief work is the great panel of the high altar of the cathedral at Siena; Pietro and Ambrogio Lorenzetti, Simone di Martino (or Memmi), Lippo Memmi, Andrea di Vanni (painter and statesman), and Taddio di Bartolo. In the 15th century we have Sano di Pietro, Giovanni di Paolo, Stefano di Giovanni (Il Sassetta), and Matteo di Giovanni Bartoli, whose several paintings of the massacre of the Innocents show a fine sentiment and much observation of reality. The 16th century boasts the names of Guidoccio Cossarelli, Giacomo Pacchiarotto, Girolamo del Pacchia, Baldassare Peruzzi (1481–1537), who was excellent in many branches of art and especially celebrated for his frescos and studies in perspective and chiaroscuro; Giovanni Antonio Bazzi, otherwise known as Il Sodoma (1477–1549), who, born at Vercelli in Piedmont and trained at Milan in the school of Leonardo da Vinci, came to Siena in 1504 and there produced his finest works; Domenico Beccafumi, otherwise known as Micharino (1486–1550), noted for the Michelangelesque daring of his designs; and Francesco Vanni.

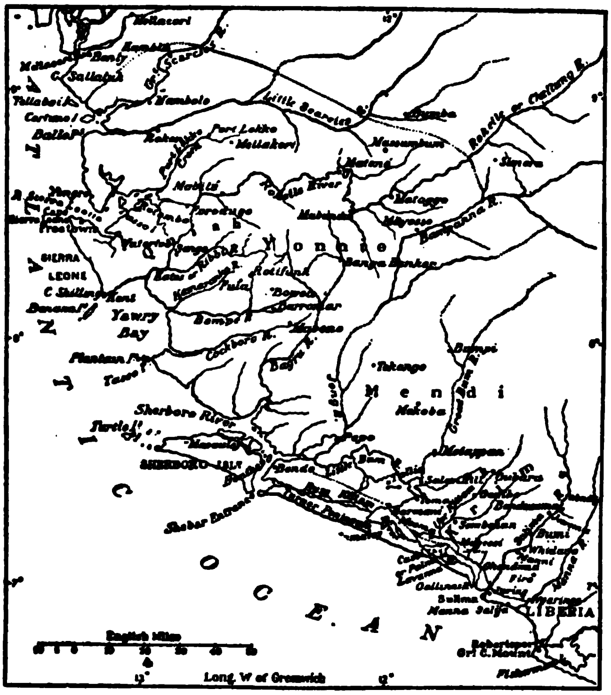
Sculptors and architects.

Side by side with these painters marches a notable band of sculptors and architects, such as Lorenzo Maitani, architect of the Orvieto cathedral (end of 13th century); Camaino di Crescentino; Tino di Camaino, sculptor of the monument to Henry VII. in the Campo Santo of Pisa; Agostino and Agnolo, who in 1330 carved the fine tomb of Bishop Guido Tarlati in the cathedral of Arezzo; Lando di Pietro (14th century), architect, entrusted by the Sienese commune with the proposed enlargement of the cathedral (1339); Giacomo della Quercia, whose lovely fountain, the Fonte Gaia, in the Piazza del Campo has been recently restored by the sculptor Sarrocchi; Lorenzo di Pietro (Il Vecchietta), a pupil of Della Quercia and an excellent artist in marble and bronze; Francesco di Giorgo Martino (1439–1502), painter, sculptor, military engineer and writer on art; Giacomo Cozzarelli (15th century); and Lorenzo Mariano, surnamed Il Marrina (16th century). (C. PA.)

SIERADZ, a town of Russian Poland, in the government of Kalisz (Kalish), situated on the Warta, 127 miles southwest of Warsaw. It is one of the oldest towns of Poland, founded prior to the introduction of Christianity, and was formerly known as Syra or Syraz. The annals mention it in 1139. Several *seims* were held there during the 13th to 15th centuries, and it was a wealthy town until nearly destroyed by fire in 1447. It is full of historical interest for the Poles. The old castle, which suffered much in the Swedish war, was destroyed by the Germans in 1800. There are two churches dating from the 12th and 14th centuries. Sieradz, after having been the chief town of a *voivództvo*, has now no importance. Its population was 15,040 in 1884.

SIERRA LEONE, a British colony on the West Coast of Africa, the capital of which, Freetown, lies in 8° 29′ N. lat. and 13° 14′ W. long. It consists of Sierra Leone proper, part of the Quiah country to the east, Tasso Island, etc., in the Sierra Leone estuary, part of the Bullom country to the north, the Los Islands to the north of the Mellicoury (Mellacorée) river, the Banana Islands to the south of the main settlement, Sherbro (Sherboro) Island and part of the Sherbro country, the Turner peninsula, W. E. Tucker's territory, and generally all the seaboard south to the mouth of the Manoh (Manna) river, which is now recognized as the northern boundary of Liberia. The British territory and protectorate are estimated to have an area of about 3000 square miles; and, though it has not all been formally annexed, the whole coast region from the mouth of the Scarcies in 8° 55′ N. lat. to that of the Manoh in 6° 55′ may be considered as British, at least to the exclusion of any other European sovereignty.

Sierra Leone proper is a peninsula about 18 miles long from northwest to southeast by about 12 broad. It lies between the Sierra Leone estuary on the north and Yawry bay on the south. Lengthwise it is traversed by a range of high hills attaining a height of 3000 feet in the Sugar Loaf and nearly as much in Mount Horton farther south. From the mainland the peninsula is physically separated by the Bance or Bunce river (properly estuary), which receives the Waterloo Creek and other small streams. Towards the east and southeast the peninsula sinks to the level of the great alluvial zone which extends along the larger portion of this district of the African coast. The hills seem to consist of some kind of igneous rock (popularly misnamed granite) and of beds of red sandstone, the disintegration of which has given a dark-colored ferruginous soil of moderate fertility. The "lofty green trees" which clothed the "mountain" at the time of its discovery (Cadamosto) have for the most part been destroyed, though Sugar Loaf is still timbered to the top and the peninsula is verdant with abundant vegetation. The Negroes give so little attention to agriculture that the local produce would not feed the population for three months. Among the productions of the peninsula are cola nuts, ginger (in large quantities), malagetta pepper, castor-oil, maize, cassava, ground nuts and (in small quantities) cotton. Native coffee was discovered in Quiah in 1796, and the growing of Liberian coffee and cocoa has since 1880 been attempted with some success.



Map of Sierra Leone.

The rainfall of Sierra Leone, according to the Colonial Hospital observations at Freetown, is from 150 to 169 inches per annum. The three months of January, February, and March are practically rainless; the rains, commencing in April or May, reach their maximum in July, August and September, and rapidly diminish in October, November and December. It sometimes rains for thirty hours on end, but generally twelve hours of rain are followed by twenty-four, thirty or more hours of clear and pleasant weather. At the barracks (150 feet higher than the hospital) there are about 40 inches more rain, and at Kissy, 3 miles distant, some 18 or 20 inches less. The annual temperature indoors is from 78° to 86°. The highest reading for 1880 was 95° and the lowest 69.33°. During the dry season, when the climate is very much like that of the West Indies, there occur terrible tornadoes and long periods of the harmattan,—a northeast wind, dry and desiccating, and carrying with it those clouds of fine dust which the sailors designate "smokes." The dangers of the climate have long been exaggerated. The low swampy regions are like those of other tropical countries, and Freetown, being badly placed and carelessly kept, is too often a hotbed of malaria and fever; but the higher districts are not the "white man's grave."

According to the census of 1880, the population of the colony was as follows: peninsula of Sierra Leone with British Quiah, 53,862; Isles de Los, 1371; occupiers of factories on the Sierra Leone river paying rent to Government, 52; island of Tasso, 828; British Sherbro (including Bonthe, Mocolo, Mokate, Runteh, York Island, Yelbana, Victoria, Tasso, Bendu and Jamaica), 4333,—total, 60,446. But the census officials deem the actual population to be much greater, that of British Sherbro, for example, being pretty certainly 8000 or 9000. Ethnographically Sierra Leone is almost "an epitome of Africa." The following are the more important races that can be distinctly classified: Mandingos, 1190; Timmanehs, 7443; Joloffs, 189; Baggas, 340; Mendis, 3088; Sherbros, 2882; Gallinas, 697; Limbas, 493; Susus (Soosoos), 1470; Fulahs, 225; Lokkos, 1454; Serrakulis, 129; Bulloms, 129; Krumen, 610. The direct descendants of the liberated slaves now number 35,430. The Akus or people of Yoruba and the Eboes from the eastern banks of the Niger are most easily distinguished. The white residents number only 163, almost entirely a floating population.

Most of the inhabitants depend upon trade, and are collected at the north end of the peninsula, in **Freetown** (*q.v.*) and the neighboring villages. Freetown has a good supply of pure water, and great improvements in sanitation have recently been effected. Among the villages in the peninsula may be mentioned Kissy (founded in 1817) the seat of two hospitals for male and female incurables, Gloster (1816), Bathurst (1818), Leopold (1817), Charlotte (1818), Regent (1812), Leicester (1809).

According to the census returns of 1880, there were in Sierra Leone 18,660 Episcopalians, 17,098 Wesleyans and Methodists, 2717 of Lady Huntingdon's connection, and 369 Roman Catholics. Since 1861–62 there has been an independent Episcopal Native Church; but the Church Missionary Society, which in 1804 sent out the first missionaries to Sierra Leone and has spent about £500,000 on the colony, still maintains certain educative agencies. Fourah Bay college, built by the society on the site of General Turner's estate (1½ miles east of Freetown) and opened in 1828 with six pupils, one of whom was Bishop Crowther, was affiliated in 1876 to Durham university, and has a high-class curriculum. Other institutions are the grammar school (1846), the Wesleyan high school and the Annie Walsh Memorial Female Institution.

With the exception of ginger, most of the products are brought down the rivers from the interior, and the development of trade has been grievously hampered by inter-tribal wars in non-British territory. A considerable falling off is observable in those articles which require cultivation or labor, or are bulky in transit. Cola nuts have steadily increased in quantity,—that part of the Limba country where they are principally grown being in comparative peace. The supply of india-rubber has decreased, partly through destruction of the trees, partly through war in the Yonnie country. Gum copal is brought from the northern rivers. The Mendi country sends a good deal of rice, which is also grown largely in Sherbro. The total value of all the exports was on an average for 1877-81 £382,620, and for 1882–83 £413,148. The corresponding figures for the imports were £424,447 and £429,273.

The following figures show the average value of the principal exports in recent years:

	Benni Seed.	Cola Nuts.	Ginger.	Ground Nuts.	Hides.	Palm Kernels.	Palm Oil.	Rubber.	Gum Copal.
	£	£	£	£	£	£	£	£	£
1877-81	6,847	23,731	11,989	30,808	12,607	116,822	35,869	41,941	12,671
1882	10,001	25,547	7,916	15,217	13,545	101,164	47,217	96,674	11,262
1883	9,721	31,661	13,409	11,282	12,326	81,578	21,954	89,782	14,780
1884	3,776	40,002	16,304	4,846	17,674	68,377	17,774	50,894	12,539

The most northerly territory belonging to the colony is the little group of the Los Islands (Islas de los Idolos), about 80 miles north-northwest of Freetown to the south of Sangareah Bay. Tamara or Futabar to the west and Factory Island to the east "inclose, like an atoll, an inner basin, in the centre of which lies the much smaller Crawford Island." The highest point is a knoll some 450 feet above sea-level in Tamara. All these islands are richly clothed with palm trees and flowering underwood. Factory Island is occupied by a French trading settlement. At one time the islands were a great seat of the slave-trade and about 1812–13 were garrisoned by British troops for the suppression of the traffic. The climate was then found to be exceedingly fatal.

The small island of Matakong, 25 miles southeast, is also British. On the mainland the watershed between the Great Scarcies and the Mellicoury (Mellacorée) has been adopted as the boundary between the French and English protectorates or annexation areas. The Great Scarcies river (Rio dos Carceres) appears to take its rise in the highlands of the Futa-Jallon not far from the sources of the Senegal, but its upper course has not been completely explored. It is navigable for boats a long way inland, though the ascent from the sea is interrupted by rapids a short distance above Kambia, an important Mohammedan town. The Little Scarcies has its headwaters to the northeast of Falaba, a town of the Sulima country, built in 1768 and visited by Laing (1822), Winwood Reade (1869), and Zweifel and Moustier (1879). The Rokelle or Mabilé river, which falls into the Sierra Leone estuary, is formed by the drainage of the Koranko country. On a creek which reaches the estuary near the Rokelle mouth stands (at the head of navigation) the important township of Port Lokko, a mission station of the Church Missionary Society. The maritime country between the Scarcies and Sierra Leone is called North Bullom (*i.e.*, low land); the tribe of the same name has been expelled from much of its territory by the Susus (whose country is the unexplored tract to the south of 11° N. lat.) and the Timmanehs (Timnis). At the angle of Yawry Bay lies the mouth of the Ribbi or Kates river, and about 10 miles farther south is the common outflow of the Kamaranka and the Bompé. At the south side of the bay the small cluster of Plantain Islands corresponds to the Banana Islands on the north off Cape Shilling, which were ceded to the British in 1819 and are noted for their healthiness. Southward opens the broad estuary of the Sherbro (popularly river), which lies between the island of Sherbro, annexed in 1862, and the territory of the same name. The estuary receives the Bagru from the Manoh-Bagru country and the Jong river, whose headstream, the Bampanna, rises far inland in the same country as the Rokelle and has a breadth of 200 feet at Mayosso. From the sea the Jong is navigable for steamers to Matonghbah (or Matubah). It is connected by the Little Bûm Creek with the Great Bûm river, which passes through the Mendi country and descends into the alluvial seaboard by rapids at Motappan. The Bûm loses itself in a curious network of lagoons and creeks separated from the ocean by the long low tract of Turner's peninsula. The upper Kittam joins it from the east, and by another creek communicates with the Palma or Cassi Lake (20 miles long), which in its turn has a connection with the Gallinas river (7° S. lat.). On the narrow strip of land between the ocean and the lake lies Lavanna, an important trading port, where a short line of railway has been laid down. Parallel with the Gallinas flows the Moah or Sulimah river (falls at Whidaro), at the mouth of which is the town of Sulimah; and about 10 miles farther east is the Manoh river. The countries inland between the Manoh and the Sulimah are Gbemma or Massaquoi, Soro, M'perri, Barrie, Cowrah, etc.

History.—Sierra Leone (in the original Portuguese form Sierra Leona) was known to its native inhabitants as Romarong or the Mountain, and received the current designation from the Portuguese discoverer Piedro de Cintra (1462) on account of the lion-like roaring of the thunder on its hill-tops. An English fort was built on the Sierra Leone estuary towards the close of the 17th century, but was soon afterwards abandoned. In 1786 Dr. Smeathman proposed his scheme for founding on the peninsula a colony of liberated African slaves; and in 1787 Captain Thompson, having purchased the territory from Naimbana or King Tom of the Timmanehs, commenced the settlement with 400 Negroes and 60 Europeans. Owing mainly to the utter shiftlessness of the settlers and partly to a hostile attack by a body of natives, this first attempt proved a complete failure. In 1791 Falconbridge collected the surviving fugitives and laid out a new settlement (Granville's Town); and the promoters of the enterprise—Granville Sharp, William Wilberforce, William Ludlam, Sir Richard Carr Glynn, etc., hitherto known as the St. George's Bay Company—obtained a charter incorporating them as the Sierra Leone Company (31 Geo. III. c. 55). In 1792 Clarkson introduced into the colony 1200 Negroes from the Bahamas and Nova Scotia. Afzelius the botanist and Nordenskjöld the mineralogist were sent out to explore the capabilities of the country; but the latter soon after died at Port Lokko (Port Logo). In 1794 the settlement, which had been again transferred to Freetown, was plundered by the French. An attempt to found a similar colony on Bulama (mouth of the Rio Grande) was a complete failure (Dalrymple and Beaver). In 1800 the company was allowed to make laws not repugnant to those of England, but in 1807 it was glad to transfer all its rights to the crown. Sydney Smith's jest that Sierra Leone had always two governors, one just arrived in the colony and the other just arrived in England, is but a slight exaggeration. There were eight changes between 1808 and 1824, and as many between 1865 and 1881. The names of Zachary Macaulay, Sir Charles Macarthy, Sir Stephen J. Hill, Sir Arthur Kennedy, Sir Samuel Rowe, and A. E. Havelock deserve to be mentioned. In 1825 General Turner concluded a treaty placing Turner's peninsula, etc., under British protection; but effect was not given to it till 1881. In 1875 the mouths of the Kates, Kamaranka, Bompé, and Cockboro were annexed, and in 1883 the seaboard towards the Liberian frontier. British influence has been peacefully advancing inland under Sir Samuel Rowe. In 1866 Sierra Leone was made the seat of government of the new general government of the British settlements on the West Coast of Africa (comprising Sierra Leone, Gambia, the Gold Coast, and Lagos, each of which was to have a legislative council); but in 1874 the Gold Coast and Lagos were raised to a separate government, and the Gambia alone remains attached to Sierra Leone.

Besides the older works of Falconbridge (1794), Winterbottom (1803), Walker (1847), Shrewe (1847), Poole (1850), see the various works of Robert Clarke (*Sketches of the Colony of Sierra Leone*, 1863, etc.) and Dr. Africanus B. Horton (*West African Countries and Peoples*, 1868, etc.); A. Menzies, "Exploratory Expedition to the Mende Country," in *Church Miss. Intell.*, 1864; A. B. C. Sidthorpe, *Hist. of Sierra Leone*; T. R. Griffith, "Sierra Leone, Past, Present, and Future," in *Proc. Roy. Col. Inst.*, 1881–82, vol. xiii.; "Britische Annexionen an der Sierra-Leone-Küste," in *Petermann's Mitt.*, 1883. (H. A. W.)

SIEYÈS, Emmanuel Joseph (1748–1836), one of the chief political thinkers and writers of the period of the French Revolution and the first empire, was born at Fréjus (Var) on 3d May, 1748. He was destined for the church, was educated by the Jesuits, became a licentiate of the canon law, and, having early distinguished himself by the astuteness and originality of his ideas, was appointed vicar-general by the bishop of Chartres. He shared the political fervor of the party of advance, and was fearlessly logical in working out the new and as yet indistinct principles of reform. An excellent opportunity was provided for the inculcation of his views by the invitation which Necker addressed to all French writers to publish their opinions upon the mode of convening the states-general. Sieyès startled his countrymen by the issue of various pamphlets upon the political situation, and particularly by his daring and original treatise upon the Third Estate, with its three famous divisions in question and answer: "1st, What is the Third Estate?—Everything. What has it hitherto been in the political order?—Nothing. What does it demand?—To become something." He attacked unsparingly the privileged classes, and indeed in this his most famous work he constructed, single-handed and at once, a programme for the Revolution. The influence of the book and of its author soon became enormous, and in 1789 the Abbé Sieyès was elected by the city of Paris as a representative to the states-general, where he was the first to propose that the three estates should meet together in one assembly. On the rejection of his motion he boldly suggested the formation of an "assembly of representatives of France already verified." He was not, however, successful as a speaker, his style being obscure and his matter too compressed for oral expression,—faults which disappeared when he committed his thoughts to writing. Yet he was one of the leaders of the assembly, and was appointed a member of the committee on the constitution. His published speech in opposition to the power of absolute veto by the king brought him still further into notice. But he recognized his inaptitude for public speaking, and, although even Mirabeau declared that the silence of Sieyès was a public calamity, he stood aside while his own ideas were being developed amidst violence and riot both within and without the constituent and afterwards the legislative assembly. As excess followed upon excess in the wild course of the Revolution, Sieyès had neither the courage nor the power to quell the riot. In danger of becoming a suspect, and fearful of his life, he emerged from obscurity in November, 1793, on the occasion of the installation of Reason in Notre Dame. Before the national convention he denied his faith, abjuring the title of priest, professing that his only worship was that of liberty and equality, and his only religion the love of humanity and country, and concluding by formally renouncing to the state the commuted pension which he enjoyed in lieu of his former benefice. The overthrow of the Jacobins at last overcame his fears, and in March, 1795, he is found publicly lauding the memory of those guillotined Girondists in whose defence he, two years before, had never once lifted his voice.

In the same year (1795) the ex-abbé was commissioned by the convention to The Hague, where he successfully concluded an offensive and defensive alliance between the United Provinces and France. Without Sieyès no framing of a constitution could be attempted, and he was accordingly appointed member of a commission to draw up organic laws, the constitution of 1793 having been found unworkable. When the commission brought forward its report Sieyès did not dissent; but he proposed to the convention a separate scheme of his own, the specialty of which was the provision for the appointment of a constitutional jury which should be charged with the duty of revising all legislative decrees against which the challenge was brought that they were themselves at variance with the constitution. His scheme was, however, rejected in favor of the new constitution, and from that moment he became its secret enemy. He was elected one of the first directory of five, but he declined the honor. In 1798 he was appointed the plenipotentiary of France to Prussia, where he was received with great honor, and where he speedily began to plot against the Government he represented. He communicated his views to Napoleon, then in Egypt. Meanwhile (1799) he was again elected to the directory, and, his plans being ripe, he accepted office. Then came the *coup d'état* of 18th Brumaire (9th November, 1799), in which Sieyès took so important a part, but in which he was unquestionably overborne by the genius and audacity of Bonaparte. The provisional consulate composed of Napoleon, Sieyès, and Ducos, lasted but a few weeks. After a little, Sieyès is a count of the empire and the proprietor of Crosne (Seine-et-Oise), while Napoleon is able to boast of how he has bribed the ex-abbé out of his constitutional views. Amid the political changes of France, Sieyès on the second return of the Bourbons fled to Brussels; but after the revolution of 1830 he felt it safe to return to Paris, where he died on 20th June, 1836.

SIGALON, Xavier (1788–1837), French painter, born at Uzès (Gard) towards the close of 1788, was one of the few leaders of the romantic movement who cared for treatment of form rather than of color. The son of a poor rural schoolmaster, he had a terrible struggle before he was able even to reach Paris and obtain admission to Guérin's studio. But the learning offered there did not respond to his special needs, and he tried to train himself by solitary study of the Italian masters in the gallery of the Louvre. The Young Courtesan (Louvre), which he exhibited in 1822, at once attracted attention and was bought for the Luxembourg. The painter, however, regarded it as but an essay in practice and sought to measure himself with a mightier motive; this he did in his Locusta (Nîmes), 1824, and again in Athaliah's Massacre (Nantes), 1827. Both these works showed incontestable power; but the vision of St. Jerome (Louvre), which appeared at the salon of 1831, together with the Crucifixion (Issengeaux), was by far the most individual of all his achievements, and that year he received the cross of the Legion of Honor. The terrors and force of his pencil were not, however, rendered attractive by any charm of color; his paintings remained unpurchased, and Sigalon found himself forced to get an humble living at times by painting portraits, when Thiers, then minister of the interior, recalled him to Paris, and intrusted him with the task of copying the Sistine fresco of the Last Judgment for a hall in the Palace of the Fine Arts. On the exhibition, in the Baths of Diocletian at Rome, of Sigalon's gigantic task, in which he had been aided by his pupil, Numa Boucoiran, the artist was visited in state by Gregory XVI. But Sigalon was not destined long to enjoy his tardy honors and the comparative ease procured by a small Government pension; returning to Rome to copy some pendants in the Sistine, he died there of cholera on the 9th August, 1837.

See Julius Meyer, *Gesch. d. französischen Kunst;* Villot, *Cat. Tableaux, Louvre;* C. Blanc, *Histoire des Peintres, École Française.*

SIGHTS. A sight for shooting may be defined as an apparatus for determining the point of impact of a projectile; in popular language, for "aiming," or "laying." In its simplest form it is scarcely recognizable as a sight. When an expert cricketer throws the ball straight to the wicket, the eye and the hand assume that relative position which experience has taught to be correct, and the eye may be said to lay the hand on the wicket by means of the intervening muscles, which therefore constitute the sight. The next step towards accuracy is seen in the ordinary shot-gun, where the eye is placed over and behind the centre of the breech, and sees that a bead placed above the centre of the muzzle is in a direct line with the desired point of impact. If we add a notch at the centre of the breech, to fix the eye more accurately, we shall have the hind-sight, the fore-sight, and the object brought into line when the gun is correctly laid.

This would constitute a perfect direct mechanical sight, if we could assume (1) that the projectile was not subject to gravity; (2) that it had no tendency to deviate if passing through a calm atmosphere; (3) that the object aimed at was stationary; (4) that the weapon discharged was stationary; (5) that the atmosphere was still.

(1) The first condition is never realized: the projectile begins to drop towards the earth the moment it leaves the gun, and therefore to make it strike at a given level its first direction must be above this level. Hence the hind-sight must be raised to make the necessary correction, and the angle between the axis of the piece and the straight line connecting the elevated hind-sight with the fore-sight an object is called the "angle of elevation." Supposing the projectile to move *in vacuo* and to drop simply under the action of gravity, the calculation of the amount of elevation to be given for any range at any velocity would be easily made, but the resistance of the air renders the problem an exceedingly complicated and difficult one (see Gunnery), and only approximate solutions have as yet been discovered. Next, supposing the hind-sight to be correctly elevated, it is evidently necessary to keep it upright; deviation to the right will cause the projectile to strike to the right of the object and deviation to the left to strike to the left of it. The amount of error is given by the equation

$$d = r \tan \theta \tan \varepsilon,$$

where d = error in direction, r = range, θ = angle made by plane of elevation with the perpendicular, and ε = angle of elevation. The rifleman should study to keep the hind-sight as upright as possible, and indeed little error is likely to occur with a good shot from this cause. But the case is very different with a gun mounted on an uneven or moving platform, and many devices have been resorted to for automatically overcoming the difficulty. They all, however, belong to either the spirit-level or the pendulum type.

(2) Secondly, the projectile deviates of its own accord from the vertical plane. If it is unrifled, its imperfections of manufacture cause errors which may be in any direction, and which, therefore, cannot be compensated by any method of sighting. If it is rifled, the spin given to it renders these imperfections of little consequence, but on the other hand, confers a constant tendency to deviation. If we lay a gun on the face of a clock, and the rifling causes a point on the surface of the shot to turn in the same direction as the hands, the shot will deviate to the right, contrariwise to the left. The cause and extent of this motion have never been thoroughly worked out. It appears to arise from the circumstance that the axis round which the shot rotates points always above the trajectory, since the principle of least resistance causes the direction of the axis to follow tardily the ever-changing curve; hence the pressure of the air, which of course acts in the direction of the trajectory, is greater on the lower than on the upper surface and the unequal friction thereby set up causes the shot, as it were, to roll sideways; here also the principle of least resistance turns the axis slightly out of the vertical plane of fire towards

the actual direction of the projectile. The path is doubly curved,—first downwards by gravity; secondly, sideways by the rotation; the latter curve, seen in plan, is nearly a parabola. In order to correct this tendency of rifled projectiles to shoot round the corner, as it may be said, the hind-sight is inclined at an angle with the vertical, so that the more it is raised to give elevation the greater becomes the correction, which assumes the form of a curve not very dissimilar to that due to rotation. The amount of error is practically determined on the firing ground, and the proper angle for the sight is given by the formula

$$\tan \theta = \frac{d}{r \sin \epsilon}.$$

(3) Every one who shoots birds on the wing is acquainted with the difficulties appertaining to the nonfulfilment of the third condition. The expert game-shot aims ahead of the object more or less, according to his judgment of the relative velocities of the projectile and the target and of the distance of the latter. Practice makes this comparatively easy at the short ranges of ordinary sport; but in the case of a heavy fort gun firing at a vessel under full steam 3000 yards off, it becomes evident that considerable allowance must be made. Put the mean horizontal velocity of the shot over a 3000 yards range at 1000 foot-seconds, the time of flight will be 9 seconds; if the ship is running past at the rate of 20 foot-seconds it will have traversed 180 feet during the shot's flight, and it will be necessary to direct the gun so much ahead of the desired point of impact. The angle of divergence in the case just given is $\tan^{-1} \cdot 02$; and, supposing the horizontal velocity of the projectile to be constant throughout its flight, this angle would be correct for a ship running at a speed of 20 foot-seconds whatever the range.

(4) The fourth condition is rarely met with except on board ship, and it is evident that it obeys the same laws and is subject to the same kind of correction as the third. The correcting angle, however, is here given by the ship's speed across the line of fire and the starting velocity of the projectile.

(5) The fifth source of error differs from the others in being variable and uncontrollable. A gust of wind may spoil the best shot; and, though it is possible in practice to allow for deviation due to a steady breeze, yet the force and even the direction of the moving air differ so frequently at different parts of the trajectory that it has hitherto been found impossible to devise any satisfactory correction beyond that obtainable from knowledge of the point of impact of a previous shot. The effect of wind on direction may be calculated from the formula

$$D = W t \sin \phi - 990 \frac{w}{Ag} \log \left\{ \frac{Ag\, Wt \sin \phi}{500\, w} + 1 \right\}$$

where D = deflection in feet, W = velocity of wind in feet per second, t = time of flight in seconds, ϕ = angle between direction of wind and line of fire, A = area of longitudinal section of shot in square feet, w = weight of shot in pounds, g = force of gravity. This formula assumes that the wind steadily carries the shot sideways without changing the parallelism of its axis, an assumption not greatly in error with heavy projectiles having the centre of gravity nearly coincident with the centre of figure. The effect of wind on range may be arrived at by adding or subtracting the velocity of the air, resolved in the direction of the object, to or from the horizontal velocity of the projectile and calculating by the tables (see GUNNERY) the loss or gain due to the increased or diminished resistance.

The accompanying diagrams (Figs. 1, 2) represent what are called "speed-sights" in the royal navy as applied to a 4-inch breech-loading gun. The gun is shown elevated at 8° for a range of 4600 yards. The hind or "tangent" sight is sloped sideways at an angle of 1° 30′ to correct the constant tendency of the projectile to deviate to the right. The sight is raised in the socket till the lowest visible graduation on the bar reads the required range on the face towards the breech and the elevation in degrees on the face towards the muzzle. A crosshead carries a leaf, which is traversed to the right or left by a double-threaded screw; this leaf is provided with a fine wire strung horizontally between two uprights; hence this form of sight is sometimes known as the H sight. The crosshead is graduated with two scales, one on the muzzle-face reading minutes of deflection for giving any desired correction for wind or uneven platform, the other on the breech-face for allowing for the speed of the enemy in knots across the line of fire. The fore-sight is fixed in the gun, and cannot be raised or lowered. It has a crosshead provided with a traversing leaf, which carries a round bead on a thin support. The crosshead is graduated to allow for the speed of the firing vessel across the line of fire. In practice the gunner makes all these adjustments as nearly as he can judge, then takes up his position about 4 feet behind the breech of the gun, holding the firing lanyard taut; when the object and the bead of the fore-sight appear to be on the centre of the wire across the H of the hind-sight he fires.

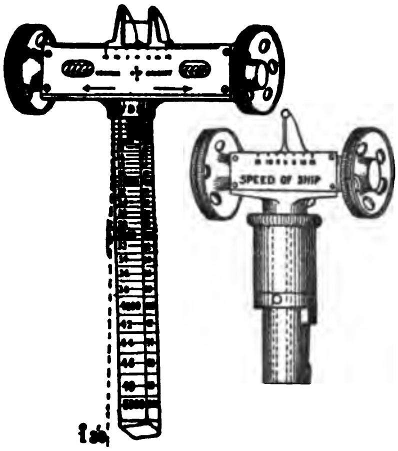


FIG. 1.—Hind-sight. Fore-sight.

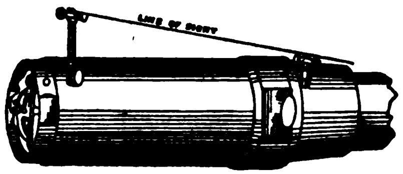


FIG. 2.—Speed-sights used in the British navy.

The forms of sights preferred by experts for accurate laying are extremely varied; and nothing but practice can determine the most suitable to individual eyesight. Where the eye can be brought close to the hind-sight, one of the best systems is that adopted for British field-guns, where a fine peep-hole constitutes the hind-sight, and the fore-sight consists of diagonal cross-wires; the first rapid or rough adjustment of the gun is made with the aid of a V-shaped notch on the hind-sight and an acorn point on the fore-sight. Some prefer pointers for the fore-sight, either O-shaped, so that the object appears between the cusps of the O—this is the French method—or placed diagonally like cross-wires with the intersection removed. Silvered vertical lines are preferred by many good shots. If the gun is mounted in a fixed position, say on a siege platform, and if the relative positions of the target and some other object are known, it may be found convenient to lay the gun on the target by directing the sights at the other object. This is principally done in the case of howitzers dropping shells at high elevation into a work. They fire over a protecting bank and are laid by reversed sights from the muzzle backwards at a steeple, a pole, or other convenient object.

To secure greater accuracy than can be attained by the eye, telescopes are resorted to. It is obviously easy to apply to a match rifle a telescope with sufficient strength to resist the jar of firing, and to provide it with the necessary fittings for elevation, deflection, etc.; but with ordnance the shock is much greater, and the telescope has to be removed before firing. This renders it difficult to secure a truly accurate attachment; but probably the immediate future will witness a sufficiently satisfactory solution of the problem as regards guns on firm platforms. Efforts have been made from time to time to overcome the necessity for extreme accuracy due to the short bearing of the telescope by bringing the fore-sight into play; this can be done either by great powers of adjustment of focus, so as to view first the fore-sight and then the target, or by adding a half-object lens, and so getting simultaneous images of fore-sight and target.

The application of electricity to the laying and firing of heavy guns has caused a remarkable development of the systems of sighting introduced recently into the forts which protect the shores of the United Kingdom. Suppose a battery of guns to command a channel, and that it is desired to concentrate their fire on a hostile vessel endeavoring to run past. Each detachment lays its gun both for elevation and direction in accordance with the figures which appear on a dial in the emplacement. Each dial is worked by electricity from an observing station away from the smoke and noise of the fort; as the hostile vessel approaches the observing officer follows its course on a chart. The observing station is placed at a considerable height above the water-line, so that a vertical base of calculation is obtained. Hence the angle of depression given by the telescope when pointing at the object indicates the range, and the direction of the telescope indicates the line of fire; these indications are automatically corrected for the positions of the guns. In practice the officer follows the ship's course, signals to the battery the line and distance of a point a little ahead of the vessel, and receives a signal from the battery that the guns are laid and ready. He then fires electrically as the ship is coming into the expected position. (E. M.)

SIGISMUND (1362–1437), German emperor, was born on 14th February, 1362.[1] After the death of his father, the emperor Charles IV., he received the margraviate of Brandenburg; and his betrothal with Mary, the daughter and heiress of Louis of Poland and Hungary, gave him a right to look forward to the succession in these two countries. But in 1383, when Louis died, the Poles chose Hedwig, Mary's sister, as their queen; and Sigismund was unable to marry Mary and to secure the crown of Hungary until 1387, as her rights had been seized by Charles of Durazzo, and after his death she had been made prisoner by the ban of Croatia. Sigismund was soon involved in a war with the Turks, and in order to obtain the means of carrying on the struggle he gave Brandenburg in pledge to his cousin Jobst of Moravia. Defeated at Nicopolis in 1396, Sigismund fled to Greece; and in his absence his wife died. When he returned to Hungary the people rose against him, made him prisoner, and gave the crown to Ladislaus of Naples. Sigismund escaped, and having sold the Altmark, which he had inherited from his brother John, he was able to collect an army and to crush the Hungarian rebellion. Meanwhile his brother Wenceslaus, king of the Romans, had been deposed, and Rupert of the Palatinate was chosen as his successor. In 1410 Rupert died, and Sigismund and Jobst of Moravia were both elected to the crown. Jobst died in the following year, and then Sigismund was universally recognized as king. One of the chief events of his reign was the assembling of the council of Constance, which met for the purpose of bringing the great schism in the church to an end. Sigismund marred his services in connection with the council by assenting to the burning of John Hus, to whom he had granted a safe conduct. For this treachery he had to pay a heavy penalty, for it led indirectly to the Husite War, which raged for about sixteen years. In 1435 peace was restored, and Sigismund obtained possession of Bohemia. In 1415 he gave Brandenburg, which had been restored to him after Jobst's death, in fief to Frederick, burgrave of Nuremburg; and in 1423, in reward for services rendered in the Husite War, Frederick, margrave of Meissen, received the duchy of Saxony with the electoral dignity. Sigismund was crownd emperor in 1433, having obtained the Italian crown two years before. He died at Znaim in Moravia on 9th December, 1437. He possessed considerable intellectual ability, but he never did full justice to his powers,—being recklessly extravagant and of a wayward and impulsive temper.

See Aschbach, *Geschichte Kaiser Sigismund's* (1838–45); Schroller, *Die Wahl Sigismund's zum römischen König* (1875); Bezold, *König Sigmund und die Reichskriege gegen die Husiten* (1872–77); Kerler, *Deutsche Reichstagsakten unter Kaiser Sigmund* (1878).

SIGISMUND, the name of three kings of Poland. See POLAND, vol. xix. pp. 302–3 and 305–6.

SIGMARINGEN, the seat of government of the Prussian administrative division of the same name. is a small town on the Danube with (1880) 4154 inhabitants. The division of Sigmaringen is composed of the two formerly sovereign principalities of Hohenzollern-Sigmaringen and Hohenzollern-Hechingen (see HOHENZOLLERN, vol. xii. p. 55) and has an area of 440 square miles, with a population in 1880 of 67,624. The Sigmaringen part of the Hohenzollern lands was the larger of the two (297 square miles) and lay mainly to the south of Hechingen, though the district of Haigerloch on the Neckar also belonged to it. The name of Hohenzollern is used much more frequently than the official Sigmaringen to designate the combined principalities.

SIGNALS, NAVAL. A system of naval signals comprises different methods of conveying orders or information to or from a ship in sight and within hearing, but at a distance too great to permit of hailing,—in other words, beyond the reach of the voice, even when aided by the speaking-trumpet. Signals are divided into classes according to the instruments with which and the circumstances under which they are made. There are sight and sound signals; flag, semaphore, fixed lantern, flashing, firework, horn or steam-whistle, and gun signals; day, night, fog, and distant signals. Besides these, there are other divisions, such as general, vocabulary, evolutionary, etc., which depend upon technical considerations and are matters of arrangement.

The necessity of some plan of rapidly conveying orders or intelligence to a distance was early recognized. Polybius describes two methods, one proposed by Æneas Tacitus more than three centuries before Christ, and one perfected by himself, which, as any word could be spelled by it, anticipated the underlying principle of recent systems. The signal codes of the ancients are believed to have been elaborate. Generally some kind of flag was used. Shields were also displayed in a preconcerted manner, and some have imagined that the reflected rays of the sun were flashed from them as with the modern heliograph (see HELIOGRAPHY). In the Middle Ages flags, banners, and lanterns were used to distinguish particular squadrons, and as marks of rank, as they are at present, also to call officers to the admiral, and to report sighting the enemy and getting into danger. The invention of cannon made an important addition to the means of signalling. In the instructions issued by Don Martin de Padilla in 1597 the use of guns, lights, and fires is mentioned. The introduction of the square rig permitted a further addition, that of letting fall a sail a certain number of times. Before the middle of the 17th century only a few stated orders and reports could be made known by signalling. Flags were used by day, and lights, occasionally with guns, at night. The signification then, and for a long time after, depended upon the position in which the light or flag was displayed. Orders, indeed, were as often as possible communicated by hailing or even by means of boats. As the size of ships increased the inconvenience of both plans became intolerable. Some attribute the first attempt at a regular code to Admiral Penn, but the credit of it is usually given to James II. when duke of York. Notwithstanding the attention paid to the subject by Paul Hoste and others, signals continued strangely imperfect till late in the 18th century. Towards 1780 Admiral Kempenfelt devised a plan of flag-signalling which was the parent of that now in use. Instead of indicating differences of meaning by varying the position of a solitary flag, he combined distinct flags in pairs. About the beginning of the 19th century Sir Home Popham improved a method of conveying messages by flags proposed by Mr. Hall Gower, and greatly increased a ship's power of communicating with others. The number of night and fog signals that could be shown was still very restricted. In 1867 an innovation of prodigious importance was made by the adoption in the British navy of Captain Philip Colomb's flashing system, on which he had been at work since 1858. This is in general use in all fleets, though, oddly enough, on its first trial at sea it was condemned. It is not too much to say that the Colomb system has made it possible to handle, with confidence and safety, in darkness and fog, squadrons composed of the gigantic armor-clads of the day. Its adoption has not only contributed very materially to the increased efficiency of the British fleets but also immensely reduced the risk of accidents; and the saving to the taxpayer since its introduction may probably be estimated in hundreds of thousands of pounds.

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[1] [Carlyle in his *Frederick the Great* adheres with Aschbach and Schroller to the commonly accepted birth date 1368.—AM. ED.]

In the British navy, which is copied by most others, sight-signals are made with flags, the semaphore, "flashes," fixed lanterns, and occasionally with fireworks, and for "distant" signals with flags, balls, and pendants displayed on account of shape but not of color. Sound-signals are made with horns, steam-whistles, and guns. There are two sets of flags,—one of ten numbered from 1 to 10, and another of twenty-one called after letters of the alphabet. There are also pendants and a few special flags. The numbered flags are used with the general signal book, a kind of dictionary in which figures stand opposite sentences conveying orders or announcements. Opposite 123 might stand "hoist in all boats," which would mean that, when the flag called 1 was hoisted with 2 beneath it and 3 beneath 2, the ship or ships addressed—indicated by a special flag or by pendants—were ordered to hoist all boats in. The lettered flags are used with the vocabulary signal book, in which opposite collections of letters are put single words or small groups of words. Thus, if ABC were opposite the word "admiral" and STO opposite "will sail at noon," when the first three flags were hoisted the signalman on board each ship addressed would note them down by their signification. When all addressed had acknowledged the first "hoist" the flags would be hauled down and STO would be hoisted, to be acknowledged and noted in like manner. The admiral would thus have made known his intention of sailing at a given hour. From this it will appear that the general code is used for words of command and the vocabulary for long communications. The night signal book contains a limited number of definite orders and announcements made known by exhibiting lanterns, never more than four, arranged vertically, horizontally, or in a square. For a few signals some kind of firework is displayed. Fog-signals are made by firing different numbers of guns at fixed intervals. Owing to the slowness of flag-signalling, it is now, especially for the vocabulary and at moderate distances, largely superseded by the semaphore, an upright post with two arms moving in a vertical plane. The changed positions of the arms indicate letters and each world is spelled. Before the adoption of Captain Colomb's system, at night and in fogs only a few announcements could be made by signal, and sending messages was unknown. By a series of symbols formed of dots and short lines, like those of the Morse alphabet, he represents figures, letters, and special words. Thus ... means 3, and .—7. The system can be employed in daylight, at night, and in fogs. In daylight long and short waves of a flag on a staff reproduce the flashes; in fogs long and short blasts on a fog-horn or steam-whistle; and at night the alternate exposure and concealment of the light of a lamp. Every order in the general signal book and every word in the vocabulary—by spelling, indeed, every word in the language—may be communicated by this system. Distant signals, now rarely used, are made by hoisting flags of different shapes at distances at which colors become invisible. The *Army and Navy Signal Book* contains the code for communications between a ship and its boats or military stations on shore; the *International*, with special flags, is for communicating with merchant vessels. In the British navy there is a corps of signalmen rising in grade from boys to chief petty officers. They are selected from the most intelligent and best educated boys in the training ships, and go through a course of special instruction in their duties. (C. A. G. B.)

SIGNORELLI, Luca (*c.*1442–*c.*1524), one of the greatest of the Italian painters who ushered in the full culmination of the art under Leonardo da Vinci, Michelangelo, and Raphael, was born in Cortona—his full name being Luca d'Egidio di Ventura; he has also been called Luca da Cortona. The precise date of his birth is uncertain; but, as he is said to have died at the age of eighty-two, and as he was certainly alive during some part of 1524, the birth-date of 1442 must be nearly correct. He belongs to the Tuscan school, associated with that of Umbria. His first impressions of art seem to be due to Perugia,—the style of Bonfigli, Fiorenzo, and Pinturicchio. Lazzaro Vasari, the great-grandfather of Giorgio Vasari, the historian of art, was brother to Luca's mother; he got Luca apprenticed to Piero della Francesca. In 1472 the young man was painting at Arezzo, and in 1474 at Città di Castello. He presented to Lorenzo de' Medici a picture which is probably the one named the School of Pan, discovered some years ago in Florence, and now belonging to Marquis Corsi; it is almost the same subject which he painted also on the wall of the Petrucci palace in Siena,—the principal figures being Pan himself, Olympus, Echo, a man reclining on the ground, and two listening shepherds (see SCHOOLS OF PAINTING, vol. xxi. p. 453, Fig. 8). He executed, moreover, various sacred pictures, showing a study of Botticelli and Lippo Lippi. Pope Sixtus IV. commissioned Signorelli to paint some frescos, now mostly very dim, in the shrine of Loreto,—Angels, Doctors of the Church, Evangelists, Apostles, the Incredulity of Thomas, and the Conversion of St. Paul. He also executed a single fresco in the Sistine Chapel in Rome, the Acts of Moses; another, Moses and Zipporah, which has been usually ascribed to Signorelli, is now recognized as the work of Perugino. Luca may have stayed in Rome from 1478 to 1484. In the latter year he returned to his native Cortona, which remained from this time his ordinary home. From 1497 he began some professional excursions. In Siena, in the convent of Chiusuri, he painted eight frescos, forming part of a vast series of the Life of St. Benedict; they are at present much injured. In the palace of Pandolfo Petrucci he worked upon various classic or mythological subjects, including the School of Pan already mentioned. From Siena he went to Orvieto, and here he produced the works which, beyond all others, stamp his greatness in art. These are the frescos in the chapel of S. Brizio, in the cathedral, which already contained some pictures on the vaulting by Fra Angelico. The works of Signorelli represent the Last Days of the Mundane Dispensation, with the Pomp and the Fall of Antichrist, and the Eternal Destiny of Man, and occupy three vast lunettes, each of them a single picture. In one of them, Antichrist, after his portents and impious glories, falls headlong from the sky, crashing down into an innumerable crowd of men and women. Paradise, the Elect and the Condemned, Hell, the Resurrection of the Dead, and the Destruction of the Reprobate follow in other compartments. To Angelico's ceiling Signorelli added a section showing figures blowing trumpets, etc.; and in another ceiling he depicted the Madonna, Doctors of the Church, Patriarchs, and Martyrs. There is also a great deal of subsidiary work connected with Dante, and with the poets and legends of antiquity. The daring and terrible invention of the great compositions, with their powerful treatment of the nude and of the most arduous foreshortenings, and the general mastery over complex grouping and distribution, marked a development of art which had never previously been attained. It has been said that Michelangelo felt so strongly the might of Signorelli's delineations that he borrowed, in his own Last Judgment, some of the figures or combinaions which he found at Orvieto; this statement, however, has not been verified by precise instances. The contract for Luca's work is still on record. He undertook on 5th April, 1499, to complete the ceiling for 200 ducats (for gold, $453.60), and to paint the walls for 600 (for gold, $1360.80), along with lodging, and in every month two measures of wine and two quarters of corn. Signorelli's first stay in Orvieto lasted not more than two years. In 1502 he returned to Cortona, and painted a dead Christ, with the Marys and other figures. Two years later he was once more back in Orvieto, and completed the whole of his work in or about that time, *i.e.*, some two years before 1506—a date famous in the history of the advance of art, when Michelangelo displayed his cartoon of Pisa.

After finishing off at Orvieto, Signorelli was much in Siena. In 1507 he executed a great altar-piece for St. Medardo at Arcevia in Umbria—the Madonna and Child, with the Massacre of the Innocents and other episodes. In 1508 Pope Julius II. determined to readorn the camere of the Vatican, and he summoned to Rome Signorelli, in company with Perugino, Pinturicchio, and Bazzi (Sodoma). They began operations, but were shortly all superseded to make way for Raphael, and their work was taken down. Luca now returned to Siena, living afterwards for the most part in Cortona. He continued constantly at work, but the performances of his closing years were not of special mark. In 1520 he went with one of his pictures to Arezzo. Here he saw Giorgio Vasari, aged eight, and encouraged his father to second the boy's bent for art. Vasari tells a pretty story how the well-nigh octogenarian master said to him: "Impara, parentino" ("You must study, my little kinsman"), and clasped a jasper round his neck as a preservative against nosebleeding, to which the child was subject. He was partially paralytic when he began a fresco of the Baptism of Christ in the chapel of Cardinal Passerini's palace near Cortona, which is the last picture of his that we find specified. Signorelli stood in great repute not only as a painter but also as a citizen. He entered the magistracy of Cortona as early as 1488, and in 1524 held a leading position among the magistrates of his native place. In or about the year 1524 he died there.

Signorelli from an early age paid great attention to anatomy, carrying on his studies in burial grounds. He surpassed all his contemporaries in showing the structure and mechanism of the nude in immediate action; and he even went beyond nature in experiments of this kind, trying hypothetical attitudes and combinations. His drawings in the Louvre demonstrate this and bear a close analogy to the method of Michelangelo. He aimed at powerful truth rather than nobility of form; color was comparatively neglected, and his chiaroscuro exhibits sharp oppositions of lights and shadows. He had a vast influence over the painters of his own and of succeeding times, but had no pupils or assistants of high mark; one of them was a nephew named Francesco. He was a married man with a family; one of his sons died, seemingly through some sudden casualty, and Luca depicted the corpse with sorrowful but steady self-possession. He is described as full of kindliness and amiability, sincere, courteous, easy with his art assistants, of fine manners, living and dressing well; indeed, according to Vasari, he always lived more like a nobleman than a painter. The Torrigiani Gallery in Florence contains a grand life-sized portrait by Signorelli of a man in a red cap and vest; this is said to be the likeness of the painter himself, and corresponds with Vasari's observation. The pictorial reputation of Signorelli has revived and ripened very much throughout Europe in recent years. The foregoing account of him is principally founded upon that given by Messrs. Crowe and Cavalcaselle. In Great Britain there is no better specimen of his work than the Circumcision of Jesus, a panel lately in Hamilton Palace, near Glasgow. (W. M. R.)

SIKHS. See INDIA, vol. xii. pp. 784, 847, and PUNJAB, vol. xx. pp. 116–18; also HINDUSTANI LITERATURE, vol. xi. pp. 758–9.

SIKKIM, a native state of India, in the eastern Himalaya Mountains, between 27° 9′ and 27° 58′ N. lat., and between 88° 4′ and 89° E. long., and bounded on the north and northeast by Tibet, on the southeast by Bhután, on the south by the British district of Darjiling, and on the west by Nepál. It covers an area of 2600 square miles, with an estimated population of 7000. The Tibetan name for Sikkim is Dingjing or Demo-jong, and for the people Deungjong Maro; the Gúrkhas call them Lepchas, but Mr. Clements Markham in his work on Tibet (1879), says that their proper name is Rong. The whole of the state is situated at a considerable elevation within the Himalayan mountain zone. From the level of the sea to an elevation of 12,000 feet, Sikkim is covered with dense forests of tall umbrageous trees. The mountains in the south are generally lower than those of Darjiling district, but north of Tumlung the passes are of great height. Jelap-la, the most southerly of these, rises to 13,000 feet; the two next are the Guiatu-la and Yak-la, leading into the Chumbi valley of Tibet, the latter being 14,000 feet high; further north are the Cho-la (15,000 feet), on the direct road from Tumlung to Chumbi, and the Tankra-la (16,083 feet), the most snowy pass in Sikkim. The state is drained by the Tista and its affluents, and by the Am-machu which rises near Parijong, at the foot of the Chamalhari peak (23,929 feet), and flows through the Chumbi valley into the district of Jalpaiguri under the name of the Torsha. Through Sikkim lie the most promising routes for trade with Tibet. At present, however, the Tibetan passes are closed to ordinary British subjects, though an active trade is maintained in certain articles by Bhuteas and Tibetans.

The capital of Sikkim is Tumlung, where the raja resides during the winter and spring, usually going to his estates at Chumbi in Tibet in summer, in order to avoid the heavy rains. The raja receives a subsidiary allowance of £1200 [$5832] a year from the British Government, in consideration of his position as former ruler of the hill territory of Darjiling and a submontane tract on the plain called the Morung. Communication with the state is kept up through the deputy commissioner of Darjiling. Sikkim produces rice, Indian corn, millet, oranges, and two or three sorts of Lepcha cloth. Its mineral products are lime and copper.

SILENUS, a personage of Greek mythology, a drunken attendant of Bacchus and closely allied to the satyrs, of whom he appears as the leader. Elderly satyrs were called Sileni. The Sileni belong especially to the legends of Asia Minor, and particularly of Lydia and Phrygia. The stories as to the birth of Silenus were various. Some called him a son of Hermes, others of Pan and a nymph; others said that he sprang from the drops of the blood of Sky. Sometimes he figures as the guardian of Dionysus. In spite of his dissipated habits he possessed a large stock of general information, which however, like Proteus, he only imparted on compulsion. Midas, king of Phrygia, caught him by mixing wine in the spring out of which Silenus, in a moment of weakness, had condescended to drink. The conversation which followed is fully reported by Theopompus and Aristotle (Ælian, *Var. Hist.*, iii. 18; Plutarch, *Consol. ad Apoll.*, 27). Prefacing his remarks with a slight sketch of terrestrial geography and a brief reference to the fauna characteristic of the different continents, Silenus proceeded to draw an edifying picture of the pleasures of true piety as contrasted with the dreadful fate in store for the wicked, winding up with a gloomy reflection on the vanity of human life and the expression of a wish that he had never been born. Another of his homilies has been preserved by Virgil (*Ecl.*, 6); two shepherds surprise the sage drunk in a cave; they bind him with flowery chains, and he tells them how the world was made, with stories "of remotest eld." Apart from this gift of sermonizing, the Sileni seem to have resembled the satyrs in their love of music, wine, and women. Indeed, the Greeks appear not to have sharply distinguished between them; for Marsyas, the mythical flute player, is called sometimes a satyr, sometimes a Silenus. In art Silenus appears as a fat, dumpy old man, with a snub nose and a bald head, riding on an ass and supported by satyrs who keep the jolly toper from tumbling off. Or he is depicted standing or lying with his inseparable companion, a wine-skin, which again he sometimes bestrides. Sometimes he is sitting with his Pan's-pipe or flute in his hand.

SILESIA (Germ. *Schlesien*), a district in the eastern part of Germany, between 49° 28′ and 52° 7′ N. lat. and 13° 50′ and 19° 20′ E. long., was formerly united with the kingdom of Bohemia in the form of a duchy (or rather group of duchies), and is now unequally shared between Prussia and Austria. Geographically it is divided into Lower and Upper Silesia, the whole of the former and part of the latter belonging to Prussia. The total area is 17,540 square miles.

It is generally asserted that the original inhabitants of Silesia were the Germanic tribes of the Lygii and Quadi, who retired before the Slavonic immigrations of the 6th century, but this statement is beyond the range of positive proof. The earliest form of the name, Sleenzane or Zlesane, shows a Slavonic origin, and further than this we have no means of penetrating. Various explanations have been given of the name, and one old writer gravely connects it with the prophet Elisha; but there is little doubt that it was first applied to the district round Mount Zlenz (the modern Zobten) and the river Zlenza (Lohe), and thence spread gradually over the whole region now known as Silesia. These early Slavonic inhabitants belonged to the family of Lechs (Poles), and the modern Polish name for the inhabitants is Zlesaki. The history of Silesia consists substantially of the process which has converted it from a Slavonic territory into a predominantly German land.

The earliest notices of Silesia are extremely vague, nor can we exactly define the scope of the name in the first thousand years of our era. It seems to have formed part of the great but short-lived kingdom of **Moravia** (*q.v.*) in the 9th century, and afterwards oscillated between the neighboring kingdoms of Bohemia and Poland, becoming definitely incorporated with the latter at the end of the 10th century. Christianity was introduced about the year 960, and from 1000 on we have an unbroken list of bishops of Breslau. The first contact of Germany with Silesia was disastrous to the former, as it was on the fastnesses of Silesia that Henry V. squandered his strength in his unsuccessful expedition against Poland in 1109. More fortunate was the intervention of Frederick Barbarossa in 1163[1] in behalf of the three sons of the dispossessed Ladislaus, a member of the Polish royal family of the Piasts. He succeeded in securing as their share of the Polish dominions the whole of Silesia, though it was not till forty or fifty years later that it could be said to have gained actual independence of Poland. These three princes were the ancestors and founders of the various ducal lines that henceforth ruled in Silesia, and their intimate connection with the German king accounts in great measure for the process of Germanization which Silesia now began to undergo, chiefly through the introduction of German colonists in scantily peopled or desolated districts. The eldest of the three sons of Ladislaus received the town of Breslau and by far the largest portion of territory, so that the history of Silesia for the next two or three generations is practically that of his line. Under his grandson Henry the Bearded (1202–1238) the Germanization of Silesia made rapid progress, and the duchy at that time may be looked upon as a bulwark or mark against the Slavs in the southeast of Germany, just as the duchy of Prussia was in the northeast. Henry extended his sway much beyond the limits of Silesia, and in fact united under his sceptre nearly three-quarters of the old Polish dominions. His son Henry II. (1238–1241) had a short reign with a glorious end, falling in 1241 at the battle of Liegnitz, where his determined resistance turned back from Germany the alarming Mongolian invasion. On his death his territories were shared among his sons, and the series of divisions and subdivisions began which resulted in almost every Silesian town of any importance becoming the capital of an independent prince. At the beginning of the 14th century there were no fewer than 17 principalities of this kind, nearly all held by dukes of the Piast family. It was inevitable that these petty rulers should feel the want of a support against the encroachments of Poland, and it was inevitable, too, that the relation opened in consequence with Bohemia should gradually change from mere protection to feudal supremacy. By 1355 the supremacy of Bohemia was formally recognized as extending over the whole of Silesia, though the Silesians retained a considerable measure of independence, including the right to hold general diets for the settlement of their internal relations. The kings of Bohemia at this time (John, Charles IV.) were members of the German house of Luxemburg, and Silesia under their sway may be looked upon as an entirely German land.

During the Hussite wars of the 15th century Silesia, which adhered zealously to the old faith, suffered greatly from Hussite forays. The Luxemburg dominion broke up in 1458, when Hungary and Bohemia elected rulers of their own nationality. Silesia, however, neglected the opportunity to elect a German king for itself, and supported the Bohemian king George Podiébrad. Breslau, still the most powerful of the principalities, threw in its lot with Matthew Corvinus of Hungary, who fought many of his battles on Silesian soil. By the treaty of Olmütz in 1479 Matthew acquired all the tributary lands of the Bohemian crown, including Silesia, which remained attached to Hungary down to 1490. In that year Bohemia and Hungary became once more united under the same king. In 1526 Silesia passed with the rest of the Bohemian inheritance to the house of Hapsburg (see **Bohemia**). The Reformation at first made rapid progress in Silesia, and the native dukes placed little opposition in its way. The Hapsburg princes, however, acted very differently, and the Silesian Protestants suffered much persecution before, during, and after the Thirty Years' War. It was not indeed till the 18th century that they acquired formal recognition and the restoration of some of their confiscated churches.

The First Silesian War between Austria and Prussia, which broke out in 1740, had its ultimate cause (nominally at least) in a compact of mutual succession entered into in 1537 by the elector of Brandenburg on the one side and the duke of Liegnitz on the other.

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[1] [In vol. ix. p. 641, the emperor is said to have settled Ladislaus in Bohemia as king in 1157.—Am. Ed.]

The emperor, as feudal superior of the duke, had indeed refused to recognize this agreement, but the Great Elector did not fail to put in his claim on the death of the last duke in 1675, and Frederick now thought the opportunity too good to be lost. The progress of the three Silesian wars is recounted in the article Austria (vol. iii. pp. 111–113). At the peace of Hubertusburg (1763) Prussia was left in possession of nearly the whole of Silesia, with the frontier as it still exists. Frederick exerted himself to atone for the evils brought upon the district through the ravages of war by introducing colonists and capital, reforming the administration, granting complete religious liberty, and the like. That this seed did not fall on ungrateful soil seems proved by the modern prosperity of Silesia and the loyalty with which its inhabitants have clung to the Prussian cause. Silesia formed part of the reduced kingdom of Prussia left by the peace of Tilsit in 1806, and it was the centre of the national rising of 1813, when the king issued his celebrated address "To my People" from Breslau. Stein's emancipating edict of 1807 was welcomed with profound satisfaction in Silesia, where the conditions of serfdom had been particularly oppressive, and no doubt contributed materially to the enthusiasm with which the Silesians flocked to the standard a few years later.[1]

Prussian Silesia, the largest province of Prussia (see vol. xx. plate I.), with an area of 15,560 square miles, forms the southeastern limb of the kingdom, and is bounded by Brandenburg, Posen, Russian Poland, Galicia, Austrian Silesia, Moravia, Bohemia, and the kingdom and province of Saxony. Besides the bulk of the old duchy of Silesia, it comprises the countship of Glatz, a fragment of the Neumark and part of Upper Lusatia, taken from Saxony in 1815. The province is divided into three governmental districts,—Liegnitz and Breslau corresponding to lower Silesia, while Oppeln takes in the greater part of upper, southern or mountainous Silesia.

Physiographically Silesia is roughly divided into a flat and a hilly portion by the so-called Silesian Langenthal, which begins on the southeast near the Malapane, and extends across the province in a west-by-north direction to the Black Elster, following in part the valley of the Oder. The southeast part of the province, to the east of the Oder and south of the Malapane, consists of a hilly outpost of the Carpathians (the Tarnowitz plateau), with a mean elevation of about 1000 feet. To the west of the Oder the land rises gradually from the Langenthal towards the southern boundary of the province, which is formed by the central part of the Sudetic system, including the Glatz Mountains and the Riesengebirge (Schneekoppe, 5266 feet). Among the loftier elevations in advance of this southern barrier the most conspicuous is the Zobten (2215 feet), the historical connection of which with the name of the province has been mentioned above. To the north and northeast of the Oder the province belongs almost entirely to the great North-German plain, though a hilly ridge, rarely attaining a height of 1000 feet, may be traced from east to west, asserting itself most definitely in the Katzengebirge. Nearly the whole of Silesia lies within the basin of the Oder, which flows through it from southeast to northwest, dividing the province into two approximately equal parts. The Vistula touches the province on the southeast, and receives a few small tributaries from it, while on the west the Spree and Black Elster belong to the system of the Elbe. The Iser rises among the mountains on the south. Among the chief feeders of the Oder are the Malapane (right), the Glatzer Neisse (left), the Katzbach (left), and the Bartsch (right); the Bober and its tributary the Queiss flow through Silesia but join the Oder beyond the frontier. The only lake of any extent is the Schlawa See, 7 miles long, on the north frontier. There is a considerable difference in the climate of Lower and Upper Silesia, and some of the villages in the Riesengebirge have the lowest mean temperature of any inhabited place in Prussia (below 40° Fahr.).

Of the total area of the province 56 per cent. is occupied by arable land, 10.8 per cent. by pasture and meadow, and nearly 29 per cent. by forests. The soil along the foot of the mountains is generally good, and the district between Ratibor and Liegnitz, where 70 to 80 per cent. of the surface is under the plough, is reckoned one of the most fertile in Germany. The parts of lower Silesia adjoining Brandenburg, and also the district to the east of the Oder, are sandy and comparatively unproductive. The different cereals are all grown with success, wheat and rye sometimes in quantity enough for exportation. Flax is still a frequent crop in the hilly districts, and more sugar-beets are raised in Silesia than in any other Prussian province except Saxony. Tobacco, oil-seeds, chicory, and hops may also be specified, while a little wine, of an inferior quality, is produced near Grünberg. Mulberry trees for the silk-culture have been introduced and thrive fairly. Large estates are the rule in Silesia, where 35 per cent. of the land is in the hands of owners possessing at least 250 acres, while properties of 50,000 to 100,000 acres are common. The districts of Oppeln and Liegnitz are among the most richly wooded parts of Prussia. According to the live-stock census for 1883, Silesia contains 275,122 horses, 1,397,130 cows, 1,309,495 sheep, 518,612 pigs, 175,283 goats, and 128,828 beehives. The merino sheep was introduced by Frederick the Great, and since then the Silesian breed of sheep has been greatly improved. The woods and mountains harbor large quantities of game, such as red deer, roedeer, wild boars, and hares, while an occasional wolf finds its way into the province from the Carpathians. The fishery includes salmon in the Oder, trout in the mountain-streams, and carp in the small lakes or ponds with which the province is sprinkled. Compare the tables in Prussia (vol. xx. p. 18).

The great wealth of Silesia, however, lies underground, in the shape of large stores of coal and other minerals, and its mining records go back to the 12th century. The coal-measures of Upper Silesia, in the southeast part of the province, are among the most extensive in continental Europe, and there is another large field near Waldenburg. The annual output, ranging between twelve and fifteen millions of tons, valued at nearly £3,000,000 sterling [$14,580,000], is equal to more than a quarter of the entire yield of Germany. The district of Oppeln also contains a great quantity of iron (annual produce 750,000 to 800,000 tons, value about £1,000,000 [$4,860,000]). The deposits of zinc in the vicinity of Beuthen are perhaps the richest in the world, and produce four-fifths of the zinc of Germany (550,000 tons). The remaining mineral products include lead (from which a considerable quantity of silver is extracted), copper, cobalt, arsenic, the rare metal cadmium, alum, brown coal, marble, and a few of the commoner precious stones (jaspers, agates, amethysts, etc.). The province contains practically no salt or brine springs, but there are well-known mineral springs at Warmbrunn, Salzbrunn, and several other places.

A busy manufacturing activity has long been united with the underground industries of Silesia, and the province in this respect yields the palm to no other part of Prussia except districts in the Rhineland and Westphalia. On the plateau of Tarnowitz the working and smelting of metals is naturally the predominant industry, and in the neighborhood of Beuthen, Königshütte, and Gleiwitz there seems an almost endless succession of iron-works, zinc-foundries, machine-shops, and the like. In 1881 the total value of the metals produced in the various foundries of the province was £2,376,250 [$11,548,575]. At the foot of the Riesengebirge, and along the southern mountain line generally, the textile industries prevail. Weaving has been practiced in Silesia, on a large scale, since the 14th century; and Silesian linen still maintains its reputation, though the conditions of production have greatly changed. Cotton and woollen goods of all kinds are also made in large quantities, and among the other industrial products are beetroot sugar (157,000 tons in 1883–84), spirits, chemicals, tobacco, starch, paper, pottery, and "Bohemian glass." Lace, somewhat resembling that of Brussels, is made by the women of the mountainous districts. The trade of Silesia is scarcely so extensive as might be expected from its important industrial activity. On the east it is hampered by the stringent regulations of the Russian frontier, and the great waterway of the Oder is sometimes too low in summer for navigation. The extension of the railway system has, however, had its usual effect in fostering commerce, and the mineral and manufactured products of the province are freely exported.

At the census of 1880 the population of Silesia was 4,007,925, of whom 2,082,084 were Roman Catholics, 1,867,489 Protestants, and 52,682 Jews. About 35 per cent. of the population is urban and 65 per cent. rural. The density is 257 per square mile, less than that of Westphalia (262) and the Rhineland (390); but the average is of course very greatly exceeded in the industrial districts, such as Beuthen. The occupation census of 1883 shows that 44 per cent. of the population are supported by agriculture, 36 per cent. by industries, 8.4 per cent. by trade, and 2.2 per cent. by daily labor and domestic service, while 4 per cent. belong to the official and 5 per cent. to the unemployed classes. Nearly three-fourths of the inhabitants and territory are German, but to the east of the Oder the Poles (nearly 1,000,000) form the bulk of the population, while there are about 50,000 Czechs in the south part of the province and 30,000 Wends near Liegnitz. The Roman Catholics, most of whom are under the ecclesiastical sway of the prince-bishop of Breslau, are predominant in Upper Silesia and Glatz; the Protestants prevail in Lower Silesia, to the west of the Oder, and in Lusatia. The noblesse is very numerous in Silesia, chiefly in consequence of the Polish districts it includes. The educational institutions of the province are headed by the university of Breslau. In 1883-84 the percentage of illiterate recruits, in spite of the large Polish-speaking contingent, was only 1.70. The capital and seat of the provincial diet is Breslau, which is also by far the largest and most important town (298,893 inhabitants in 1885). The towns next in point of size are Görlitz (55,120 inhabitants), Liegnitz (43,351), Königshütte (31,831), Beuthen (26,478), Schweidnitz (23,775), Neisse (21,444), and Glogau (20,003). The province sends thirty-five members to the reichstag and sixty-five to the Prussian chamber of deputies. The government divisions of Breslau and Oppeln together form the district of the 6th army corps (seat, Breslau), while Liegnitz belongs to that of the 5th army corps, the headquarters of which are at Posen. Glogau, Glatz, Neisse, and Cosel are fortresses.

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[1] Compare Grünhagen, *Geschichte Schlesiens* (Gotha, 1884 sq.). An account of the poetical schools of Silesia is given under the heading Germany (vol. x. pp. 474–5).

AUSTRIAN SILESIA, the part of the duchy that remained to Austria after the Seven Years' War, is a mere fraction of the whole, its area being only 1980 square miles, or about one-eighth of that of Prussian Silesia. It falls into two small portions of territory, separated by a projecting limb of Moravia and surrounded by Prussian Silesia, Moravia, Hungary, and Galicia. Until 1849 it was for administrative purposes reckoned a part of Moravia, but since that year it has been a crownland of the Austrian empire (the smallest of all), with the style of duchy. The Troppau or western division of the crownland is flanked by the Sudetic Mountains (Altvater, 4678 feet), and the Teschen or eastern half by the Carpathians (Lissahorn, 4330 feet), and a great proportion of the surface is occupied by offshoots of these ranges. The Vistula rises on the Carpathians, within Austrian Silesia, while the western part of the crownland is close to the headwaters of the Oder, which rises near at hand in Moravia. Owing to its mountainous character and its slope towards the north and northeast the crownland has a somewhat severe climate for its latitude, the mean temperature being only 50° Fahr. while the annual rainfall varies from 20 to 30 inches. Upwards of 45 per cent. of the surface is occupied by arable land, 7½ per cent. by meadows and gardens, 10½ per cent. by pastures, and 32 per cent. by forests, while 4½ per cent. is unproductive ground. The soil cannot as a rule be termed rich, though some of the valleys are fertile. The chief crops are oats, rye, barley, potatoes, clover, and flax. Dairy-farming is carried on in the mountains after the Alpine fashion, and sheep are fairly numerous. Geese and pigeons are reared in great quantities, and the hunting and fishing are both very prolific. The principal mineral resources are coal (Silesia producing 13 per cent. of the produce of Austria-Hungary), iron, marble, and slate. Like its Prussian neighbor, the crownland boasts a very busy industrial activity, the chief products of which are its iron and steel goods, textile fabrics (linen, woollen, cotton, velvet, silk), chemicals, liqueurs, and beetroot sugar. The trade is chiefly a transit one, though the manufactures and agricultural produce of the province are exported in considerable quantity. Troppau, the capital of the duchy, contains large cloth manufactories, while Teschen, Bielitz, and Jägerndorf are also busy places. The population in 1885 was 577,593, of whom 81,000 were Protestants and 9000 Jews. About 48 per cent. of the population is supported by agriculture and 27.5 per cent. by industry. Divided according to nationalities, there are 275,000 Germans, 130,000 Czechs, and 158,000 Poles. The German element is predominant in the towns, the Polish in the eastern or Teschen division. The duchy sends ten members to the Austrian house of representatives and has a provincial diet of thirty-one members. (J. F. M.)

SILICA, the only known oxide of silicon (see CHEMISTRY, vol. v. pp. 451–454), occurs native in a great variety of forms, which, however, correspond to only the four distinct species of QUARTZ (*q.v.*; see also MINERALOGY, vol. xvi. pp. 404–5), tridymite, OPAL (*q.v.*, and compare vol. xvi. pp. 405–6), and siliceous earth. Ordinary quartz-rock and sand are more impure forms of quartz. Tridymite differs from quartz only by a lower specific gravity, and in crystallometric details; the crystals are as a rule arranged in triplets—hence the name (see vol. xvi. p. 405). Siliceous earth when dry forms a very voluminous, soft, fine powder; it consists of the shells of *Infusoria*. As a chemical species it differs little from opal. Siliceous earth, having a very low rate of thermal conductivity, serves well as a stuffing for the hollow walls of ice-chests, fire-proof safes, etc. It is used besides for the making of DYNAMITE (*q.v.*). Silica of any kind is absolutely non-volatile, and is fusible only at the temperature of the oxyhydrogen flame; a slight admixture of base (potash, lime, etc.), however, suffices to cause it to "*frit*" at a red heat. It is absolutely proof against the action of water and ordinary mineral acids; hydrofluoric acid acts on it energetically, as explained in CHEMISTRY, vol. v. p. 452.

Alkaline Silicates.—Silica readily dissolves at a red heat in fused alkaline carbonates, with evolution of carbonic acid and formation of alkaline silicates. In this process one molecule SiO_2 of silica is capable of decomposing at most $2R_2OCO_2$ (where $R = K$ or Na). The compound $SiO_2.2R_2O$, "orthosilicate" of alkali, freezes into a compact non-transparent mass, readily soluble in water, with formation of an intensely alkaline solution. It does not unite with any additional alkali, but readily fuses up with more silica. Without going beyond a red heat it is easy to produce thus homogeneous masses of *any* composition, $Na_2O.xSiO_2$ from $x = \frac{1}{2}$ up to $x =$ (at least) 4.

Compounds approximating to $x = 4$ are known as *water glass*. Potash water glass, $K_2O.4SiO_2$, was discovered in 1825 by Fuchs in Munich, who noticed all its practically important properties and saw their significance. Water glass when in compact pieces looks like ordinary glass, and is not at all obviously attacked by cold water. But when the powdered substance is boiled with water it dissolves, and the solution can be boiled down to the consistence of a syrup without anything separating out even in the cold. Such water glass syrup, when applied as a coating to wood, pasteboard, etc., dries up into a coherent varnish which renders the object non-inflammable, because in the heat of a fire the coating melts into a continuous viscid covering which prohibits access of oxygen to the interior. The early application of water glass to the scenery of the Munich court theatre explains its long immunity from destructive fires. When mixed with powdered chalk, magnesite, phosphate of lime, and many other similar materials, it gradually unites with these into hard stone-like masses. Caustic lime and magnesia (MgO) thus unite with it with exceptional promptitude, with elimination of alkali. Water glass, in short, is to the class of mineral substances referred to what ordinary glue is to wood and paper, etc., and it is used largely for analogous purposes. Fuchs himself based upon this property of his preparation a new process of wall painting which was subsequently developed and brought to great perfection by Kaulbach and others. In this process of "stereochromy," as it is called, the more immediate basis for the painting consists of a thin layer of a kind of cement made up of powdered marble, dolomite, quartz, and air-worn quicklime with water glass. On it the colors are laid with plain water, which causes them to stick on, but quite loosely, so that the artist can work at leisure and correct mistakes. The finished painting is fixed by applying to it a spray of water-glass solution, which, in the course of a few days, makes it perfectly fast. All that then remains to be done is to wash the painting with alcohol to remove the eliminated alkali and any dust that may have collected. A stereochromic painting (unlike one made by the old fresco process) is practically proof against atmospheric influences, even under a northern climate. In a water-glass solution the alkali is, so to say, only half combined with the silica; part of it in fact must be presumed to be present in the free state. At any rate the solution emulsionizes fats, and therefore is a cleansing agent in the same sense as soap-solution is. Water glass and other alkaline silicates are accordingly used as additions to some of the cheaper kinds of soap.

SILISTRIA, or SILISTRA, a fortified town on the south side of the Danube, 75 miles below Rustchuk, and 150 miles from the mouth of the river, is now at the head of a district in the principality of Bulgaria. In 1881 the population was 10,657.

Silistria is the Durostorum of the Romans, the Durostolos of the Byzantines, the Drstr of the Bulgarians. It was one of the most important towns of the Roman province of Mœsia Inferior, successively the headquarters of the legio I. Italica and the legio XI. Claudia. It was defended by the Bulgarian czar Simeon against the Hungarians (893).

Captured by Svyatoslaff, the Varingian called to the assistance of the emperor Nicephorus (967), it was subsequently recovered by the Bulgarians after a three-months' heroic defence. Under the Turks, whose rule began in the latter part of the 14th century, Silistria continued to flourish: Hajji Khalfa describes it as the most important of all the Danubian towns. It was the seat of a Greek metropolitan with five bishops under him; and a settlement of Ragusan merchants kept alive its commercial interests. The Russians, who captured Silistria in 1810, destroyed its fortifications before they withdrew; but they were rebuilt by foreign engineers, and in 1828–9 were strong enough to offer a serious resistance to the Russians, who lost 3000 men. At that date the population, including the garrison, was 24,000, but in 1837 it was only about 4000. In 1854 the town was successfully defended by General Krach against the Russians till the arrival of the Austrians in the peninsula. It was again invested by the Russians in 1877, and on the conclusion of peace was evacuated by the Turks.

SILIUS ITALICUS, a Latin epic poet, was born in 25 and died in 101 A.D. His birthplace is unknown. From his cognomen Italicus the conclusion has been drawn that he came from the town of Italica in Spain; but Latin usage would in that case have demanded the form *Italicensis*, and it is highly improbable that Martial would have failed to name him among the literary celebrities of Spain in the latter half of the 1st century. The conjecture that Silius was from Italica, the capital of the Italian confederation during the Social War, is open to still stronger objection. Most likely some ancestor of the poet acquired the title "Italicus" from having been a member of one of the corporations of "Italici" who are often mentioned in inscriptions from Sicily and elsewhere. In early life Silius was a renowned forensic orator, later a safe and cautious politician, without ability or ambition enough to be legitimately obnoxious to the cruel rulers under whom he lived. But mediocrity was hardly an efficient protection against the murderous whims of Nero, and Silius was generally believed to have secured at once his own safety and his promotion to the consulship by putting his oratorical powers to discreditable use in the judicial farces which often ushered in the doom of the emperor's victims. He was consul in the year of Nero's death (69), and is mentioned by Tacitus as having been one of two witnesses who were present at the conferences between Vitellius and Flavius Sabinus, the elder brother of Vespasian, when the legions from the East were marching rapidly on the capital. The life of Silius after his consulship is well depicted by the younger Pliny: "He conducted himself wisely and courteously as the friend of the luxurious and cruel Vitellius; he won repute by his proconsulship of Asia, and obliterated by the praiseworthy use he made of his leisure the stain he had incurred through his active exertions in former days. In dignity and contentment, avoiding power and therefore hostility, he outlived the Flavian dynasty, keeping to a private station after his governorship of Asia." His poem contains only two passages relating to the Flavians; in both Domitian is eulogized as a warrior; in one he figures as a singer whose lyre is sweeter than that of Orpheus himself. Silius had evidently little taste for bowing down in the house of Rimmon, and refrained from using the many opportunities which his epic afforded for humoring the vanity of the imperial house. He was a great student and patron of literature and art, and a passionate collector. Two great Romans of the past, Cicero and Virgil, were by him idealized and veritably worshipped; and he was the happy possessor of their estates at Tusculum and Naples. The later life of Silius was passed on the Campanian shore, hard by the tomb of Virgil, at which he offered the homage of a devotee. He closely emulated the lives of his two great heroes: the one he followed in composing epic verse, the other in debating philosophic questions with his friends of like tastes. Among these was Epictetus, who judged him to be the most philosophic spirit among the Romans of his time, and Cornutus, the Stoic, rhetorician, and grammarian, who appropriately dedicated to Silius a commentary upon Virgil. Though the verse of Silius is not wrapped in Stoic gloom like that of Lucan, yet Stoicism lends in many places a not ungraceful gravity to his poem. Silius was one of the numerous Romans of the early empire who had the courage of their opinions, and carried into perfect practice the theory of suicide adopted by their school. Stricken by an incurable disease, he starved himself to death, keeping a cheerful countenance to the end.

Whether Silius committed to writing his philosophic dialogues or not, we cannot say. Chance has preserved to us his epic poem entitled *Punica*, in seventeen books, and comprising some fourteen thousand lines. The epics of Silius, Lucan, Statius, and Valerius Flaccus are but a few waifs carried down to us by the wandering stream of time from the vast mass of post-Virgilian epics. Long before Silius bethought himself of his epic all possible historical and mythological themes had been worn to tatters by these poets. In choosing the Second Punic War for his subject, Silius had, we know, many predecessors, as he doubtless had many followers. From the time of Nævius onwards every great military struggle in which the Romans had been engaged had found its poet over and over again. In justice to Silius and Lucan, it should be observed that the mythologic poet had a far easier task than the historic. In a well-known passage Petronius pointedly describes the difficulties of the historic theme. A poet, he said, who should take upon him the vast subject of the civil wars would break down beneath the burden unless he were "full of learning," since he would have not merely to record facts, which the historians did much better, but must possess an unshackled genius, to which full course must be given by the use of digressions, by bringing divine beings on to the stage, and by giving generally a mythologic tinge to the subject. The Latin laws of the historic epic were fixed by Ennius, and were still binding when Claudian wrote. They were never seriously infringed, except by Lucan, who substituted for the *dei ex machina* of his predecessors the vast, dim, and imposing Stoic conception of destiny. By protracted application, and being (to use the significant phrase of Petronius) "full of learning," Silius had acquired excellent recipes for every ingredient that went to the making of the conventional historic epic. Though he is not named by Quintilian, he is probably hinted at in the mention of a class of poets who, as the writer says, "write to show their learning." To seize the moments in the history, however unimportant, which were capable of picturesque treatment; to pass over all events, however important, which could not readily be rendered into heroics; to stuff out the somewhat modern heroes to something like Homeric proportions; to subject all their movements to the passions and caprices of the Olympians; to ransack the poetry of the past for incidents and similes on which a slightly new face might be put; to foist in by well-worn artifices episodes, however strange to the subject, taken from the mythologic or historic glories of Rome and Greece,—all this Silius knew how to do, as he knew his own fingers and nails. He did it all with the languid grace of the inveterate connoisseur, and with a simplicity foreign to his time, which sprang in part from cultivated taste and horror of the venturesome word, and in part from the subdued tone of a life which had come unscathed through the reigns of Caligula, Nero, and Domitian. The more threadbare the theme, and the more worn the machinery, the greater the need of genius. Two of the most rigid requirements of the ancient epic were abundant similes and abundant single combats. But all the obvious resemblances between the actions of heroic man and external nature had long been worked out, while for the renovation of the single combat little could be done till the hero of the Homeric type was replaced by the mediæval knight. Silius, however, had perfect poetic appreciation, with scarce a trace of poetic creativeness. No writer has ever been more correctly and more uniformly judged by contemporaries and by posterity alike. Only the shameless flatterer, Martial, ventured to call his friend a poet as great as Virgil. But the younger Pliny gently says that he wrote poems with greater diligence than talent, and that, when, according to the fashion of the time, he recited them to his friends, "he sometimes found out what men really thought of them." It is, indeed, strange that the poem lived on. Silius is never mentioned by ancient writers after Pliny except Sidonius, who, under different conditions and at a much lower level, was such another as he. Since the discovery of Silius by Poggio, no modern enthusiast has arisen to sing his praises, and in the last sixty years he has found no editor, even for his text. Eighteenth-century editors, at a time when modern Silii were numerous in the field of literature and more fashionable than they have been since, found in the *Punica* passages not unworthy of comparison with the *Henriade*, and thought that Silius did not disgrace Virgil; but even such gentle commendation is not likely to be repeated again. Yet, by the purity of his taste and his Latin in an age when taste was fast becoming vicious and Latin corrupt, by his presentation to us of a type of a thousand vanished Latin epics, and by the historic aspects of his subject, Silius merits better treatment from scholars than he has received. The general reader he can hardly interest again. He is indeed of imitation all compact, and usually dilutes what he borrows; he may add a new beauty, but new strength he never gives. Hardly a dozen lines anywhere are without an echo of Virgil, and there are frequent admixtures of Lucretius, Horace, Ovid, Lucan, Homer, Hesiod, and many other poets still extant. If we could reconstitute the library of Silius we should probably find that scarcely an idea or a phrase in his entire work was wholly his own.

The raw material of the *Punica* was supplied in the main by the third decade of Livy, though Silius may have consulted other historians of the Hannibalic war. Such facts as are used are generally presented with their actual circumstances unchanged, and in their historic sequence. The spirit of the Punic times is but rarely misconceived,—as when to secret voting is attributed the election of men like Flaminius and Varro, and distinguished Romans are depicted as contending in a gladiatorial exhibition. Silius clearly intended the poem to consist of twenty-four books, like the Iliad and the Odyssey, but after the twelfth he hurries in visible weariness to the end and concludes with seventeen. The general plan of the epic follows that of the Iliad and the Æneid. Its theme is conceived as a duel between two mighty nations, with parallel dissensions among the gods. Scipio and Hannibal are the two great heroes who take the place of Achilles and Hector on the one hand and of Æneas and Turnus on the other, while the minor figures are all painted with Virgilian or Homeric pigments. In the delineation of character our poet is neither very powerful nor very consistent. His imagination was too weak to realize the actors with distinctness and individuality. His Hannibal is evidently at the outset meant for an incarnation of cruelty and treachery, the embodiment of all that the vulgar Roman attached to the name "Punic." But in the course of the poem the greatness of Hannibal is borne in upon the poet, and his feeling of it betrays itself in many touches. Thus he names Scipio "the great Hannibal of Ausonia"; he makes Juno assure the Carthaginian leader that if fortune had only permitted him to be born a Roman he would have been admitted to a place among the gods; and, when the ungenerous monster of the first book accords in the fifteenth a splendid burial to Marcellus, the poet cries, "You would fancy it was a Sidonian chief who had fallen." Silius deserves little pity for the failure of his attempt to make Scipio an equipoise to Hannibal and the counterpart in personal prowess and prestige of Achilles. He becomes in the process almost as mythical a figure as the mediæval Alexander. The best drawn of the minor characters are Fabius Cunctator, an evident copy of Lucan's Cato, and Paullus, the consul killed at Cannæ, who fights, hates, and dies like a genuine man.

Clearly it was a matter of religion with Silius to repeat and adapt all the striking episodes of Homer and Virgil. Hannibal must have a shield of marvellous workmanship like Achilles and Æneas; because Æneas descended into Hades and had a vision of the future history of Rome, so must Scipio have his revelation from heaven; Trebia, choked with bodies, must rise in ire like Xanthus, and be put to flight by Vulcan; for Virgil's Camilla there must be an Asbyte, heroine of Saguntum; the beautiful speech of Euryalus when Nisus seeks to leave him is too good to be thrown away,—furbished up a little, it will serve as a parting address from Imilce to her husband Hannibal. The descriptions of the numerous battles are made up in the main, according to epic rule, of single combats—wearisome sometimes in Homer, wearisome oftener in Virgil, painfully wearisome in Silius. The different component parts of the poem are on the whole fairly well knit together, and the transitions are not often needlessly abrupt; yet occasionally incidents and episodes are introduced with all the irrelevancy of the modern novel. A son of Regulus escapes from Thrasymene to a hut, merely to find there an old servant of his father, and to afford him the opportunity of telling over again the tale of the first war against the Carthaginians. To give scope for a eulogy of Cicero, an ancestor of his fights at Cannæ, and strong devices sometimes usher in such stories as the judgment of Paris and the choice of Hercules. The interposition of the gods is, however, usually managed with dignity and appropriateness.

As to diction and detail, we miss, in general, power rather than taste. The metre runs on with correct smooth monotony, with something always of the Virgilian sweetness, though attenuated, but nothing of the Virgilian variety and strength. The dead level of literary execution is seldom broken by a rise into the region of genuine pathos and beauty, or by a descent into the ludicrous or the repellent. There are few absurdities, but the restraining force is trained perception and not a native sense of humor, which, ever present in Homer, not entirely absent in Virgil, and sometimes finding grim expression in Lucan, fails Silius entirely. The address of Anna, Dido's sister, to Juno compels a smile. Though deified on her sister's death, and for a good many centuries already an inhabitant of heaven, Anna meets Juno for the first time on the outbreak of the *Second* Punic War, and deprecates the anger of the queen of heaven for having deserted the Carthaginians and attached herself to the Roman cause. Hannibal's parting address to his child is also comical: he recognizes in the "heavy wailing" of the year-old babe "the seeds of rages like his own." But Silius might have been forgiven for a thousand more weaknesses than he has if in but a few things he had shown strength. The grandest scenes in the history before him fail to lift him up; his treatment, for example, of Hannibal's Alpine passage falls immensely below Lucan's vigorous delineation of Cato's far less stirring march across the African deserts.

But in the very weaknesses of Silius we may discern merit. He at least does not try to conceal defects of substance by contorted rhetorical conceits and feebly forcible exaggerations. In his ideal of what Latin expression should be he comes near to his contemporary Quintilian, and resolutely holds aloof from the tenor of his age. Perhaps his want of success with the men of his time was not wholly due to his faults. His self-control rarely fails him; it stands the test of the horrors of war, and of Venus working her will on Hannibal at Capua. The reader of Statius and even Propertius will be thankful for the rarity of recondite epithets, such as "Rhœtean destiny," "Garamantian standards," "Lagean river," "Smyrnæan strings." Only a few passages here and there betray the true silver Latin extravagance, as when Hannibal is compared for speed to a tigress reft of her cubs, which darts forth *and in a few hours* traverses the Caucasus, and with a "winged" leap flies across *the Ganges;* or when the Carthaginians after Capua launch their spears but are too enervated to *make them whiz;* or when the plague-stricken and famine-wasted men of Syracuse hide their diminished faces far within their helmets, and carefully shade their pallor lest hope should arise for the enemy. In the avoidance of rhetorical artifice and epigrammatic antithesis Silius stands in marked contrast to Lucan. Yet he can be pointed; so of Fabius, "laudum cladumque quieta Mente capax"; and of Scævola, "Aspera semper amans et par cuicumque periclo"; and of Africa, "Altrix bellorum bellatorumque virorum Tellus, nec fidens nudo sine fraudibus ensi." Looking at Silius merely as a poet he may not deserve high praise; but, as he is a unique specimen and probably the best of a once numerous class, the preservation of his poem among the remains of Latin literature is a fortunate accident.

The poet's full name, Ti. Catius Silius Italicus, is preserved in an inscription (*C. I. L.*, vi. 1984). The poem was discovered in a MS., possibly at Constance, by Poggio, in 1416 or 1417; from this now lost MS. all existing MSS., which belong entirely to the 15th century, are derived. A valuable MS. of the 8th or 9th century, found at Cologne by L. Carrion in the latter part of the 16th century, disappeared soon after its discovery. Two *editiones principes* appeared at Rome in 1471; the principal editions since have been those of Heinsius (1600), Drakenborch (1717), and Ernesti (Leipsic, 1791). A useful *variorum* edition is that of Lemaire (Paris, 1823). The recent *lucubrationes* on Silius are mostly small pamphlets, enumerated by Engelmann (*Bibl. Script. Class.*, 1878).

(J. S. R.)

SILK.

SILK is a fibrous substance produced by many insects, principally in the form of a cocoon or covering within which the creatures are inclosed and protected during the period of their principal transformations. The webs and nests, etc., formed by spiders are also of silk. But the fibres used for manufacturing purposes are exclusively produced by the mulberry silk-moth of China, *Bombyx mori*, and a few other moths closely allied to that insect (see vol. iv. pp. 530–1). Among the Chinese the name of the silk-worm is "si," Corean "soi"; to the ancient Greeks it became known as *σήρ*, the nation whence it came was to them *Σῆρες*, and the fibre itself *σηρικόν*, whence the Latin *sericum*, the French *soie*, the German *Seide*, and the English *silk*.

The silk industry originated in China; and according to native records it has existed there from a very remote period. The empress Se-ling-she, wife of a famous emperor, Hwang-te (2640 B.C.), encouraged the cultivation of the mulberry tree, the rearing of the worms, and the reeling of silk. This empress is said to have devoted herself personally to the care of silkworms, and she is by the Chinese credited with the invention of the loom. A voluminous ancient literature testifies not only to the antiquity but also to the importance of Chinese sericulture, and to the care and attention bestowed on it by royal and noble families. The Chinese guarded the secrets of their valuable art with vigilant jealousy; and there is no doubt that many centuries passed before the culture spread beyond the country of its origin. Through Corea a knowledge of the silkworm and its produce reached Japan, but not before the early part of the 3d century. One of the most ancient books of Japanese history, the *Nihongi*, states that towards 300 A.D. some Coreans were sent from Japan to China to engage competent people to teach the arts of weaving and preparing silk goods. They brought with them four Chinese girls, who instructed the court and the people in the art of plain and figured weaving; and to the honor of these pioneer silk weavers a temple was erected in the province of Setsu. Great efforts were made to encourage the industry, which from that period grew into one of national importance. At a period probably little later a knowledge of the working of silk travelled westward, and the cultivation of the silkworm was established in India. According to a tradition the eggs of the insect and the seed of the mulberry tree were carried to India by a Chinese princess concealed in the lining of her headdress. The fact that sericulture was in India first established in the valley of the Brahmaputra and in the tract lying between that river and the Ganges renders it probable that it was introduced overland from the Chinese empire. From the Ganges valley the silkworm was slowly carried westward and spread in Khotan, Persia, and the states of Central Asia.

Most critics recognize in the obscure word *dmeshek*, Amos iii. 12, a name of silk corresponding to the Arabic *dimaks*, late Greek *μέταξα*, English *damask*, and also follow the ancients in understanding *meshi*, Ezek. xvi. 10, 13, of "silken gause." But the first notice of the silkworm in Western literature occurs in Aristotle, *Hist. Anim.*, v. 19 (17), 11 (6), where he speaks of "a great worm which has horns and so differs from others. At its first metamorphosis it produces a caterpillar, then a bombylius, and lastly a chrysalis,—all these changes taking place within six months. From this animal women separate and reel off the cocoons and afterwards spin them. It is said that this was first spun in the island of Cos by Pamphile, daughter of Plates." Aristotle's vague knowledge of the worm may have been derived from information acquired by the Greeks with Alexander the Great; but long before this time raw silk must have begun to be imported at Cos, where it was woven into a gauzy tissue, the famous *Coa vestis*, which revealed rather than clothed the form.

Towards the beginning of the Christian era raw silk began to form an important and costly item among the prized products of the East which came to Rome. Allusions to silk and its source became common in classical literature; but, although these references show familiarity with the material, they are singularly vague and inaccurate as to its source; even Pliny knew nothing more about the silkworm than could be learned from Aristotle's description. The silken textures which at first found their way to Rome were necessarily of enormous cost, and their use by men was deemed a piece of effeminate luxury. From an anecdote of Aurelian, who neither used silk himself nor would allow his wife to possess a single silken garment, we learn that silk was worth its weight in gold.

Notwithstanding its price and the restraints otherwise put on the use of silk the trade grew. Under Justinian a monopoly of the trade and manufacture was reserved to the emperor, and looms, worked by women, were set up within the imperial palace at Constantinople. Justinian also endeavored, through the Christian prince of Abyssinia, to divert the trade from the Persian route along which silk was then brought into the east of Europe. In this he failed, but two Persian monks who had long resided in China, and there learned the whole art and mystery of silkworm rearing, arrived at Constantinople and imparted their knowledge to the emperor. By him they were induced to return to China and attempt to bring to Europe the material necessary for the cultivation of silk, which they effected by concealing the eggs of the silkworm in a hollow cane. From the precious contents of that bamboo tube, brought to Constantinople about the year 550, were produced all the races and varieties of silkworm which stocked the Western world, and which gave trade, prosperity, and untold wealth to great communities for more than twelve hundred years. The necessity for again going to the East for a supply of silkworm eggs has only arisen in our own day.

Under the care of the Greeks the silkworm took kindly to its Western home and flourished, and the silken textures of Byzantium became famous. At a later period the conquering Saracens obtained a mastery over the trade, and by them it was spread both east and west,—the textures becoming meantime impressed with the patterns and colors peculiar to that people. They established the trade in the thriving towns of Asia Minor, and they planted it as far west as Sicily, as Sicilian silks of the 12th century with Saracenic patterns still testify. Ordericus Vitalis, who died in the first half of the 12th century, mentions that the bishop of St. Evroul, in Normandy, brought with him from Apulia in southern Italy several large pieces of silk, out of the finest of which, four copes were made for his cathedral chanters. The cultivation and manufacture spread northwards to Florence, Milan, Genoa, and Venice—all towns which became famous for silken textures in mediæval times. In 1480 silk weaving was begun under Louis XI. at Tours, and in 1520 Francis I. brought from Milan silkworm eggs, which were reared in the Rhone valley. About the beginning of the 17th century Olivier de Serres and Laffémas, somewhat against the will of Sully, obtained royal edicts favoring the growth of mulberry plantations and the cultivation of silk; but it cannot be said that these industries were firmly established till Colbert encouraged the planting of the mulberry by premiums, and otherwise stimulated local efforts.

Into England silk manufacture was introduced during the reign of Henry VI.; but the first serious impulse to manufactures of that class was due to the immigration in 1585 of a large body of skilled Flemish weavers who fled from the Low Countries in consequence of the struggle with Spain then devastating their land. Precisely one hundred years later religious troubles again gave the second and most effective impetus to the silk trade of England, when the revocation of the edict of Nantes sent simultaneously to Switzerland, Germany, and England a vast body of the most skilled artisans of France, who planted in these countries silk weaving colonies which are to this day the principal rivals of the French manufacturers. The bulk of the French Protestant weavers settled at Spitalfields, London,—an incorporation of silk throwsters having been there formed in 1629. James I. used many efforts to encourage the planting of the mulberry and the rearing of silkworms both at home and in the colonies. In 1825 a public company was formed and incorporated under the name of the British, Irish, and Colonial Silk Company, with a capital of £1,000,000 [$4,860,000], principally with the view of introducing sericulture into Ireland, but it was a complete failure, and the rearing of the silkworm cannot be said ever to have become a branch of British industry.

In 1522 Cortes appointed officials to introduce sericulture into New Spain (Mexico), and mulberry trees were then planted and eggs were brought from Spain. The Mexican adventure is mentioned by Acosta, but all trace of the culture had died out before the end of the century. In 1609 James I. attempted to reinstate the silkworm on the American continent, but his first effort failed through shipwreck. An effort made in 1619 obtained greater success, and, the materials being present, the Virginian settlers were strongly urged to devote attention to the profitable industry of silk cultivation. Sericulture was enjoined under penalties by statute; it was encouraged by bounties and rewards; and its prosecution was stimulated by learned essays and rhapsodical rhymes, of which this is a sample:

> Where Wormes and Food doe naturally abound
> A gallant Silken Trade must there be found.
> Virginia excels the World in both—
> Envie nor malice can gaine say this troth!

In the prospectus of Law's great *Compagnie des Indes Occidentales* the cultivation of silk occupies a place among the glowing attractions which allured so many to disaster. Onward till the period of the War of Independence bounties and other rewards for the rearing of worms and silk filature continued to be offered; and just when the war broke out Benjamin Franklin and others were engaged in nursing a filature into healthy life at Philadelphia. With the resumption of peaceful enterprise, the stimulus of bounties was again applied —first by Connecticut in 1783; and such efforts have been continued sporadically down almost to the present day. Bounties were last offered by the State of California in 1865–66, but the State law was soon repealed, and an attempt to obtain State encouragement again in 1872 was defeated. About 1838 a speculative mania for the cultivation of silk developed itself with remarkable severity in the United States. It was caused principally through the representations of Samuel Whitmarsh as to the capabilities of the South Sea Islands mulberry (*Morus multicaulis*) for feeding silkworms; and so intense was the excitement that plants and crops of all kinds were displaced to make room for plantations of *multicaulis*. In Pennsylvania as much as $300,000 changed hands for plants in one week, and frequently the young trees were sold two and three times over within a few days at ever-advancing prices. Plants of a single year's growth reached the ridiculous price of $1 each at the height of the fever, which, however, did not last long, for in 1839 the speculation collapsed; the famous *Morus multicaulis*, was found to be no golden tree, and the costly plantations were uprooted.

The most singular feature in connection with the history of silk is the persistent efforts which have been made by monarchs and other potentates to stimulate sericulture within their dominions, efforts which continue to this day in British colonies, India, and America. These endeavors to stimulate by artificial means have in scarcely any instance resulted in permanent success. In truth raw silk can only be profitably brought to the market where there is abundant and very cheap labor, —the fact that China, Japan, Bengal, Piedmont, and the Levant are the principal producing localities making that plain.

The Silkworm.

The mulberry-feeding moth, *Bombyx mori*, which is the principal source of silk, belongs to the *Bombycidæ*, a family of *Lepidoptera* in which are embraced some of the largest and most handsome moths (see vol. iv. p. 530–31). *B. mori* is itself an inconspicuous moth (Figs. 1 and 2) of an ashy white color, with a body in the case of the male not half an inch in length, the female being a little longer and stouter. Its wings are short and weak; the fore pair are falcate, and the hind pair do not reach to the end of the body. The larva (Fig. 3) is hairless, of an ashy gray or cream color, attains to a length of from 3 to 3½ inches, and is slender in comparison with many of its allies. The second thoracic ring is humped, and there is a spine-like horn or protuberance at the tail. The common silkworm produces as a rule only one generation during the year; but there are races in cultivation which are bivoltine, or two-generationed, and some are multivoltine. Its natural food is the leaves of mulberry trees. The silk glands or vessels consist of two long thick-walled sacs running along the sides of the body, which open by a common orifice—the spinneret or seripositor—on the under lip of the larva. Fig. 4 represents the head (*a*) and feet (*b*, *b*) of the common silkworm, while *c* is a diagrammatic view of the silk glands. As the larva approaches maturity these vessels become gorged with a clear viscous fluid, which, upon being exposed to the air immediately hardens to a solid mass. Advantage is taken of this peculiarity to prepare from fully-developed larvæ silkworm gut used for casting lines in rod-fishing, and for numerous other purposes where lightness, tenacity, flexibility, and strength are essential. The larvæ are killed and hardened by steeping some hours in strong acetic acid; the silk glands are then separated from the bodies, and the viscous fluid drawn out to the condition of a fine uniform line, which is stretched between pins at the extremity of a board.

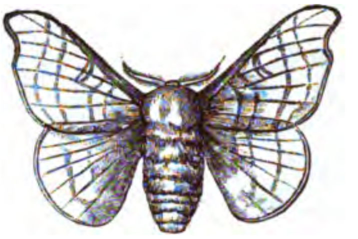

FIG. 1.—*Bombyx mori* (male).

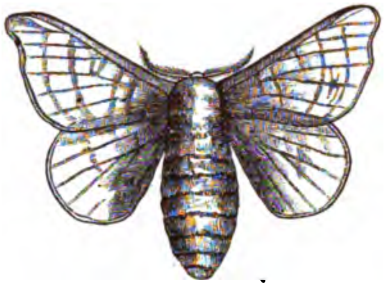

FIG. 2.—*Bombyx mori* (female).

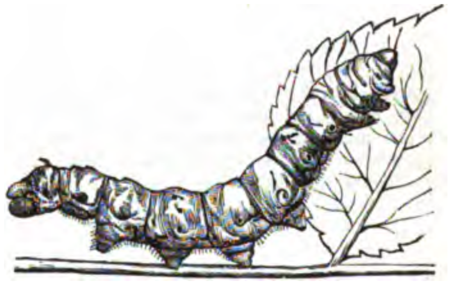

FIG. 3.—Larva of *Bombyx mori*.

The board is then exposed to the sunlight till the lines dry and harden into the condition of gut. The preparation of gut is, however, merely an unimportant collateral manufacture. When the larva is fully mature, and ready to change into the pupa condition, it proceeds to spin its cocoon, in which operation it ejects from both glands simultaneously a line or thread about 4000 yards in length, moving its head round in regular order continuously for three days or thereby. The thread so ejected forms the silk of commerce, which as wound in the cocoon consists of two filaments—one from each gland—laid side by side and agglutinated into one fibre (Fr. *bave*) by their own adhesive constituents. Under the microscope, therefore, cocoon silk presents the appearance (Fig. 5) of a somewhat flattened combination of two filaments placed side by side, being on an average from .033 to .036 mm. broad by .020 to .025 mm. in thickness. The cocoons are white or yellow in color, oviform in shape, with often a constriction in the middle (Fig. 6). According to race, etc., they vary considerably in size and weight, but on an average they measure from an inch to an inch and a half in length, and from half an inch to an inch in diameter. They form hard, firm, and compact shells with some straggling flossy filaments on the exterior, and the interior layers are so closely and densely agglutinated as to constitute a parchment-like mass which resists all attempts at unwinding. The whole cocoon with its enclosed pupa weighs from 15 grains for the smaller races to about 50 grains for the breeds which spin large cocoons. From two to three weeks after the completion of the cocoon the enclosed insect is ready to escape; it moistens one end of its self-made prison, thereby enabling itself to push aside the fibres and make an opening by which the perfect moth comes forth. The sexes almost immediately couple; the female in from four to six days lays her eggs, numbering 500 and upwards; and, with that the life cycle of the moth being complete, both sexes soon die.

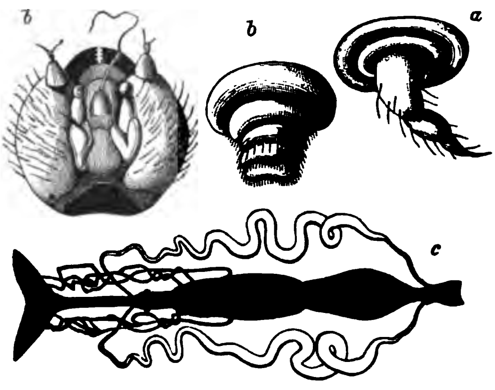

FIG. 4.

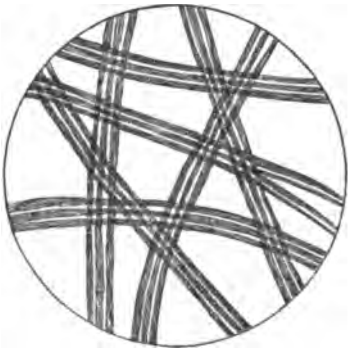

FIG. 5.—Microscopic appearance of Silk of *Bombyx mori*.

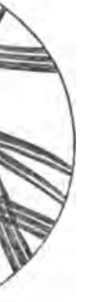

FIG. 6.—Cocoon of *Bombyx mori*.

Sericulture.

The art of sericulture concerns itself with the rearing of silkworms under artificial or domesticated conditions, their feeding, the formation of cocoons, the securing of these before they are injured and pierced by the moths, and the maturing of a sufficient number of moths to supply eggs for the cultivation of the following year. The first essential is a stock of mulberry trees adequate to feed the worms in their larval stage. The leaves preferred in Europe are those of the white-fruited mulberry, *Morus alba*, but there are numerous other species which appear to be equally suitable. The soil in which the mulberry grows, and the age and condition of the trees, are important factors in the success of silkworm cultivation; and it has been too often proved that the mulberry will grow in situations where, from the nature of the leaf the trees put forth and from other circumstances, silkworms cannot be profitably reared. An elevated position with dry friable well-drained soil produces the best quality of leaves. Throughout the East the species of mulberry cultivated are numerous, but, as these trees have been grown for special purposes at least for three thousand years, they show the complex variations peculiar to most cultivated plants.

The eggs of the silkworm, called *graine*, are hatched out by artificial heat at the period when the mulberry leaves are ready for the feeding of the larvæ. These eggs are very minute—about one hundred weighing a grain; and a vast number of hatched worms may at first be kept in a small space; but the rapid growth and voracious appetite of the caterpillars demand quickly increasing and ample space. Pieces of paper punctured with small holes are placed over the trays in which the hatching goes on; and the worms, immediately they burst their shell, creep through these openings to the light, and thereby scrape off any fragments of shell which, adhering to their skin, would kill them by constriction. The rearing-house in which the worms are fed (Fr. *magnanerie*) must be a spacious, well-lighted, and well-ventilated apartment, in which scrupulous cleanliness and sweetness of air are essential, and in which the temperature may to a certain extent be under control. The worms are more hardy than is commonly supposed, and endure variations of temperature from 62° to 78° F. without any injury; but higher temperature is very detrimental. The lower the temperature at which the worms are maintained the slower is their growth and development; but their health and vigor are increased, and the cocoon they spin is proportionately bigger. The worms increase in size with astonishing rapidity, and no less remarkable is their growing voracity. Certain races moult or cast their skin three times during their larval existence, but for the most part the silkworm moults four times —about the sixth, tenth, fifteenth, and twenty-third days after hatching. As these moulting periods approach, the worms lose their appetite and cease eating, and at each period of change they are left undisturbed and free from noise. The worms from 1 oz. of graine —numbering, say, 40,000—consume in their first stage about 6 ℔ of picked leaf, in the second 18 ℔, in the third 60 ℔, fourth 180 ℔, and in their final stage 1098 ℔,—in all 1362 ℔ of mulberry leaf; but from that is to be deducted about 590 ℔ of unconsumed fragments removed in the litter, giving of leaf really consumed 772 ℔. An ounce of graine so treated may yield from 80 to 120 ℔ of cocoons, 85 per cent. of which consists of the weight of chrysalides and 15 per cent. of pure cocoon. The growth of the worms during their larval stage is thus stated by Count Dandolo:

	Weight per 100.	Size in Lines.
Worms newly hatched......	1 gr.	1
After 1st moult.................	15 "	4
" 2d "	94 "	6
" 3d "	400 "	12
" 4th "	1628 "	20
Greatest weight and size...	9500 "	40

When the caterpillars are mature and ready to undergo their transformation into the pupa condition, they cease eating for some time and then begin to ascend the brushwood branches or echelletes provided for them, in which they set about the spinning of their cocoons. Crowding of positions must now be guarded against, to prevent the spinning of double cocoons (*doubions*) by two worms spinning together and so interlacing their threads that they cannot be reeled. The insects complete their cocoons in from three to four days, and in two or three days thereafter the cocoons are collected, and the pupa killed to prevent its further progress and the bursting of the shell by the fully developed moth. Such cocoons as are selected for the production of graine, on the other hand, are collected, freed from the external floss, and preserved at a temperature of from 66° to 72° Fahr., and after a lapse of from eleven to fifteen days the moths begin to make their appearance. The coupling which immediately takes place demands careful attention; the males are afterwards thrown away, and the impregnated females placed in a darkened apartment till they deposit their eggs.

Diseases.—That the silkworm is subject to many and serious diseases is only to be expected of a creature which for upwards of 4000 years has been propagated under purely artificial conditions, and these most frequently of a very insanitary nature, and where, not the healthy life of the insect, but the amount of silk it could be made to yield, was the object of the cultivator. Among the most fatal and disastrous of these diseases with which the cultivator had long to grapple was "muscardine," a malady due to the development of a fungus, *Botrytis bassiana*, in the body of the caterpillar. The disease is peculiarly contagious and infectious, owing to the development of the fungus through the skin, whence spores are freed, which, coming in contact with healthy caterpillars, fasten on them and germinate inwards, giving off corpuscles within the body of the insect. Muscardine, however, has not been epidemic for many years. But about the year 1853 anxious attention began to be given in France to the ravages of a disease among silkworms, which from its alarming progress threatened to issue in national disaster. This disease, which at a later period became known as "pebrine,"—a name given to it by M. de Quatrefages, one of its many investigators,—had first been noticed in France at Cavaillon in the valley of the Durance near Avignon. Pebrine manifests itself by dark spots in the skin of the larvæ; the eggs do not hatch out, or hatch imperfectly; the worms are weak, stunted, and unequal in growth, languid in movement, fastidious in feeding; many perish before coming to maturity; if they spin a cocoon it is soft and loose, and moths when developed are feeble and inactive. When sufficient vitality remains to produce a second generation it shows in increased intensity the feebleness of the preceding. The disease is thus hereditary, but in addition it is virulently infectious and contagious. From 1850 onwards French cultivators were compelled, in order to keep up their silk supply, to import graine from uninfected districts. The area of infection increased rapidly, and with that the demand for healthy graine correspondingly expanded, while the supply had to be drawn from increasingly remote and contracted regions. Partly supported by imported eggs, the production of silk in France was maintained, and in 1853 reached its maximum of 26,000,000 kilos [57,330,000 ℔] of cocoons, valued at 117,000,000 francs [$22,581,000]. From that period, notwithstanding the importation at great cost of foreign graine, reaching in some years to 60,000 kilos [132,300 ℔], the production of silk fell off with startling rapidity: in 1856 it was not more than 7,500,000 kilos [16,537,500 ℔] of cocoons; in 1861 and 1862 it fell as low as 5,800,000 kilos [12,789,000 ℔]; and in 1865 it touched its lowest weight of about 4,000,000 kilos [8,820,000 ℔]. In 1867 De Quatrefages estimated the loss suffered by France in the 13 years following 1853, from decreased production of silk and price paid to foreign cultivators for graine, to be not less than one milliard of francs [$193,000,000]. In the case of Italy, where the disease showed itself later but even more disastrously, affecting a much more extended industry, the loss in 10 years De Quatrefages stated at two milliards [$386,000,000]. A loss of £120,000,000 sterling [$583,200,000] within 13 years, falling on a limited area, and on one class within these two countries, constituted indeed a calamity on a national scale, calling for national effort to contend with its devastating action. The malady, moreover, spread eastward with alarming rapidity, and, although it was found to be less disastrous and fatal in Oriental countries than in Europe, the sources of healthy graine became fewer and fewer, till only Japan was left as an uninfected source of European graine supply.

A scourge which so seriously menaced the very existence of the silkworm in the world necessarily attracted a great amount of attention. The disease was studied by the most eminent men of science; reports and suggestions innumerable were made, and a whole pharmacopœia of remedies proposed. So early as 1849 M. Guérin Méneville observed in the blood of diseased silkworms certain vibratory corpuscles, but neither did he nor the Italian Signor Filippi, who studied them later, connect them distinctly with the disease. The corpuscles were first accurately described by Signor Cornalia, whence they are spoken of as the corpuscles of Cornalia. The French Academy charged MM. de Quatrefages, Decaisne, and Peligot with the study of the disease, and these learned men issued two elaborate reports —*Études sur les Maladies Actuelles des Vers à Soie*, 1859, and *Nouvelles Recherches sur les Maladies Actuelles des Vers à Soie*, 1860; but the suggestions they were able to offer had not the effect of stopping the march of the disease. In 1865 M. Pasteur undertook a Government commission for the investigation of the malady. Attention had been previously directed to the corpuscles of Cornalia, and it had been found, not only that they occurred in the blood, but that they gorged the whole tissues of the insect, and their presence in the eggs themselves could be microscopically demonstrated. Pasteur set himself to elucidate the life-history of these corpuscles, and he soon established (1) that the corpuscles are the special characteristic of the disease, and that these invariably manifest themselves, if not in earlier stages, then in the mature moths; (2) that the corpuscles are parasites, and not only the sign but the cause of the disease; and (3) that the disease manifests itself by heredity, by contagion with diseased worms, and by the eating of leaves on which corpuscles are spread. In this connection he established the very important practical conclusion that worms which contract the disease during their own life-cycle retain sufficient vitality to feed, develop, and spin their cocoon, although the next generation is invariably infected and shows the disease in its most virulent and fatal form. But this fact enabled the cultivator to know with assurance whether the worms on which he bestowed his labor would yield him a harvest of silk. He had only to examine the bodies of the moths yielding his graine: if they were free from disease then a crop was sure; if they were infected the education would assuredly fail. Pasteur brought out the fact that the malady had existed from remote periods and in many unsuspected localities. He found corpuscles in Japanese cocoons and in many specimens which had been preserved for lengthened periods in public collections. Thus he came to the conclusion that the malady had been inherent in many successive generations of the silkworm, and that the epidemic condition was only an exaggeration of a normal state brought about by the method of cultivation and production of graine pursued. The cure proposed by Pasteur was simply to take care that the stock whence graine was obtained should be healthy, and the offspring would then be healthy also. Small educations reared apart from the ordinary magnanerie, for the production of graine alone, were recommended. At intervals of five days after spinning their cocoons specimens were to be opened and the chrysalides examined microscopically for corpuscles. Should none have appeared till towards the period of transformation and escape of the moths, the eggs subsequently hatched out might be depended on to yield a fair crop of silk; should the moths prove perfectly free from corpuscles after depositing their eggs the next generation would certainly live well through the larval stage. For special treatment towards the regeneration of an infected race, the most robust worms were to be selected, and the moths issuing from the cocoons were to be coupled in numbered cells, where the female was to be confined till she deposited her eggs. The bodies of both male and female were to be examined for corpuscles, and the eggs of those found absolutely free from taint were preserved for similar "cellular" treatment in the following year. By this laborious and painstaking method it has been found possible to re-establish a healthy stock of valuable races from previously highly-infected breeds. The rearing of worms in small educations under special supervision has been found to be a most effective means of combating pebrine. In the same way the rearing of worms for graine in the open air, and under as far as possible natural conditions, has proved equally valuable towards the development of a hardy, vigorous, and untainted stock. The open-air education was originally proposed by Dr. Chavannes of Lausanne, and largely carried out in the canton of Vaud by M. Roland, who reared his worms on mulberry trees enclosed within "manchons" or cages of wire gauze and canvas. The insects appeared quickly to revert to natural conditions; the moths brought out in open air were strongly marked, lively, and active, and eggs left on the trees stood the severity of the winter well, and hatched out successfully in the following season. M. Roland's experience demonstrated that not cold but heat is the agent which saps the constitution of the silkworm and makes it a ready prey to disease.

Wild Silks.—The ravages of pebrine and other diseases had the effect of attracting prominent attention to the numerous other insects, allies of the mulberry silkworm, which spin serviceable cocoons. It had been previously pointed out by Captain Hutton, who devoted great attention to the silk question as it affects the East Indies, that at least six species of *Bombyx*, differing from *B. mori*, but also mulberry-feeding, are more or less domesticated in India. These include *B. textor*, the boro-pooloo of Bengal, a large species having one generation yearly and producing a soft flossy cocoon; the Chinese monthly worm, *B. sinensis*, having several generations, and making a small cocoon; and the Madrasi worm of Bengal (*B. crœsi*), the Dassee or Desi worm of Bengal (*B. fortunatus*), and *B. arracanensis*, the Burmese worm,—all of which yield several generations in the year and form reelable cocoons. Besides these there are many other mulberry-feeding *Bombycidæ* in the East, principally belonging to the genera *Theophila* and *Ocinara*, the cocoons of which have not attracted cultivators. The moths yielding wild silks which have obtained most attention belong to the extensive and handsome family *Saturnidæ*. The most important of the species at the present time is the Chinese tusser or tasar worm, *Antheræa pernyi* (Figs. 7, 8), an oak-feeding species, native of Mongolia, from which is derived the greater part of the so-called tusser silk now imported into Europe. Closely allied to this is the Indian tusser moth (Fig. 9) *Antheræa mylitta*, found throughout the whole of India feeding on the bher tree, *Zizyphus jujuba*, and on many other plants. It yields a large compact cocoon (Fig. 10) of a silvery gray color, which Mr. Thomas Wardle of Leek, who has devoted a great amount of attention to the wild-silk question, has succeeded in reeling. Next in promising qualities is the muga or moonga worm of Assam, *Antheræa assama*, a species to some extent domesticated in its native country. The yama-mai worm of Japan, *Antheræa* (*Samia*) *yama-mai*, an oak-feeder, is a race of considerable importance in Japan, where it was said to be jealously guarded against foreigners. Its eggs were first sent to Europe by M. Duchêne du Bellecourt, French consul-general in Japan in 1861; but early in March following they hatched out, when no leaves on which the larvæ would feed were to be found. In April a single worm got oak-buds, on which it throve, and ultimately spun a cocoon whence a female moth issued, from which M. Guérin Méneville named and described the species. A further supply of eggs was secretly obtained by a Dutch physician, M. Pompe van Meedervoort, in 1863, and, as it was now known that the worm was an oak-feeder, and would thrive on the leaves of European oaks, great results were anticipated from the cultivation of the yama-mai. These expectations, however, for various reasons, have been disappointed. The moths hatch out at a period when oak leaves are not ready for their feeding, and the silk is by no means of a quality to compare with that of the common mulberry worm. The mezankoorie moth of the Assamese, *Antheræa mezankooria*, yields a valuable cocoon, as does also the Atlas moth, *Attacus atlas*, which has an omnivorous larva found throughout India, Ceylon, Burmah, China, and Java. The Cynthia moth. *Attacus cynthia*, is domesticated as a source of silk in certain provinces of China, where it feeds on the *Ailanthus glandulosa*. The eria or arrindi moth of Bengal and Assam, *Attacus ricini*, which feeds on the castor-oil plant, yields seven generations yearly, forming loose flossy orange-red and sometimes white cocoons. The ailanthus silkworm of Europe is a hybrid between *A. cynthia* and *A. ricini*, first obtained by Guérin Méneville, and now spread through many silk-growing regions. These are only a few of the moths from which silks of various usefulness can be produced; but none of these presents qualities, saving perhaps cheapness alone, which can put them in competition with common silk.

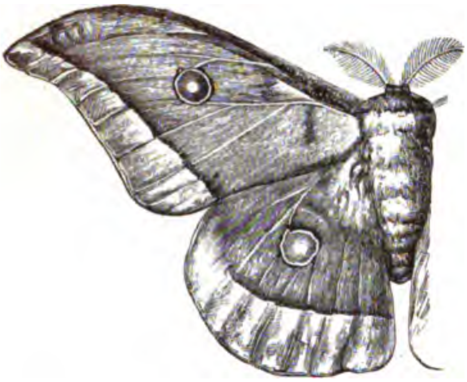

Fig. 7.—Chinese Tusser Moth, *Antheræa pernyi* (male).

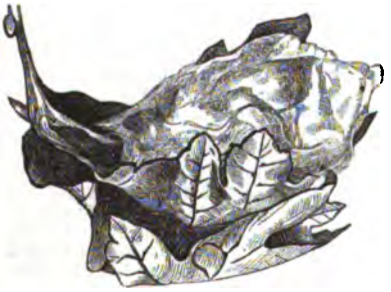

Fig. 8.—Cocoon of *Antheræa pernyi*.

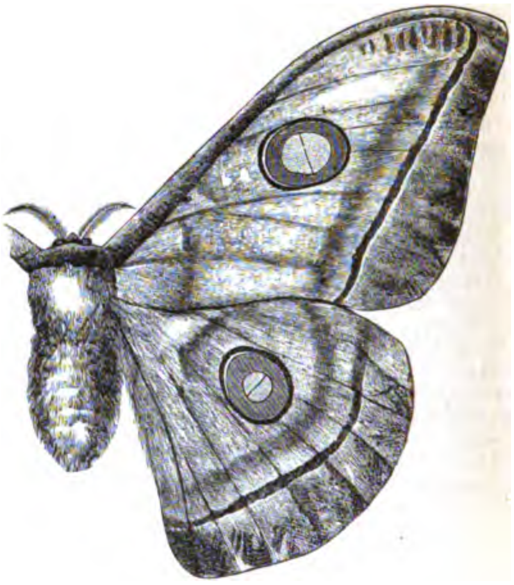

Fig. 9.—*Antheræa mylitta* (female).

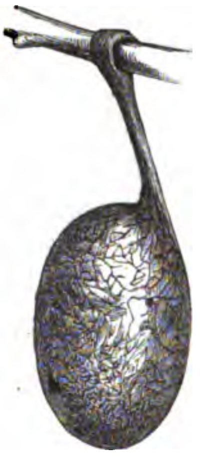

Fig. 10.—Cocoon of *Antheræa mylitta*.

Physical and Chemical Relations of Silk.

Common cocoons enclosing chrysalides weigh each from 16 to 50 grains, or say from 300 to 600 of small breeds and from 270 to 300 of large breeds to the ℔ One-seventh of this weight is pure cocoon, and of that not more than one-half is obtainable as reeled silk, the remainder consisting of surface floss and of hard gummy husk or "knub." The total length of double thread or "bave" which the silk-worm winds into its cocoon may amount to 4000 yards; the quantity reelable therefrom rarely exceeds 900 yards, and may range from 330 to 650 yards. It is found that the reelable fibre is as a rule thickest and strongest at the middle portion, tapering down very notably towards each extremity. In 1885 Mr. T. Wardle of Leek showed by an elaborate series of measurements that the transverse section of common silk double thread or bave measures on the average $\frac{1}{900}$ to $\frac{1}{1000}$ in. at the thinnest and from $\frac{1}{700}$ to $\frac{1}{800}$ in. at the thickest part, and in some instances the middle was one-third thicker, stronger, and more elastic than the ends. As a great deal of silk remains on the husk after reeling, it is obvious that the thread last emitted by the silkworms on the inner wall of the cocoons must be of extreme tenuity. The silk of the various species of *Antheræa* and *Attacus* is also thicker and stronger at the centre of the reeled portion than towards its extremities; but the diameter is much greater than that of common silk, and the filaments under the microscope (Fig. 11) present the appearance of flat bands, the exudation from the two spinnerets being joined at their flat edges. On this account the fibres of tusser silk tend to split up into fine fibrillæ under the various preparatory processes in manufacturing, and its ribbon structure is the cause of the glassy lustre peculiar to the woven and finished fibres.

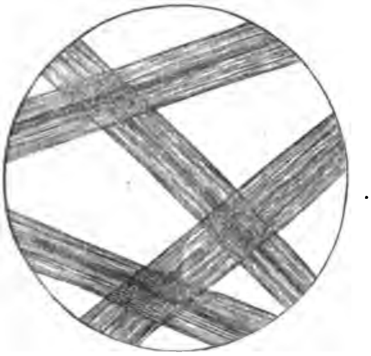

FIG. 11.—Microscopic appearance of Silk of Chinese Tusser.

Silk fibre consists essentially of a centre or core of fibroin, with a covering of sericin or silk albumen, and a little waxy and coloring matter. Fibroin, which is analogous to horn, hair, and like dermal products, constitutes about 66 per cent. of the entire mass, and has a composition represented by the formula $C_{15}H_{23}N_5O_6$. It has the characteristic appearance of pure silk,—a brilliant soft white body with a pearly lustre,—insoluble in water, alcohol, and ether, but it dissolves freely in concentrated alkaline solutions, mineral acids, strong acetic acid, and in ammoniacal solution of oxide of copper. Sericin, which constitutes the gummy covering (Fr. *gres*) of the fibre, is a gelatinous body which dissolves readily in warm soapy solutions, and in hot water, in which on cooling it forms a jelly with even as little as 1 per cent. of the substance. It is precipitated from hot solutions by alcohol, falling as a white powder. Its formula is $C_{15}H_{25}N_5O_8$. According to the researches of P. Bolley, the glands of the silkworm contain semi-liquid fibroin alone, and it is on exposure to the air that the surface is acted on by oxygen, transforming the external pellicle into the more soluble form of sericin. Silk is highly hygroscopic, taking up as much as 30 per cent. of water without feeling perceptibly damp. It is a most perfect non-conductor of electricity, and in its dry state the fibres frequently get so electrically excited as to seriously interfere with their working, so that it becomes necessary to moisten them with glycerin or soapy solutions. Silk is readily distinguished from wool and other animal fibres by the action of an alkaline solution of oxide of lead, which darkens wool, etc., owing to the sulphur they contain, but does not affect silk, which is free from that body. Again, silk dissolves freely in common nitric acid, which is not the case with wool. From vegetable fibres, silk is readily distinguished by the bright yellow color it takes from a solution of picric acid, which does not adhere to vegetable substances. The rod-like appearance of silk and its absence of markings under the microscope are also easily recognizable features of the fibre.

Silk Manufacture.

Here we must distinguish between the reel silk and the spun or waste silk manufactures. The former embraces a range of operations peculiar to silk, dealing as they do with continuous fibres of great length, whereas in the spun silk industry the raw materials are treated by methods analogous to those followed in the treatment of other fibres. It is only floss, injured and unreelable cocoons, the husks of reeled cocoons, and other waste from reeling, with certain wild silks, which are treated by the spun silk process, and the silk thereby produced loses much of the beauty, strength, and brilliance which are characteristic of the manufactures from reeled silk.

Filature or Reeling.—When the cocoons have been gathered the chrysalides they contain are killed either by dry heat or by exposure to steam. All cocoons stained by the premature death of the chrysalides (*chiques*), pierced cocoons, double cocoons, and any from other causes rendered unreelable, are put aside for the spun-silk manufacture. Then the uninjured cocoons are by themselves sorted into classes having similar shades of color, size, and quality of fibre. This assortment is of great consequence for the success of the reeling operations, as uniformity of quality and evenness and regularity of fibre are the most valuable features in raw silk. The object of reeling is to bring together the filaments (*bave*) from two or more (generally four or five, but sometimes up to twenty) cocoons, and to form them into one continuous, uniform and regular strand, which constitutes the "raw silk" of commerce. To do this, the natural gum of the cocoons which holds the filaments together must be softened, the ends of the filaments of the required number of cocoons must be caught, and means must be taken to unwind and lay these filaments together so as to form a single uniform rounded strand of raw silk. As the reeling proceeds the reeler has to give the most careful attention to the thickness of the strand being produced, and to introduce new cocoons in place of any from which the reelable silk has become exhausted. In this way a continuous uniform fibre or strand of raw silk of indefinite length is produced. The apparatus used for these purposes in some localities is of a very primitive kind, and the reeling being uneven and lumpy, the silk is of inferior quality and low value. With comparatively simple appliances, on the other hand, a skilled reeler, with trained eye and delicate touch, can produce raw silk of remarkably smooth and even quality. According to the method commonly adopted in North Italy and France the cocoons are for a few minutes immersed in water a little under the boiling point, to which a small quantity of alkali has been added. A girl with a small hand brush of twigs keeps stirring them in the water till the silk softens, and the outer loose fibres (floss) get entangled with the twigs and come off till the end of the main filament (*maître brin*) is found. These ends being secured, the cocoons are transferred to a basin or tray containing water heated to from 75° to 85° Fahr., in which they float while the silk is being reeled off. If the water is too cold the gum does not soften enough and the cocoons rise out of the basin in reeling; if it is too hot the cocoons collapse and fall to the bottom. The ends of the requisite number of filaments being brought together, they are passed through an eyelet or guide, and similarly another equal set are passed through a corresponding guide. The two sets of filaments are then crossed or twisted around each other several turns as if to make one thread, after which they are separated and passed through separate guides to the reel round which they are separately wound. When a large number of cocoons are to be combined into one strand they may be reeled from the tray in four sets, which are first crossed in pairs, then combined into two, and those two then crossed and afterwards combined into a single strand. The object of crossing (*croissage*) is to round, smooth, and condense the separate filaments of each set into one strand, and as the surface of the filaments are gummy and adhesive it is found on drying that they have agglutinated into a compact single fibre of raw silk. In the most approved modern filatures there is a separate cocoon boiler (*cuiseuse*), an oblong tank containing water boiled by steam heat. In these the cocoons are immersed in rectangular perforated boxes for about three minutes, when they are transferred to the beating machine (*batteuse*), an earthenware trough having a perforated false bottom through which steam keeps the water at a temperature of from 140° to 160°. In this water the cocoons are kept stirring by small brushes rotated by mechanical means, and as the silk softens the brushes gradually rise out of the water, bringing entangled with them the loose floss, and thereby revealing the main filament of each cocoon. The cocoons are next, in sufficient number, transferred to the reeler's tray (*bacinella*), where the water is heated to about 120°. From the tray the filaments are carried through a series of porcelain and glass eyelets, so arranged that the strand returns on itself, two portions of the same strand being crossed or intertwisted for rounding and consolidation, instead of the croissage of two separate strands as in the old method. The reel to which the raw silk is led consists of a light six-armed frame, enclosed within a wooden casing having a glass frame in front, the enclosure being heated with steam-pipes. To keep the strands from directly overlaying each other and so adhering, the last guide through which the silk passes has a reciprocating motion whereby the fibre is distributed within certain limits over the reel. A sectional view of the reeling apparatus and arrangement—now in common use in Italy—is shown in Fig. 12.

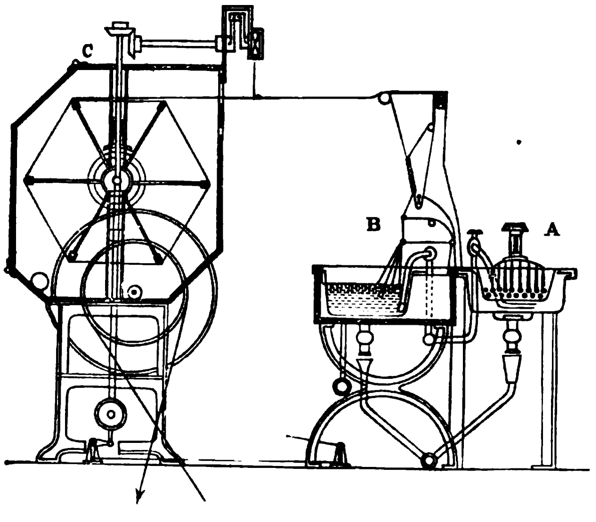

FIG. 12.

Throwing.—Raw silk, being still too fine and delicate for ordinary use, next undergoes a series of operations called throwing, the object of which is to twist and double it into more substantial yarn. The first operation of the silk throwster is winding. He receives the raw silk in hanks as it is taken from the reel of the filature, and putting it on a light reel of similar construction, called the swifts, he winds it on bobbins with a rapid reciprocating motion, so as to lay the fibre in diagonal lines. These bobbins are then in general taken to the first spinning frame, and there the single strands receive their first twist, which rounds them, and prevents the compound fibre from splitting up and separating when, by the subsequent scouring operations, the gum is removed which presently binds them into one. Next follows the operation of cleaning, in which the silk is simply reeled from one bobbin to another, but on its way it passes through a slit which is sufficiently wide to pass the filament but stops the motion when a thick lump or nib is presented. In the doubling, which is the next process, two or more filaments are wound together side by side on the same reel, preparatory to their being twisted or thrown into one yarn. Bobbins to the number of strands which are to be twisted into one are mounted in a creel on the doubling frame, and the strands are passed over smooth rods of glass or metal through a reciprocating guide to the bobbin on which they are wound. Each separate strand passes through the eye of a faller, which, should the fibre break, falls down and instantly stops the machine, thus effectually calling attention to the fact that a thread has failed. The spinning or throwing which follows is done on a frame with upright spindles and flyers, the yarn as it is twisted being drawn forward through guides and wound on revolving bobbins with a reciprocating motion. From these bobbins the silk is reeled into hanks of definite length for the market. Numerous attempts have been made to simplify the silk-throwing by combining two or more operations on one machine, but not as yet with much success.

According to the qualities of raw silk used and the throwing operations undergone the principal classes of thrown silk are—(1) "singles," which consist of a single strand of twisted raw silk made up of the filaments of eight to ten cocoons; (2) tram or weft thread, consisting of two or three strands of raw silk not twisted before doubling and only lightly spun (this is soft, flossy, and comparatively weak); (3) organzine, the thread used for warps, made from two and rarely three twisted strands spun in the direction contrary to that in which they are separately twisted. Silks for sewing and embroidery belong to a different class from those intended for weaving, and thread-makers throw their raw silks in a manner peculiar to themselves.

Numbering of Silk.—The numbering (*titrage*) of raw and thrown silks, by which the size or fineness of the yarn is stated, is determined by constant length with variable weight, whereas other yarns are indicated by constant weight with variable length. The original standard length was 9600 Paris ells = 11,400 metres [12,467 yds. 6 in.], the number being the weight in deniers of 24 grains = 1.275 grammes. This still remains the most common standard, and in practice the number is ascertained by the weight in grains, $\frac{1}{24}$ of a denier of a hank containing 476 metres [520 yds. 20 in.] (properly 475⅝ metres = 400 Paris ells). According to this standard a single cocoon filament weighs 2 to 3.5 deniers, a 3 to 4 cocoon strand ranges from 7 to 10 deniers, and a 16 to 17 cocoon strand is numbered from 48 to 52. Spun silk is numbered on a different principle. In the United Kingdom it is determined by the cotton standard, the number of skeins of 840 yards per pound. In Continental manufacturing centres generally the standard is the number of écheveaux of 500 metres [546 yds. 29 in.] contained in a half kilogramme [1.1 lbs.], or, more simply, the number of kilometres per kilogramme. According to the resolution of the international congress for promoting uniformity in the numbering of yarns, held at Vienna in 1873 and at Brussels in 1874, the grade of silk ought now to be expressed by ten times the number of grammes given by a hank of 1000 metres [1093 yds. 22 ins.].

These methods of indicating grades of silk give, however, only the most imperfect idea as to the quality of the thread; and specially they convey no information as to uniformity of diameter and strength. To test the raw material in respect of uniformity a most ingenious American invention, the serigraph, has been introduced, and is now largely used. The serigraph has two reels mounted on one spindle, or at least so arranged that they make precisely the same number of revolutions. The reels are covered with india-rubber, and No. 2 is 3 per cent. greater in circumference than No. 1. The silk to be tested is placed on No. 1 reel and from that wound on No. 2, which, being of greater diameter, puts a certain amount of strain on the elastic fibre. In passing from the one reel to the other the silk is carried over an agate hook attached to the bob of a pendulum, so that the strain on the yarn is communicated to the pendulum. The strain caused by the 3 per cent. tension of course varies with the strength of the yarn to which it is applied, being greater with increased strength and thickness, and falling away just as the strength of the yarn decreases. Thus the yarn in passing over the agate hook keeps by its tension the pendulum at one particular position while it is uniform, but when it increases in strength it raises the pendulum higher, and when it becomes weaker the pendulum falls. To the extremity of the pendulum is attached a pencil or marker, which traces on a web of paper, travelling at a rate in fixed proportion to the winding, the changes in the pendulum, and thus is obtained a graphic record in a most distinct manner of every variation in the strength of the silk. The precise spot where any imperfection occurs is shown on the tracing, which thus not only absolutely certifies the quality of the yarn, but also automatically measures the quantity reeled.

Conditioning.—Silk in the raw and thrown state, as has already been pointed out, absorbs a large amount of moisture, and may contain from 20 to 30 per cent. of water without being manifestly damp. As it is largely sold by weight it becomes necessary to ascertain its condition in respect of absorbed water, and for that purpose official conditioning houses are established in all the considerable centres of silk trade. In these the silk is tested or conditioned, and a certificate of weight issued in accordance with the results. The silk is for four hours exposed to a dry heat of 230° Fahr., and immediately thereafter weighed. To the weight 11 per cent. is added as the normal proportion of water held by the fibre.

Scouring.—Up to this point the silk fibre continues to be comparatively lustreless, stiff, and harsh, from the coating of albuminous matter (gum or *grès*) on its surface. As a preliminary to most subsequent processes the removal of the whole or some portion of this gum is necessary by boiling-off, scouring, or *decreusage*. To boil off say 300 ℔ of thrown silk, about 60 ℔ of fine white soap is shred, and dissolved in about 200 gallons of pure water. This solution is maintained at a heat of 195°, and in it the hanks of raw silk are immersed, hung on a wooden rod, the hanks being continually turned round so as to expose all portions equally to the solvent influence of the hot solution. After being dried, the hanks are packed in linen bags and boiled for three hours in a weaker soapy solution, then washed out in pure warm water and dried in a centrifugal hydro-extractor. According to the amount of gum to be boiled off the soap solutions are made strong or weak; but care has to be exercised not to overdo the scouring, whereby loss of strength, substance, and lustre would result. For some purposes—making of gauzes, crapes, flour-bolting cloth, and for what is termed "souples"—the silk is not scoured, and for silks to be dyed certain dark colors half-scouring is practiced. The perfect scouring of French silks removes from 25 to 27 per cent. of their weight, and Chinese silks lose from 30 to 31 per cent. Scouring renders all common silks, whether white or yellow in the raw, a brilliant pearly white, with a delicate soft flossy texture, from the fact that the fibres which were agglutinated in reeling, being now degummed, are separated from each other and show their individual tenuity in the yarn. Silks to be finished white are at this point bleached by exposure in a closed chamber to the fumes of sulphurous acid, and at the close of the process the hanks are washed in pure cold water to remove all traces of the acid.

Spun Silk Manufacture.—The materials of the spun silk trade are—(1) the floss or loose outer fibres which surround ordinary cocoons; (2) the remains of cocoons after the reelable silk has been removed; (3) waste from throwing processes and from all the stages through which reeled silk passes in manufacturing; (4) unreelable cocoons, *i.e.*, those which are pierced, torn, or cut, stained by dead chrysalides, etc., and double cocoons; (5) cocoons of various wild silks, which are either unreelable or most profitably worked by carding. The waste spinners' first duty is to bring these diverse materials into uniform fibrous condition for spinning. In dealing with cocoons and cocoon husks, the fibres, which are gummed together into a dense compact mass, must be so washed, softened, and freed from each other that they can be readily teased and torn into a tow-like mass. For this purpose they are washed with a strong hot soap solution in a revolving washing machine, in which they are continuously subjected for three or four hours to the action of falling stampers. From this treatment they are taken to the cold-water washing machine, where they are treated with a continuous spray of pure water whilst revolving in the tub under the action of falling stampers, as in the hot-water machine. Next the cocoons are rinsed in a spray of pure water, then the moisture is expelled in a hydro-extractor, and so, thoroughly degummed and softened, they are allowed to dry. For further treatment they are damped with a sprinkling of weak solution of Marseilles soap, then beaten either with the hand or by means of a machine. This machine has a series of leather straps attached to an endless band, which by its rapid revolution causes the straps to hit with a quick whipping stroke against the surface of a revolving tray on which are placed the washed cocoons. The beating serves to free the fibres fully from each other, and expels in the form of a fine dust the remains of chrysalides from the interior of the cocoons. It now remains only by the operation of the cocoon opener to tease out and separate the fibres into a kind of lap. The cocoon-opener is a modified carding machine, the drum or cylinder of which is covered with strong card teeth. On this drum the fibres collect as they are opened and teased out, and when the teeth are full the lap so formed is stripped off by the attendant. The silken fibres are now ready for the operations preparatory to spinning.

To bring raw waste other than cocoons to this point a different series of operations are necessary. The removal of the gum is first usually effected by a process of fermentation or maceration instead of washing with soap, whereby a great saving of soap is secured. Into a large tank a quantity of waste is packed, and soaked with a weak soapy solution which is maintained by steam at about 170°. The tank is closed over, and in the course of a few days fermentation begins, and according to circumstances is allowed to go on from two to three weeks. From time to time proof samples are withdrawn to observe the progress of the rotting, as over-fermentation would result in the same injury which arises from over-scouring,—weakness of fibre, loss of lustre, and waste of substance. By maceration the silk loses from 20 to 30 per cent. of its weight. From the maceration vat the silk is conveyed to the hot-water washing machine, where with a weak soapy solution it is washed under the influence of stampers for about five minutes. Great care is necessary to prevent the silk from cooling before this washing, as thereby the macerated slime would form an almost insoluble deposit on the silk fibre. From the hot soap solution the silk is taken to the cold-water machine, where, with the aid of stampers, it undergoes a thorough and prolonged washing. After being hung over hurdles to dry it is sprinkled with a weak solution of Marseilles soap, and then dried by means of the hydro-extractor and subsequent exposure in a heated well-ventilated chamber. At this point both cocoon waste, as already described, and floss waste are in the same condition.

The spinner has now to deal with a mass of entangled fibres of all lengths, which he must render even, parallel, and comparatively uniform in length before it can be spun. The fibres are slightly damped with a weak soapy solution and taken to a filling drum, which consists of a large cylinder having set into it, parallel with its axis, from twelve to twenty rows of strong steel spikes. A feeding apron of cloth covered with card teeth is provided to the machine, and, as the fibre is carried forward towards the drum, a similar card-teeth-covered band travels close over the surface of the apron, so that the fibre is presented to the drum from between two sets of card-teeth. The rows of spikes catch the fibre as presented to them, draw it through the card-teeth, and carrying it with them lap it around the drum in regular combed-out order. When the spikes are sufficiently filled, the lap is cut at each set of spikes, and so stripped from the drum it forms a definite number of "stricks," of the breadth of the drum itself and the length of the space between the sets of spikes. These stricks are caught in wooden clamps or "books," which are fastened in the bed of the flat dressing frame. Over them an endless band travels, having on it at short intervals belts of heckle-teeth, called combs, which comb out doubled and short fibres, and, acting first on one end of the strick and next on the other, leave the silk in the condition of beautifully parallel and comparatively uniform flakes. The product of the first combing, called the first draft, is the longest and purest fibre. The material combed out as it fills the comb teeth is caught in books, and when itself combed out forms second drafts, shorter and less valuable than the first; and again the combings of second drafts, when combed, form third drafts still shorter. In this way five or six separate drafts or combings from the original lap are obtained, all increasingly short and impure. The final combed waste is treated by a different process for making noil or bourette yarn.

A new form of dressing-frame is now coming into favor, in which the stricks of silk have their ends rolled round wooden rods, and so secured between wooden clamps on the surface of a huge cylinder which revolves so slowly that the attendant can change and fill the clamps as the drum goes round. In its revolution the exposed portion of the silk is first combed on one side by a rapidly revolving card-toothed cylinder, from which it passes onwards to meet a second similar cylinder revolving in a contrary direction, which combs the opposite side. In the second revolution of the cylinder the portion of the strick which was previously wound on the rod is similarly combed on both sides, and thus the entire strick is rendered smooth and parallel.

The above is an outline of the ordinary process of preparing silk waste as practiced in Switzerland and in the United Kingdom, etc., the range of machines being that of Messrs. Greenwood and Batley of Leeds. In the great Manningham silk mills at Bradford, Mr. S. C. Lister, the well-known inventor of wool-combing machinery, while using machinery of the class described, treats by patented methods peculiar to himself a great proportion of his material. According to his original process, scoured, teased, and opened waste is first drawn into a lap on a screw gill box. These laps, containing all the fibres both long and short, are taken to the circular nip combing machine, where the "top" of long fibre is drawn out as a continuous sliver and separated from the "noil" or short fibre, which according to its length is delivered at separate points. In his most recent mode of working, Mr. Lister forms his waste into a broad lap on the large drum of a kind of carding engine, the drum being stripped when its teeth are filled with the prepared fibre. These laps are laid on the feeding-table of a machine which has an oscillating or rocking filling head. At each oscillation the end of the lap in front of the table is "filled" on to a row of heckle-teeth parallel with it, and just as the feeding-table recedes a knife comes down between the heckles and the table with a sudden stroke and separates from the lap such fibres as have been placed or filled on to the heckle-teeth. These heckle-teeth in the meantime, being fixed on an endless band, are continuously moving forward in a horizontal direction parallel with the front of the feeding machine, and a set of three such machines place a portion of their laps on to the heckle-teeth in their progress, thus filling the teeth with a fair "bite" of silk. Immediately the heckles have passed the machines, the silk is caught and cleaned off the endless comb by pairs of endless revolving nips rising from under and descending from above, and between these nips the stricks are carried forward in the same horizontal line in which they travelled on the heckle-teeth, which here begin their return journey to be again filled. The stricks in their progress are now submitted to the combing action of revolving card-covered cylinders and card-covered cloth. Half-way on in its horizontal path a second set of endless nips seize the combed portion of the silk, the uncombed portion held between the first set is released, and it in its turn is submitted to the combing action of cylinders and endless card-bands. In the end the fully dressed stricks of silk fall on a narrow feeding cloth, which has a combined reciprocating and forward motion, so that the material is spread with the utmost regularity and evenness. It passes through a set of screw gills, and is delivered into cans in the form of a most uniform and equal continuous sliver. The great advantage of these machines is the small amount of tending they require and the large quantity of dressed silk they deliver with unerring regularity.

The spinning proper of dressed waste is done precisely as in the spinning of flax yarn. The flakes are formed into a broad sliver on the spreading frame, and further attenuated and equalized on the set frame and the drawing frame, from which last the silk passes to the roving frame, where it receives its first preliminary twist and is sufficiently condensed to wind on a bobbin. The rovings are finally elongated and spun on the ordinary spinning frame, and for twisting into thread the yarns in two, three, or more strands are wound together on the doubling frame, and finally twisted as in dealing with raw silk spinning.

Spun silk, as it comes from the spinning frame, shows a good many nibs and irregularities and some roughness of surface. To remove these it is wound from one bobbin to another over an improving or cleaning and gassing machine, which consists of a frame having attached to it a number of small cone rollers, around which the yarn passes in a way which makes the entering portion of the thread rub against the portion running off. In this way, with considerable rubbing, the yarn cleans itself; and in its course over the rollers it rapidly passes through a gas flame, which singes off the fine projecting fibres, leaving the yarn clean, round and compact. It is submitted to a further examination by eye and hand after being wound into hanks; and some yarns are finally dressed with albumen and gum solutions.

In the combing of waste silk as much as from 25 to 30 per cent. of waste in a second degree arises, much of which is very short, full of nibs and dust. From this a lower quality of yarn is spun, called noil yarn, and on the Continent "bourette" silk, to distinguish it from the "floret" silk made from first waste. On account of the shortness of staple it is worked up by machinery different from that used in the floret manufacture, being prepared by carding, and combed out with a modification of Heilmann's or Lister's combing machines. The finished noil yarn is very lumpy, and requires severe improving and singeing.

Spun silk lacks the smoothness, brilliance, and strength of raw silk yarn, but still it is an extremely valuable and useful material, and its comparative cheapness gives it an important place among the products of textile industry. It is used very largely in mixed fabrics, as well as for the cheaper ribbons, velvets, hat plush, and for many other silk woven fabrics, as also in the hosiery and glove trades and for sewing, knitting, and embroidering yarns.

Silk Weighting.—Into the dyeing of silk it is not here necessary to enter, except in so far as concerns a nefarious practice, carried on in dye-houses, which has exercised a most detrimental influence on the silk trade. Silk, we have seen, loses about one-fourth of its weight in scouring. To obviate that loss it has long been the practice to dye some dark silks "in the gum," the dye combining in these cases with the gum or gelatinous coating, and such silks are known as "souples." Both in the gum and in the boiled off state silk has the peculiar property of imbibing certain metallic salts largely and combining very firmly with them, the fibre remaining to external appearance undiminished in strength and lustre, but much added to in size and weight. Silk in the gum, it is found, absorbs these salts more freely than boiled-off; so to use it for weighting there are these great inducements—a saving of the costly and tedious boiling-off, a saving of the 25 per cent. weight which would have disappeared in boiling, and a surface on which much greater sophistication can be practiced than on scoured silk. In dyeing a silk black a certain amount of weight must be added; and the common practice in former times was to make up on the silk what was lost in the scouring. Up to 1857, the utmost the dyer could add was "weight for weight," but an accidental discovery that year put dyers into the way of using tin salts in weighting with the result that they can now add 40 oz. per ℔ to scoured silks, 120 oz. to souples, and as much as 150 oz. to spun silks, and yet call these compounds "silk." Not only so, but the use of tin salts, especially stannic chloride, $SnCl_4$, enables dyers to weight all colors the same as black. In his "Report on English Silk Industry" to the Royal Commission on Technical Instruction (1885) Mr. Thomas Wardle of Leek says:

> "Colors and white of all possible shades can very easily be imparted to this compound of silk and tin, and this method is becoming extensively used in Lyons. Thus weighting, which was until recently thought to apply only to black silks, and from which colored silks were comparatively free, is now cheapening and deteriorating the latter in pretty much the same ratio as the former. Thus the proto- and per-salts of iron, as well as the proto- and per-salts of tin, including also a large variety of tannin, sumac, divi-divi, chestnut, valonia, the acacias (*Areca Catechu* and *Acacia Catechu* from India), from which are obtained cutch and gambier, etc., are no longer used solely as mordants or tinctorial matters, but mainly to serve the object of converting the silk into a greatly expanded fibre, consisting of a conglomeration of more or less of these substances."

Sugar also is employed to weight silk. On this adulterant Mr. Wardle remarks:

> "With a solution of sugar, silk can have its weight augmented from 1 oz. to 3 oz. per ℔. I am not quite sure that this method of weighting was not first used by the throwsters, as sugar is known to have been used for adulterating and loading gum silk for a very long time, and then the idea was afterwards applied to silk after the dyeing operations. It is much resorted to for weighting colored silks by dyers on the Continent, and, though a very clumsy method, no substitute has been found so cheap and easy of application. Bichloride of tin, having chemical affinity for silk fibre, bids fair to extinguish the use of sugar, which, from its hygrometric qualities, has a tendency to ruin the silk to which it is applied, if great care be not taken to regulate the quantity. There is not the slightest use or excuse for the application of sugar, except to cheapen the silk by about 15 to 20 per cent."

Wild Silk Dyeing.—Among the disadvantages under which the silks of the wild moths long labored, one of the most serious was the natural color of the silks, and the extreme difficulty with which they took on dyes, specially the light and brilliant colors. For success in coping with this difficulty, as well as in dealing with the whole question of the cultivation and employment of wild silks, the unwearying patience and great skill of Mr. Thomas Wardle of Leek deserve special mention here. The natural color of tusser silk is a grayish fawn, and that shade it was found impossible to discharge by any of the ordinary bleaching agents, so as to obtain a basis for light and delicate dyes. Moreover, the chemical character of the tusser silk differs from that of the mulberry silk, and the fibre has much less affinity for tinctorial substances, which it takes up unevenly, requiring a large amount of dye-stuffs. After protracted experimenting Mr. Wardle was able in 1873 to show a series of tussers well-dyed in all the darker shades of color, but the lighter and bright blues, pinks, scarlets, etc., he could not produce. Subsequently the late M. Tessie du Motay found that the fawn color of natural tusser could be discharged by solution of permanganate of potash, but the oxidizing action was so rapid and violent that it destroyed the fibre itself. Gentler means of oxidation have since been found for bleaching tusser to a fairly pale ground, but the dyeing of light colors cannot yet be said to be a commercial success. The silk of the eria or castor-oil worm (*Attacus ricini*) presents the same difficulties in dyeing as the common tusser. A portion of the eria cocoons are white, while the others are of a lively brown color, and for the dyeing of light colors the latter require to undergo a bleaching process. The silk takes up color with difficulty from a strong vat, and is consequently costly to dye. Moonga silk from *Antheræa assama* has generally a rather dark brown color, but that appears to be much influenced by the leaves on which

the worm feeds, the cocoons obtained on the champaca tree (*Michelia champaca*) giving a fine white fibre much valued in Assam. The dark colors are very difficult to bleach, but the silk itself takes dye-colors much more freely and evenly than either tusser or eria silk.

Trade and Commerce.

About the commencement of this century the chief silk-producing regions of the world were the Levant (including Broussa, Syria, and Persia), India, Italy, and France, the two first named sending the low-priced silk, the other two the fine qualities. Between 1840 and 1850, after the opening of trade with China, large quantities of silk were sent from the northern port of Shanghai, and afterwards also from the southern port of Canton. The export became important just at the time when disease in Europe had lessened the production on the Continent. This increased production of medium silk, and the growing demand for fine sorts, induced many of the cocoon-growers in the Levant to sell their cocoons to Europeans, who reeled them in Italian fashion under the name of "Patent Brutia," thus producing a very fine valuable silk. In 1857 commenced the importation of Japan silk, which became so fierce a competitor with Bengal silk as gradually to displace it in favor; and recently the native silk reeled in Bengal has almost ceased to be made, only the best European filatures, produced under the supervision of skilled Europeans, now coming forward.

China and Japan, both of which contribute so largely to the supplies that appear in European and American statistics, only export their excess growth, silk weaving being carried on and native silk worn to an enormous extent in both countries. The other Asiatic exporting countries also maintain native silk manufactures which absorb no inconsiderable proportion of their raw material. The silk production of the world, including only the amount exported from these Oriental countries, amounts on an average to from 20,000,000 ℔ to 25,000,000 ℔ yearly; but the crop is subject to great variations.

The supply available for European consumption during recent years was thus stated, in bales of 100 ℔, by the *Moniteur des Soies* of Lyons, 25th July, 1885:

	1854–55.	1875–76.	1876–77.	1877–78.	1878–79.	1879–80.	1880–81.	1881–82.	1882–83.	1883–84.	1884–85.	1885–86 (estim's).	
												Max'm.	Min'm.
Italy	92,400	57,000	25,000	40,500	62,500	82,000	68,500	70,000	62,000	73,000	65,000	45,000	40,000
France	44,000	16,000	2,000	19,000	13,500	8,500	9,500	9,500	17,500	14,500	10,000	10,000	8,000
Spain	3,300	2,500	1,500	750	1,100	800	1,500	1,500	2,300	1,750	1,500	500	500
Greece and As. Minor	6,600	16,000	10,000	6,000	6,000	5,000	5,000	5,000	6,000	12,000	12,000	10,000	8,000
Total bales	146,300	91,500	38,500	66,250	83,100	46,300	84,500	86,000	77,800	101,250	88,500	65,500	56,500
China	55,000	68,000	65,000	46,000	53,000	55,000	67,000	44,000	47,000	50,000	50,000	45,000	42,000
Canton	19,800	14,000	10,000	12,500	9,000	12,500	5,000	14,500	11,500	16,000	7,000	12,000	12,000
Bengal	11,000	8,492	6,000	5,000	6,000	5,000	4,000	3,000	3,000	3,000	3,000	2,000	2,000
Japan	...	14,000	13,000	22,000	22,000	14,000	15,000	15,500	25,000	25,000	20,000	15,000	12,000
Total bales	85,800	104,492	94,000	85,500	90,000	86,500	91,000	77,000	86,500	94,000	80,000	74,000	68,000
Grand total of bales	232,100	195,992	132,500	151,750	173,100	132,800	175,500	163,000	164,300	195,250	168,500	139,500	124,500
Price of Tsatlee No. 4	15s.	15s.	28s.	17s. 6d.	15s.	15s. 3d.	18s. 9d.	17s.	14s. 6d.	16s.	13s.	12s. 6d.	12s. 6d.

While these tables indicate remarkable fluctuation of supply they show generally that Asiatic countries, besides supplying their own considerable demands, send to Europe fully one-half of the whole silk consumed in Western manufactures. China stands first as a silk-producing country, yielding about 35 per cent. of the entire supply; the whole produce of Italy amounts to nearly the same proportion; the exports of Japan account for about 12 per cent. of the annual supply; while in recent years France and the Levant are credited with about equal proportions.

In the United Kingdom the trade in raw silks has been in a condition of decline for a considerable number of years, much of the Chinese and Eastern produce which formerly came to London now being unshipped at Marseilles, and sold in the Lyons market, which has become the leading silk mart. But there is a very steady and continuous expansion in the demand for waste silks and cocoons for the spun silk trade. The following figures show the official annual returns of silk imports since 1860, the date of the French commercial treaty, which exposed many branches of the trade to severe and fatal competition:

Years.	Raw Silk.	Knubs or Husks of Silk and Waste.	Thrown Silk.	Silk Manufactures.
	℔	Cwts.	℔	£
1860–65	43,137,997	132,020	543,679	30,127,878
1865–70	31,645,505	141,628	859,251	49,885,971
1870–75	34,220,037	171,136	747,505	55,116,815
1875–80	23,003,683	158,887	545,247	62,539,166
1880	3,673,949	55,002	203,567	13,324,935
1881	2,904,580	54,119	131,836	11,727,397
1882	3,377,119	44,277	294,207	11,174,573
1883	3,178,593	62,064	292,433	10,523,920
1884	4,522,702	67,239	323,947	10,984,073

The sources whence the English imports of raw silk, the commercial names under which they pass, and their relative importance and values, are exemplified in the following table, extracted from the annual circulars issued by Messrs. H. W. Eaton & Sons of London:

Description.	Imports 1884.	Imports 1885.	Extreme Prices during 1885.	Consumption, including Export 1885.	Prices 1st Jan'ry. 1886.
China—	℔	℔	s. d. s. d.	℔	s. d. s. d.
Tsatlee[1] Haineen, etc.	2,803,572	1,001,436	9 0 to 14 6	1,225,938	9 6 to 14 6
Taysaam[2]	416,466	271,116	7 6 " 15 0	298,964	8 0 " 14 6
Canton	389,976	159,328	8 6 " 12 6	469,456	9 9 " 18 0
Szechuen	23,154	6,936	7 0 " 11 3	17,544	7 0 " 11 3
Japan	388,304	70,560	10 6 " 15 6	372,176	12 0 " 15 6
Bengal	126,450	114,000	8 0 " 14 6	154,800	9 6 " 15 0
Patent Brutia	8,750	7,875	19 0 " 23 0	7,700	19 0 " 21 0
Persian	225	...	...	...	...
Italian—					
Raw Novi	205,610	211,700	17 0 to 21 0 20 0 " 24 0	208,220	17 0 to 21 0 20 0 " 24 0
Thrown	273,760	310,300	20 0 " 25 0	307,400	20 0 " 25 0
Total	4,586,267	2,158,251	...	3,057,198	...

In the manufacture of silken fabrics France occupies the most important position among the nations. Not only is the whole of the raw silk produced in France worked up within the country, but a very considerable proportion of that imported from the Levant and from Asia passes into the hands of the French manufacturers. In all, between 8,000,000 and 9,000,000 ℔ of raw silk are on an average manufactured into various textures in France. Lyons is the headquarters of the trade, and, if the surrounding regions be included, employment is given to about 120,000 looms,—20,000 of which are driven by power,—principally in the production of dress silks, plain and figured, and in other heavy silken fabrics, and at St. Étienne and St. Chamond in the ribbon trade. There are also important manufactures of silk at Calais, St. Pierre les Calais (tulles and passementerie), Paris, Nîmes, Tours, Avignon, and Roubaix. Next to France in the extent and value of manufactures comes Germany, where the principal seat of the silk trade is at Crefeld, nearly one half of the whole production of the empire being manufactured there. The looms of Crefeld and the district it controls numbered in 1881 about 33,000, and the trade was flourishing and expansive. The manufacturing of union velvets is the special feature of the industry, about one-half of the looms being devoted to that textile; but Crefeld controls also a large trade in union satins, and pure silk broad goods and ribbons of all kinds. The whole value of its trade amounted in 1881 to almost £4,000,000 [$19,440,000] one-fourth of which found a market in England, and about a quarter of a million went to France. The other principal centres of the silk trade, all in Rhenish Prussia, are Viersen, Barmen, Elberfeld, and Mühlheim. Third on the list of Continental producers is Switzerland, where Zurich takes the lead with broad goods (failles, armures, satins, serges, etc.), and Basel rivals St. Étienne in the ribbon trade. The number of looms throughout the country is estimated at 40,000 of which 4000 are power-looms. Italy—the early home of the silk trade, the land of the gorgeous velvets of Genoa and the damasks and brocades of mediæval Sicily, Venice, and Florence—has fallen from its high estate, and now employs not more than 30,000 looms, the centre of greatest activity being at Como; but Genoa still makes velvets, and the brocades of Venice are not a thing of the past. In Austria the silk trade has found its principal development in Vienna and its immediate neighborhood, the number of looms throughout the entire empire being estimated at from 15,000 to 20,000, of which 2000 are power-looms. In Russia there is, with a growing cultivation of raw silk, a considerable and increasing manufacture, the special feature of which is the weaving at Moscow of gold and silver tissues and brocades for sacerdotal use, and for traffic with Central Asia.

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[1] The figures relating to Tsatlee comprise Re-reel, Hangchow, and Yuun-fa.

[2] The figures relating to Taysaam comprise Tussah.

In the United Kingdom all the silk industries—these depending on spun silk alone excepted—have been in a depressed and declining condition ever since 1860. The principal silk manufacturing towns of England have been Coventry, Macclesfield, Congleton, Leek, Derby, London (Spitalfields), Manchester, Middleton, and Nottingham, and it is estimated that at the best period not fewer than 150,000 looms found employment in the trade. In 1872 that number was reduced to 65,000, of which 12,500 were power-looms. Spitalfields in her best days (about 1825) kept 24,000 hand-looms occupied; now there are not more than 1200. Manchester once had about 20,000 looms weaving silk; now there are not 6000 so employed. When the French treaty of 1860 came into operation Coventry had about 9000 looms, principally employed in ribbon weaving; now not more than one-fourth of that number are in operation. The cause for several of these severe changes is to be found in the introduction of the factory system of working and the extension of power-loom weaving, which crushed out domestic weaving, the original form of the silk industry; but undoubtedly also the English manufacturers were beaten in the battle of free competition brought on by the French treaty. On the other hand, the remarkable development of the comparatively new trade in spun silk goes far to compensate for the loss of the older trade, and has enabled the exports of silk manufactures from the country to be at least maintained and to show some signs of expansion. The spun-silk industry has chiefly developed in the Yorkshire and Lancashire textile centres,—Bradford, Halifax, Rochdale, etc. But it is highly significant that, while the exports of British silk manufactures have not decreased, the imports in the meantime have shown a marked expansion; and unquestionably, although the use of silken goods has increased very greatly within twenty-five years, the expansion of native silk manufactures has not kept pace with that growth.

Silk and Silk Goods exported from the United Kingdom during the years 1860 to 1884 inclusive.

Year.	Raw Silk.	Knubs or Husks of Silk and Waste.	Thrown Silk.		Silk Manufact's.	
			British.	Foreign and Colonial.	British.	Foreign and Colonial.
	℔	Cwts.	℔	℔	£	£
1860	3,153,998	1,506	826,107	426,866	1,587,303	224,366
1865	3,137,292	1,212	767,058	306,701	1,404,881	166,986
1870	2,644,402	4,167	1,154,864	39,771	1,450,397	166,297
1875	2,551,417	1,779	880,923	87,924	1,734,519	328,426
1876	3,064,725	4,210	1,080,678	50,202	1,794,565	303,054
1877	1,652,985	7,450	570,999	17,910	1,705,153	229,130
1878	1,841,505	8,012	565,266	40,470	1,922,953	222,133
1879	1,375,608	5,029	694,735	24,461	1,697,209	248,495
1880	947,165	9,241	683,591	7,558	2,030,659	259,023
1881	908,997	4,528	1,008,272	5,561	2,564,730	268,826
1882	915,778	6,941	825,572	6,281	2,692,275	341,107
1883	524,182	5,216	705,825	5,596	2,426,299	340,805
1884	377,349	6,538	612,951	50,559	2,175,410	644,722

Favored by the operation of protective duties ranging from 50 to 60 per cent. *ad valorem*, the native manufacture of silk in the United States has been nursed into considerable activity and expansion, till now well-nigh one-half of the silken fabrics used in the country are of home manufacture. In 1860 the proportion of native manufacture was 13 per cent., in 1880 it reached 38 per cent., and in 1882 it was 40 per cent. of the entire consumption. Reeled silks are principally manufactured at Paterson and Hoboken, N. J., and Brooklyn and New York City, N. Y., and the spun-silk industry flourishes at South Manchester and Hartford, Conn.[1]

The following estimate of the relative importance of the silk manufacture of various countries was made in 1883 by Mr. Peixotto, the United States consul at Lyons:

France	$85,000,000	Russia	$16,000,000
Germany	45,000,000	Austria	12,000,000
United States	35,000,000	Italy	12,000,000
Great Britain	25,000,000	Spain	5,000,000
Switzerland	18,000,000	Other countries	17,000,000

Giving a total of $270,000,000. (J. P. A.)

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[1] [The United States Census Report of 1850 states that the silk manufacture comprised then 67 establishments, with a capital of $678,300, whose products were valued at $1,809,476, two-thirds representing sewing-silk. The imports of raw silk were valued at $384,535. In 1860 there were 139 establishments, employing 5435 hands and having a capital of $2,926,980. The imports of raw silk in that year were valued at $1,340,676. This was not quite two-thirds of the amount used, 462,965 pounds. The value of all materials used was $3,901,777, and value of all products, $6,607,771; there were 409,429 pounds of sewing-silk and twist manufactured. In 1870 there were reported only 86 establishments, employing 6649 hands and having a capital of $6,231,139. The materials used were valued at $7,817,559, including 684,488 pounds of raw silk. The imports for that year were 583,589 pounds, valued at $3,017,958. This, however, showed a falling off from the previous year, and was nearly doubled in the next year. The total products in 1870 were valued at $12,210,662; they comprised 1,026,422 yards of silk goods, and 3,224,264 yards of ribbons, and 516,621 pounds of machine silk, etc. The Census Report for 1880 is the most complete yet, and comprises, besides statistics for the year, a full history of the manufacture in the United States. From it has been prepared the following condensed table, showing the condition of the manufacture in those States in which it has any prominence, as well as for the whole country:

States.	Establishments.	Capital.	Value of Raw Silk and Silk Materials	Net Value of Products.
Connecticut	28	$4,436,500	$3,025,825	$5,438,075
Massachusetts	22	1,306,900	1,730,870	3,491,098
New Jersey	106	6,952,325	8,664,835	12,851,045
New York	151	4,696,775	4,333,485	9,368,025
Pennsylvania	49	1,379,900	1,207,795	2,853,165
All States	382	19,125,300	19,208,683	34,519,723
	Quantities of Products.			
	Sewing S. and Twist.	Broad Goods and Hdkfs.	Ribbons.	Trimmings.
	℔	yds.	yds.	℔
Connecticut	394,981	2,253,070	8,541,285	695
Massachusetts	278,816	99,120	573,320	39,789
New Jersey	25,580	6,975,655	3,794,100	50,405
New York	88,765	1,427,439	10,302,696	403,330
Pennsylvania	28,110	101,000	1,915,000	192,824
All States	821,528	10,856,284	30,129,951	710,149

The imports of silk manufactures at the port of New York in 1880 were valued at $33,305,460; the principal items were dress silks, $17,665,038; velvets, $2,044,139; ribbons, $3,568,848; laces, $1,540,892; braids and bindings, $1,646,868; silk and cotton fabrics, $4,751,946.—Am. Ed.]

SILLIMAN, Benjamin (1779–1864), American chemist and geologist, was born in 1779 at Trumbull (then called North Stratford), Connecticut. His father, Gold Selleck Silliman, was brigadier-general in the war of the revolution, and had also held important civil positions. The history of the family points to an Italian origin, but Daniel Silliman, the first to settle in the United States, came from Holland. Silliman received his early education at Fairfield, Connecticut, at that time the residence of his father's family, and in 1792 he entered Yale College, where he graduated in 1796. He then studied law, and was admitted to the bar in 1802, while a tutor in Yale College, to which position he had been appointed in 1799. In 1802 a professorship of chemistry and natural history was established in the college, and he was at once elected to fill it. He spent portions of 1801 and 1802 in Philadelphia in preparation for his work, and the year 1804 he spent in Europe, chiefly in England and Scotland, where he attended the lectures of Hope and Gregory, and also formed the acquaintance of Davy, Wollaston, Brewster, Leslie, and other eminent men of science. As a result of this visit he published *A Journal of Travels in England, Holland, and Scotland, and of Two Passages over the Atlantic in the years* 1805 *and* 1806 (2 vols., 1810), which had a marked success. In 1813 he began service with the medical department of Yale College as professor of chemistry and pharmacy, and continued to give instruction there for many years. In 1818 he founded the *American Journal of Science and Arts*, a periodical devoted to the physical sciences, which has been, and is, the most important American scientific serial. In 1851 he made a second journey to Europe, of which he likewise published an account in two volumes, edited by his son, who had accompanied him. In 1853 he became professor *emeritus*, but he continued to lecture for a year or two longer. His closing years were quietly spent in unabated mental activity at New Haven until his death in 1864. Though devoted to scientific pursuits, he interested himself in the public movements of the time.

One of Silliman's earliest scientific publications was an account of the famous meteorite which fell in Weston, Conn., December 14, 1807. This account, which excited great public interest in the country, was reproduced abroad, and was read before the Royal Society of London, and also before the French Academy. Among his other scientific labors may be mentioned his experiments upon the fusibility of various substances in the flame of the compound blowpipe of Hare, then a novelty in science, and upon the vaporization and transference of the carbon in the voltaic arc from the positive to the negative pole, which he was the first to observe. He also repeated the experiment by which Gay-Lussac had separated potassium from its hydrate, and obtained the element in its metallic form, doubtless for the first time in the United States. Other professional labors were an exploration of the coal formations of Pennsylvania in 1830, and an examination of the gold mines of Virginia in 1836. In 1832 and 1833, by appointment of the United States Government, he made a scientific investigation of the culture and manufacture of sugar, embodying his results in a voluminous report published by the Government. Though Silliman published a large number of scientific papers upon chemical and geological subjects, his reputation was more especially due to the courses of public lectures which he delivered in the college and in various cities and towns of the United States. The happy combination of a graceful and interesting style with unwonted splendor of experimental illustration gave these lectures an unprecedented popularity, and they exerted a powerful influence in awakening and developing a taste for scientific matters throughout the country.

Besides the works already mentioned, Silliman published in 1808 an American edition of Henry's *Chemistry*, with notes, in 1827 an edition of Bakewell's *Geology*, and in 1830 *Elements of Chemistry*, in two volumes. An account of his life, by Prof. George P. Fisher, of Yale College, was published in two volumes in 1866.

SILLIMAN, Benjamin (1816–1885), American chemist and physicist, son of the preceding, was born in 1816 at New Haven, Connecticut, and educated at Yale College, where he graduated in 1837. He then became assistant to his father in chemistry, mineralogy, and geology, working in his laboratory at the college and pursuing original investigations. He began teaching in the laboratory soon afterwards. The school thus informally established was shortly afterwards recognized by a formal act of the corporation of the college, and ultimately developed into the Sheffield Scientific School of Yale College. In 1838 he became associate editor with his father of the *American Journal of Science and Arts*, and he continued in the editorship of the journal until the close of his life, Prof. J. D. Dana (his brother-in-law) having joined him in 1846. In the winter of 1845–46 he gave a course of lectures on agricultural chemistry in New Orleans, which is believed to have been the first course of lectures upon that subject ever given in the United States. In 1849 he was appointed professor of medical chemistry and toxicology in the medical department of Louisville University, Louisville, Kentucky, which position he held for five years. In 1854 he succeeded his father as professor of chemistry, and continued to give instruction in this science, first in the academical and afterwards in the medical department of Yale College, until his death in 1885. In 1853 he was connected with the exhibition at the Crystal Palace in New York, having charge of the departments of chemistry, geology, and mineralogy. As a result of this work he edited a large quarto volume, *The World of Science, Art, and Industry* (1853), followed in 1854 by *The Progress of Science and Mechanism.*[1] He also published in 1846 *First Principles of Chemistry*, a text-book which had a wide sale and passed through three editions. In 1858 he published a manual of physics entitled *First Principles of Natural Philosophy* (2d ed. 1861). In 1864 and again in 1867 and 1872 Silliman visited California, being engaged in professional work connected with various mines and in mineralogical and geological explorations. Still later he made several visits to the mining regions of the Western States and Territories, and the results of his observations formed the subjects of numerous scientific papers. In 1874, the centennial anniversary of Priestley's discovery of oxygen, he delivered at Northumberland, Pa., where Priestley had resided during the later years of his life, an historical address on "American Contributions to Chemistry," which he afterwards expanded into a considerable volume.[2]

SILO. A modern silo is a pit or erection in which green crops are preserved in an undried condition for fodder. The term is derived from the Greek σιρός (Lat. *sirus*), a pit for holding grain. It is only of recent years that *ensilage*, *i.e.*, the preservation of green food for cattle by partial fermentation in silos, has become an important feature in agricultural economy. In various parts of Germany a method of preserving green fodder precisely similar to that used in the case of sauerkraut (see vol. iv. p. 549) has prevailed for upwards of a century. Special attention was at first directed to the practice of ensilage by a French agriculturist, M. Auguste Goffart of Sologne near Orleans, who in 1877 published a work (*Manuel de la Culture et de l' Ensilage des Mais et autres Fourrages Verts*) detailing the experiences of many years in preserving green crops in silos. An English translation of M. Goffart's book by Mr. J. B. Brown was published in New York in 1879, and, as various experiments had been previously made in the United States in the way of preserving green crops in pits, M. Goffart's experience attracted considerable attention. The conditions of American dairy farming proved eminently suitable for the ensiling of green maize fodder; and the success of the method was soon indisputably demonstrated among the New England farmers. The favorable results obtained in America led to much discussion and to the extensive introduction of the system in the United Kingdom, where, with different conditions, success has been more qualified, but still highly encouraging.

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[1] [In these works he was assisted by Charles R. Goodrich, of Long Island.—Am. Ed.]

[2] [He was for many years secretary of the American Association for the Advancement of Science, during which time he edited its *Proceedings* —Am. Ed.]

It has been abundantly proved that ensilage forms a wholesome and nutritious food for cattle. It can be substituted for root crops with advantage, because it is succulent and digestible; milk resulting from it is good in quality and taste; it can be secured largely irrespective of weather; it carries over grass from the period of great abundance and waste to times when none would otherwise be available; and a larger number of cattle can be supported on a given area by the use of ensilage than is possible by the use of green crops.

A silo should have a depth of at least 15 feet, and may either be a pit or a building above ground, provided it is water-tight and, as far as possible, air-tight. The crops suitable for ensilage are the ordinary grasses, clovers, lucerne, vetches, oats, rye, and maize; but various weeds may also be stored in silos with good results, notably spurrey (*Spergula arvensis*), a most troublesome plant in poor light soils. As a rule the crop should be mown when in full flower, and deposited in the silo on the day of its cutting. Fair dry weather is not essential; but it is found that when moisture, natural and extraneous, exceeds 75 per cent of the whole, good results are not obtained. The material is spread in uniform layers over the floor of the silo, and closely packed and trodden down. If possible, not more than a foot or thereby should be added daily, so as to allow the mass to settle down closely, and to heat uniformly throughout. When the silo is quite filled a layer of straw or some other dry porous substance is spread over the surface, then it is covered with boards, and a pressure of not less than 100 ℔ per square foot is applied by weighting or other mechanical means.

A silo thus contains, to begin with, a mass of living vegetable cells surrounded with a minimum of oxygen. The activity of the cells continuing, oxygen is absorbed and carbonic acid evolved, and part of the starch of the plants is converted into sugar. In the atmosphere of carbonic acid thus created the acid ferments manifest their vitality, and acetic, lactic, and butyric acids are developed at the expense of the starch and sugar. These chemical changes are accompanied with an evolution of heat, and the temperature of the mass rises, till, when it attains 122° Fahr., the action of the ferments is arrested. Should the heat rise to 150° the vitality of the vegetable cells themselves is destroyed; and also when the available oxygen is exhausted chemical change ceases and sweet silage is produced. When from excess of moisture or other cause the temperature of the silo does not reach 122° Fahr., the acid ferments are not killed, and they go on evolving chiefly acetic and lactic acids, the results being sour silage. These ferments, requiring nitrogen for their existence, act on the nitrogenous constituents of the plants, rendering the albuminoids partly soluble, evolving peptones, and by further splitting up producing amides, urea, and ammonia. The production of sour silage is accompanied by much greater transformation and loss than is incident to sweet silage; and in extreme action the material acquires a most disagreeable odor. There is, however, no sharp line of distinction between the two, and both varieties are eaten freely by stock. Frequently a considerable loss occurs around the edges, and at other points where air gets access to the mass, by mildewing. See *Special Report*, No, 48, of Dept. of Agriculture, Washington, D. C., 1882.

SILURIDÆ, a large family of freshwater Fishes, flourishing in the present epoch, and represented by a great variety of forms in all the tropical and temperate regions, many of them reaching back into the Tertiary age. The principal characters of this family (termed a "suborder" by some), its position in the system, its geographical distribution, and some of the most remarkable points in the structure and life-history of its members have been already sufficiently noticed under ICHTHYOLOGY, but we have here to notice more fully the sections into which it has been divided, and certain remarkable forms which were referred to nominally only in that article.

The modifications of the vertical fins, or rather the specialization of certain portions at the expense of others, and the greater or less extent of the bronchial aperture form excellent characters for subdividing the Siluroids.

I. In the *Siluridæ Homalopteræ* the vertical fins are exceedingly long, occupying nearly the whole extent of the embryonal fin, and in one genus (*Heterobranchus*) a great part of the dorsal portion retains its embryonic character, being a rayless adipose fin. All the Siluroids of this section belong to the fauna of the Old World and Australia. The rivers and lakes of tropical Africa harbor many species of the genera *Clarias* and *Heterobranchus*,—those of the Nile being known under the name of "Carmoot." One of the Nilotic species, *Clarias macracanthus*, occurs abundantly in the Lake of Galilee, and, being a long, scaleless, eel-like fish of black color, with eight long barbels round its broad mouth, was certainly included among those which the Jews were forbidden to eat by the Mosaic law. These fish grow to a length of from 4 to 6 feet, and are eaten by the natives of tropical Africa.

II. In the *Siluridæ Heteropteræ* the dorsal fin has almost or entirely disappeared; only its foremost portion and a small adipose remnant may be preserved; on the other hand the anal fin is retained in its whole extent. The gill-membranes remain separate and overlap the isthmus. This section likewise belongs to the fauna of the Old World, and includes, among many others, the species which has given the name to the whole family, *Silurus glanis*, the "Wels" of the Germans. It is the only representative of the family in Europe, and with the exception of the sturgeon, is the largest freshwater fish of the Continent. It was known to Aristotle, who described it under the name of *Glanis*. It inhabits more the central and eastern portions of Europe than the western, being absent in Italy, Greece, southern Switzerland, France, and those parts of Germany which are drained by the Rhine and its affluents. In general appearance it somewhat resembles the burbot. Its head is large and broad, its mouth wide, furnished with six barbels, of which those of the upper jaw are very long. Both jaws and the palate are armed with broad bands of small closely-set teeth, which give the bones a rasp-like appearance. The eyes are exceedingly small. The short body terminates in a long, compressed, muscular tail, and the whole fish is covered with a smooth, scaleless, slippery skin. Specimens of 4 and 5 feet in length, and of 50 to 80 ℔ in weight, are of common occurrence. Its food consists chiefly of other bottom-feeding fishes, and in inland countries it is considered one of the better class of food fishes. Stories about children having been found in the stomach of very large individuals are probably inventions.

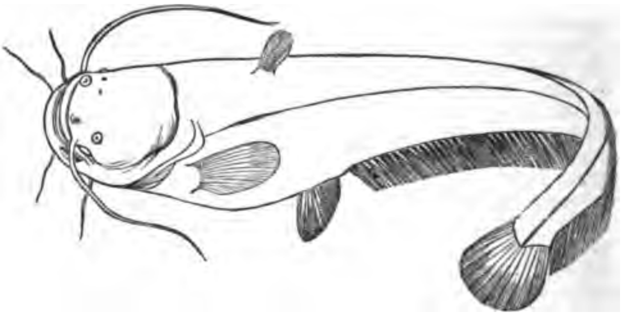

FIG. 1.—The "Wels" (*Silurus glanis*).

III. The *Siluridæ Anomalopteræ* are a small section from tropical America, in which the dorsal and adipose fins are very short and belong to the caudal vertebral column, while the anal is very long, and the gill-membranes are entirely separate, overlapping the isthmus.

IV. The *Siluridæ Proteropteræ* are a section extremely numerous in species, and represented throughout the tropics. The dorsal fin consists of a short-rayed and an adipose portion, the former belonging to the abdominal vertebral column; the anal is always much shorter than the tail. The gill-membranes are not confluent with the skin of the isthmus; they have a free posterior margin. When a nasal barbel is present, it belongs to the posterior nostril. This section includes among many others the genus *Bagrus*, of which the "Bayad" (*B. bayad*) and "Docmac" (*B. docmac*) frequently come under the notice of travellers on the Nile; they grow to a length of 5 feet, and are eaten. Of the "Cat-Fishes" of North America (*Amiurus*), locally called "bull-heads" or "horned-pouts," with eight barbels, some twenty species are known. Some of them are valued as food, especially one which is abundant in the ponds of New England, and capable of easy introduction into other localities (*A. nebulosus*). Others which inhabit the great lakes (*A. nigricans*) and the Mississippi (*A. ponderosus*) often exceed the weight of 100 lb. *Platystoma* and *Pimelodus* people the rivers and lakes of tropical America, and many of them are conspicuous in this fauna by the ornamentation of their body, by long spatulate snouts, and by their great size. The genus *Arius* is composed of the greatest number of species (about seventy), and has the widest distribution of all Siluroids, being represented in almost all tropical countries which are drained by large rivers. Some of the species enter salt water.[1] They possess six barbels, and their head is extensively osseous on its upper surface; their dorsal and pectoral spines are generally developed into powerful weapons. *Bagarius*, one of the largest Siluroids of the rivers of India and Java, exceeding a length of 6 feet, differs from *Arius* in having eight barbels, and the head covered with skin.

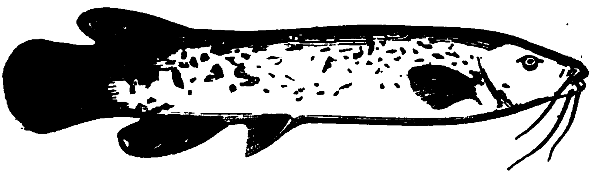

FIG. 3.—*Malapterurus electricus.*

V. In the *Siluridæ Stenobranchiæ* the dorsal fin consists of an adipose portion and a short-rayed fin which belongs to the abdominal vertebral column, and, like the adipose fin, may be sometimes absent. The gill-membranes are confluent with the skin of the isthmus. The Siluroids belonging to this section are either South American or African. Among the former we notice specially the genus *Doras*, which is distinguished by having a series of bony scutes along the middle of the side. The narrowness of their gill-openings appears to have developed in them a habit which has excited the attention of all naturalists who have visited the countries bordering upon the Atlantic rivers of tropical America, viz., the habit of travelling during seasons of drought from a piece of water about to dry up to ponds of greater capacity. These journeys are occasionally of such a length that the fish have to travel all night; they are so numerous that the Indians fill many baskets of them. Hancock supposes that the fish carry a small supply of water with them in their gill-cavity, which they can easily retain by closing their branchial apertures. The same naturalist adds that they make regular nests, in which they cover up their eggs with care and defend them,—male and female uniting in this parental duty until the eggs are hatched. *Synodontis* is an African genus and common in the Nile, where the various species are known by the name of "Shal." They frequently occur among the representations of animals left by the ancient Egyptians. The upper part of their head is protected by strong osseous scutes, and both the dorsal and pectoral fins are armed with powerful spines. Their mouth is small, surrounded by six barbels, which are more or less fringed with a membrane or with branched tentacles. Finally, the Electric Cat- or Sheath-Fishes (*Malapterurus*) also belong to this section. Externally they are at once recognized by the absence of a rayed dorsal fin, of which only a rudiment remains as a small interneural spine concealed below the skin. The entire fish is covered with soft skin, an osseous defensive armor having become unnecessary in consequence of the development of a powerful electric apparatus, the strength of which, however, is exceeded by that of the electric eel and the large species of *Torpedo*. It has been noticed in vol. xii. p. 687. Three species have been described from rivers of tropical Africa, of which one (*M. electricus*) occurs in the Nile; it rarely reaches a length of 4 feet.

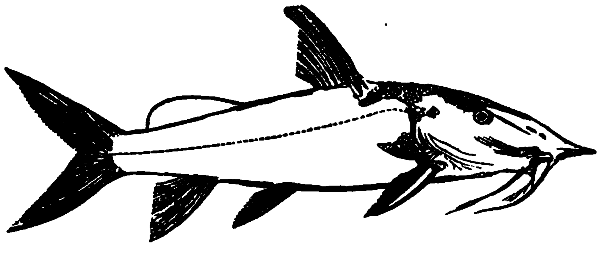

FIG. 2.—*Synodontis xiphias.*

VI. The section of *Siluridæ Proteropodes* contains small forms, some of which are of interest by the degree of specialization to which they have attained in one or the other direction. Many of them are completely mailed; but all have in common a short-rayed dorsal fin, with the ventrals below or rarely in front of it. Their gill-openings are reduced to a short slit; their pectorals and ventrals have assumed a horizontal position; and their vent is before, or not much behind, the middle of the length of the body. The first group of this section comprises alpine forms of the Andes, without any armature, and with a very broad and pendent lower lip. They have been referred to several genera (*Stygogenes*, *Arges*, *Brontes*, *Astroplebus*), but are collectively called "prefiadillas" by the natives, who state that they live in subterranean craters within the bowels of the volcanoes of the Andes, and are ejected with streams of mud and water during eruptions. These fishes may, however, be found in surface waters at all times, and their appearance in great quantities in the low country during volcanic eruptions can be accounted for by numbers being killed by the sulphuretted gases which escape during an eruption and by their being swept down with the torrents of water issuing from the volcano. The lowland forms have their body encased in large scutes, either rough, scale-like, and arranged in four or five series (*Chætostomus*), or polished, forming broad rings round the slender and depressed tail (*Loricaria*, Fig. 4), or polished and large, so as to form two series only along the body and short tail (*Callichthys*, Fig. 5). In India this section is but sparsely represented, chiefly in mountain-streams, by small loach-like Siluroids, in which various kinds of peculiar apparatus are developed to enable them to hold on to stones, this preventing their being swept away by the current; in *Pseudecheneis* the adhesive apparatus consists of transverse plaits of the skin on the thorax between the pectoral fins; in *Exostoma* the mouth is modified into a suctorial organ, probably with the same function. Finally, the South American genus *Aspredo*, which is remarkable for the peculiar mode of protecting its eggs, as mentioned in vol. xii. p. 698, belongs also to this section.

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[1] [*Smithsonian Miscellaneous Collections*, No 283, gives *Ælurichthys marinus* and *Ariopsis milberti* as sea fishes.—AM. ED.]

VII. The small section of *Siluridæ Opisthopteræ* comprises South American forms, the majority of which inhabit waters at high altitudes up to 14,000 feet above the level of the sea. All have a short-rayed dorsal fin, placed above or behind the middle of the length of the body, above or behind the ventrals, which may be absent. Also the anal is short. The nostrils are remote from each other, and the gill-membranes are not confluent with the skin of the isthmus. These little fishes, of which *Trichomycterus* and *Nematogenys* are the principal genera, replace in the Andes the loaches of the northern hemisphere; they resemble them in appearance and habits, and even in coloration, offering a striking illustration of the fact that similar forms of animals are produced under similar external physical conditions.

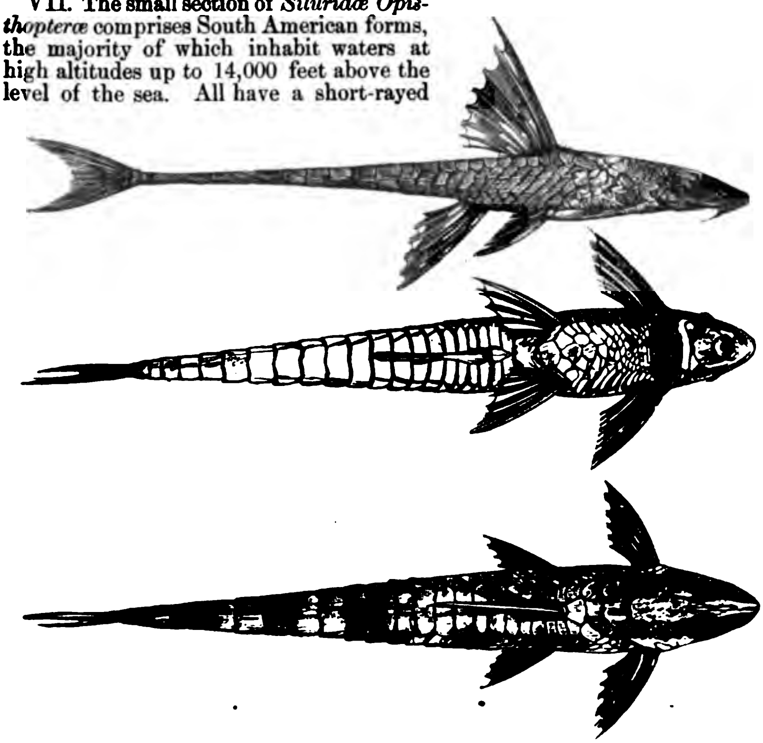

FIG. 4.—*Loricaria lanceolata*, from the upper Amazons. Natural size.

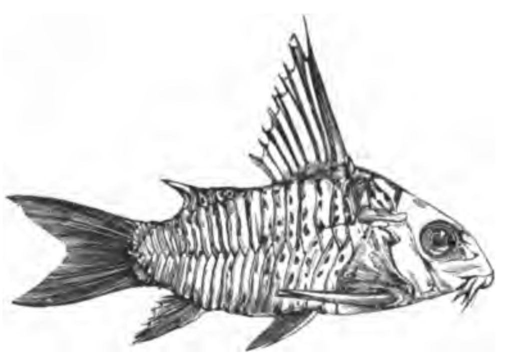

FIG. 5.—*Callichthys armatus*, from the upper Amazons. Natural size.

VIII. Finally, the *Siluridæ Branchicolæ* comprise the smallest and least developed members of the family; they are referred to two genera only from South America, *Stegophilus* and *Vandellia*, the smallest of which does not exceed the length of 2 inches. Their body is soft, narrow, cylindrical, and elongate; the dorsal and anal fins short; the vent far behind the middle of the length of the body; gill-membranes confluent with the skin of the isthmus. Each maxillary is provided with a small barbel; and the gill-covers are armed with short stiff spines. Their small size notwithstanding, these Siluroids are well known to the Brazilians, who accuse them of entering and ascending the urethra of persons while bathing, causing inflammation and sometimes death. They certainly live parasitically in the gill-cavity of large Siluroids, probably entering those cavities for places of safety, but without drawing any nourishment from their hosts.

(A. C. G.)

SILVANUS, an ancient Italian god of the woods (*silvæ*), closely allied to Faunus. Virgil speaks of him as a god of fields and cattle, and says that the Pelasgians dedicated a grove to him near Cære. Horace calls him the god of boundaries. Pigs were sacrificed to him, and at harvest festivals he received offerings of milk. He appears sometimes, especially in inscriptions, as a domestic god, and is occasionally associated with the Lares and Penates. Virgil describes him as crowned with fennel and lilies or carrying an uprooted cypress in his hand. On a relief he appears with a crown of pine branches in his hair, a pine branch in his left hand, a skin filled with fruits hanging about his neck, a pruning-knife in his right hand, and a dog by his side. On votive tablets he is oftener represented as the god of planting and gardening than as the rough woodland deity.

SILVER[1] is widely diffused throughout the earth's crust, including the ocean, which contains a trace of the noble metal—minute, it is true, in a relative sense, but in absolute amount approaching 10,000 million tons. Of the varieties of silver ores, the following chiefly are metallurgically important: (1) *Reguline Silver*, generally alloyed with mercury or gold, and if with the latter including sometimes a trace of platinum; (2) *Horn Silver*, native chloride, $AgCl$; (3) *Silver Glance*, native sulphide, Ag_2S; (4) *Silver-Copper Glance* $(Ag,Cu)_2S$; (5) *Pyrargyrite* ("Rothgültigerz"), Ag_3SbS_3; (6) *Stephanite*, Ag_5SbS_4; (7) *Polybasite*, $9(Ag_2,Cu_2)S+(Sb_2As_2)S_3$. Silver is also frequently met with in base-metallic ores, *e.g.*, in lead ores and many kinds of pyrites. Unmixed silver minerals nowhere present themselves in large continuous masses. What we call "silver ores" are all more or less complex mixtures in which the non-argentiferous components are usually decidedly in the majority. Their metallurgic treatment depends chiefly on the nature of these admixtures, the state of combination of the silver being as a rule irrelevant in the choice of a process, because some at least of the noble metal is always present as sulphide, and our modes of treatment for it include all other native forms.

Amalgamation.—If a given ore is relatively free of base "metals" (metallurgically speaking), some process of "amalgamation" may be, and often is, resorted to.

In the *Freiberg process* the first step is to roast the (ground) ore with common salt, which converts the sulphide of silver into chloride ($Ag_2S+2NaCl+4O$ from the air $=2AgCl+Na_2SO_4$). The mass, along with certain proportions of water, scrap-iron, and mercury, is placed in barrels, which are then made to rotate about their axes so that the several ingredients are forced into constantly varying contact with one another. The salt solution takes up a small proportion of chloride, which in this (dissolved) form is quickly reduced by the iron to the metallic state ($2AgCl + Fe = FeCl_2 + 2Ag$), so that there is, so to say, room made in the brine for another instalment of chloride of silver, which is reduced in its turn, and so on to the end,—the metal formed uniting with the mercury into a semi-fluid amalgam. Of this the bulk at least readily unites into larger continuous masses, which, on account of their high specific gravity, are easily separated from the dross mechanically. The amalgam is pressed in linen bags to eliminate a quantity of relatively silver-free liquid mercury (this of course is utilized as such in subsequent operations), and the remaining solid amalgam is subjected to distillation from iron retorts, whereby its mercury is recovered as a distillate while a more or less impure silver remains in the retort. This process, after having been long wrought in Freiberg with great success, is now superseded there by the Augustin method (see below) but it survives in some other places, as, for example, the Washoe or Comstock district in the Sierra Nevada (United States). It is not used in Chili, Peru, and Mexico because of the scarcity of fuel.

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[1] Compare CHEMISTRY, vol. v. pp. 458–9; also MINING, MINT, and MONEY.

The *Mexican process*, though far less perfect than that of Freiberg, evades this difficulty. It was tried for the first time, if not actually invented, by Bartolomeo de Medina in 1557. It was adopted in Mexico in 1566 and in Peru in 1574, and is in use in both countries and in Chili to this day. The stamped ore is ground into a fine paste with water; this paste, after having been allowed to dry up a little in air, is placed on a stone floor along with a quantity of salt, and the two are trodden together by mules. On the following day there are added certain proportions of "magistral" (a kind of crude sulphate of copper made by roasting copper pyrites) and of mercury, and the mules are kept going until the silver is as far as possible converted into amalgam, which takes from fifteen to forty-five days. The rationale of the process is not quite understood. According to Boussingault, the cupric chloride (formed by the salt from the sulphate) chlorinates part of the sulphide of silver, thus:

$$2CuCl_2 + Ag_2S = 2AgCl + S + Cu_2Cl_2,$$

and the cuprous chloride formed acts upon another portion of sulphide of silver, thus:

$$Cu_2Cl_2 + Ag_2S = 2AgCl + Cu_2S,$$

and in this way all the sulphide of silver is gradually converted into chloride. The chloride is reduced to the metallic state by the mercury ($AgCl + Hg = HgCl + Ag$) with formation of calomel, the metallic silver uniting with the surplus mercury into amalgam. The calomel is allowed to go to waste.

The *Augustin process* of silver extraction is only a peculiar mode of metallifying and collecting the silver of an ore after it has been by some preliminary operation converted into chloride or sulphate. Either salt is brought into solution—the chloride by means of hot brine, the sulphate by means of hot water, acidified with oil of vitriol; the solution is separated from the insolubles, and made to filter through a bed of precipitated copper. The copper reduces the silver to metal, which remains on the bed as a spongy mass, while an equivalent quantity of copper chloride (or sulphate) passes through as a solution. The silver sponge is collected, freed from adhering copper by muriatic acid in contact with air, and then sent to the furnace. From the copper liquor that metal is precipitated in its original form by means of iron.

The silver furnished by any of these methods is never pure, even in the commercial sense. A general method for its purification is to fuse it up with lead and subject the alloy to cupellation (see LEAD, vol. xiv. p. 376). Cupel-silver is apt to contain small quantities of lead (chiefly), bismuth, antimony, copper, and more or less of gold, of which metals, however, only the first three are reckoned "contaminations" by the metallurgist. They can be removed by a supplementary cupellation, without added lead, at a high temperature. Addition of lead would remove the copper likewise, but it is usually allowed to remain and the alloy sent out as cupriferous silver, to be alloyed with more copper and thus converted into some kind of commercial "silver" (see below). If gold is present to the extent of 0.1 per cent. or more, it is recovered by treatment of the metal with nitric acid or boiling vitriol. The gold in either case remains as such; the silver becomes nitrate or sulphate, and from the solution of either salt is recovered by precipitation with metallic copper. Although nitric acid is the more expensive of the two parting agents, it is often now preferred because photography has created a large demand for nitrate of silver. Compare GOLD, vol. x. p. 666.

For the "incidental" extraction of silver from essentially base-metallic ores the method in the case of all lead ores is simply to proceed as if only lead were present, and from the argentiferous lead produced to extract the noble metal by one of the processes described under LEAD (vol. xiv. p. 376–7), while for the treatment of sulphurous copper ores one method is so to smelt the ore (with, if necessary, an addition of galena or some form of oxide of lead) as to produce a regulus of lead and a "mat" of sulphide of copper (Cu_2S), which latter should contain as little lead as possible. The silver follows chiefly the lead, and is extracted from it by cupellation; but some silver remains in general even with a lead-free mat. Compare account of the Lautenbach process under LEAD.

A modern mode of extracting the silver from a copper mat is to roast it at a very low temperature, so as to produce a relatively large proportion of metallic sulphate, and then to destroy the bulk of the sulphate of copper by a judiciously-regulated higher temperature. The silver all remains as sulphate, which is extracted by hot dilute sulphuric acid and wrought by the Augustin method.

Very interesting is the process which was patented by Claudet for the remunerative extraction of the few hundredths of a per cent. of silver contained in that kind of cupriferous iron pyrites which is now used, almost exclusively, for the making of vitriol. The "cinders," as returned by the vitriol maker, are habitually worked up for copper by roasting them with salt and lixiviating the roasted mass with water, when the copper dissolves as chloride, Cu_2Cl_2 and $CuCl_2$. The silver goes with it, but for its precipitation no method was known until Field found that silver dissolved as AgCl in a chloride solution can be precipitated exhaustively by addition of the calculated proportion of a soluble iodide, as AgI. Claudet's process is only an adaptation of Field's discovery. After having diluted the copper liquor with a certain proportion of water he adds the weight of iodine, calculated from the assay, as solution of iodide of zinc, which produces a very impure precipitate of iodide of silver. From it he re-extracts the iodine, by treatment with zinc and dilute sulphuric acid, as iodide of zinc, which is used over again. The "silver precipitate," which now contains its silver as metal mixed with a large quantity of (chiefly) sulphate of lead, goes to the metal-refiner, who treats it as a lead ore.

Chemically Pure Silver.—Even the best "fine" silver of commerce contains a few thousandth-parts of copper or other base metal. To produce perfectly pure metal the most popular method is to first prepare pure chloride (by applying the method given below under "Chloride" to a nitric solution of any kind of ordinary "silver"), and then to reduce the chloride to metal, which can be done in a great variety of ways. One way is to mix the dry chloride intimately with one-fifth of its weight of pure quicklime or one-third of its weight of dry carbonate of soda, and to fuse down the mixture in a fire-clay crucible at a bright red heat. In either case we obtain a regulus of silver lying under a fused slag of chloride—$2AgCl + (CaO$ or $Na_2CO_3) = 2Ag + (CaCl_2 + O$ or $2NaCl + CO_2 + O)$. The fused metal is best granulated by pouring it from a sufficient height, and as a thin stream, into a mass of cold water. A convenient wet-way method for small quantities is to boil the recently precipitated chloride (which must have been produced and washed in the *cold*) with caustic soda-ley and just enough of sugar to take away the oxygen of the Ag_2O transitorily produced. The silver in this case is obtained as a yellowish-gray heavy powder, which is easily washed by decantation; but it tends to retain unreduced chloride, which can be removed only by fusion with carbonate of soda.

Stas recommends the following process as yielding a metal which comes nearer ideal purity. Slightly cupriferous silver is made into dry nitrate and the latter fused to reduce any platinum nitrate that may be present to metal. The fused mass is taken up in dilute ammonia and diluted to about fifty times the weight of the silver it contains. The filtered (blue) solution is now mixed with an excess of solution of sulphite of ammonia, $SO_3(NH_4)_2$, and allowed to stand. After twenty-four hours about one-half of the silver has separated out in crystals; from the mother-liquor the rest comes down promptly on application of a water-bath heat. The rationale of the process is that the sulphite hardly acts upon the dissolved oxide of silver, but it reduces some of the oxide of copper, 2CuO, to Cu_2O, with formation of sulphate $SO_4(NH_4)_2$. This Cu_2O deoxidizes its equivalent of Ag_2O, forming $Ag + Cu_2O_2$, which latter is reduced by the stock of sulphite and converted into Cu_2O which now acts upon a fresh equivalent of Ag_2O; and so on to the end.

Pure silver (ingot) has a beautiful white color and lustre; it is almost as plastic as pure gold, and, like it, very soft. It does not tarnish in natural air; but in air contaminated with ever so little sulphuretted hydrogen it gradually draws a black film of sulphide. The specific gravity of the frozen metal is 10.42 to 10.51, rising to 10.57 after compression under a die. It is the best conductor of heat and electricity. The expansion of unit length from 0° to 100° C. is 0.001936 (Fizeau). The specific heat is 0.0570 (Regnault), 0.0559 (Bunsen). It fuses at 954° C. (Violle)—*i.e.*, far below the fusing point of copper or gold—without oxidation, unless it be in contact with a surface of silicate (porcelain glaze, etc.), when a trace of silicate of Ag_2O is produced. It volatilizes appreciably at a full red heat; in the oxyhydrogen flame it boils, with formation of a blue vapor. The fused metal readily absorbs oxygen gas (under fused nitre as much as twenty times its volume—Gay-Lussac). When the oxygenated metal freezes the absorbed gas goes off suddenly at the temperature of solidification, and, by forcing its way through the solid crust produces volcanic eruptions of metal which are sometimes very beautiful. The presence of even very little base metal in the silver prevents this "spitting," the base metal combining with the oxygen faster than it can be reabsorbed. Pure silver retains a trace of the absorbed oxygen permanently, and Dumas in an experiment on one kilogramme of metal extracted from it 82 milligrammes of oxygen in an absolute vacuum at 400°-500° C. Water, and ordinary non-oxidizing aqueous acids generally, do not attack silver in the least, hydrochloric acid excepted,—which, in the presence of air, dissolves the metal very slowly as chloride. A solution of common salt acts similarly, the liberated sodium becoming NaOH. Aqueous hydriodic acid, even in the absence of air, dissolves silver perceptibly, with evolution of hydrogen (Deville). Aqueous nitric acid dissolves the metal readily as nitrate; hot vitriol converts it into a magma of crystalline sulphate, with evolution of sulphurous acid. Silver is absolutely proof against the action of caustic alkali lyes, and almost so against that of fused caustic alkalies even in the presence of air. It ranks in this respect next to gold, and is much used to make vessels for chemical operations involving the use of fused caustic potash or soda. The ordinary "fine" metal is good enough for this purpose.

SILVER ALLOYS.—Pure silver is too soft to make durable coins or vessels combining lightness with stability of form. This defect can be cured by alloying it with a little copper. All ordinary "silver" articles consist of such alloys. The proportion of silver in these (their "fineness") is habitually stated in parts of real silver per 1000 parts of alloy. In Great Britain all silver coins are made of "standard silver," the fineness of which, by legal definition, is 925. The toleration is 4 units (of pure silver in 1000 of alloy), *i.e.*, a specimen passes as long as its fineness lies between 925 and 921 (compare MINT, vol. xvi. p. 507). As regards silver-plate the "Hall" in London refuses to stamp any poorer alloy. In Germany and in the United States all silver coins, in France and Austria the major silver coins, are of the fineness 900, with a toleration of 3 units. The minor coins of Austria are of the fineness 375 to 520; in France all silver coins under one franc contain 835 of silver, 93 of copper, and 72 of zinc in 1000 parts. The fineness prescribed by law or custom for "silver" articles is 950 or 800 (±5) in France, 750 in North Germany, 812.5 in South Germany, and 820 in Austria. All *these* alloys at least are liable to "liquation," which means that, although they are perfectly homogeneous in the crucible, they freeze into layers of not absolutely the same composition. According to Leval, passing from the skin to the core of an ingot of 900 per mille silver the difference may amount to 3 units. Of all the alloys tried by that chemist only that composed according to the formula Ag_3Cu_2, corresponding to 719 per mille of silver, remained perfectly homogeneous on freezing. He therefore recommends this alloy for coinage; unfortunately, however, any silver-copper alloy which contains less than about 750 per mille of noble metal tarnishes very perceptibly in the air. British standard silver is quite free of this defect, but it is inconveniently soft, far softer than the "900" alloy.

The extent to which the properties of silver are modified by addition of copper depends on the fineness of the alloy produced. The addition of even three parts of copper to one of silver does not quite obliterate the whiteness of the noble metal. According to Kamarsch the relative abrasion suffered by silver coins of the degrees of fineness named is as follows:

Fineness..................	312	750	900	993
Abrasion................	1	2.3	3.9	9.5

The same observer established the following relation between fineness p and specific gravity in coins containing from 375 to 875 of silver per 1000:—sp. gr. $= 0.001647\,p + 8.833$.

The fusing points of all copper-silver alloys lies below that of pure copper; that of British standard silver is lower than even that of pure silver. For the alloys of silver with other metals than copper, see GOLD, PLATINUM, and NICKEL. The present writer has introduced an alloy of 91 of silver, 7 of gold, and 2 of nickel as a material far superior, on account of its higher rigidity, to fine silver for the making of alkali-proof vessels.

"Oxidized" silver is ordinary cupriferous silver superficially modified by immersion into sulphide of sodium solution (which produces a dark film of sulphide), or otherwise.

Silvering.—For the production of a silver coating on a base-metallic object we have chiefly two methods. One of these is to dissolve silver in mercury and to apply this amalgam to the (carefully cleaned) surface of the object by means of a brush. The mercury then is driven away by heat, when a coherent film of silver remains, which adheres very firmly, is quite continuous, and needs not be thick to stand polishing and other surface treatment. This very old method is to this day the best for producing a strong coating, but it is dangerous to the health of the workmen, expensive and troublesome, and has been almost superseded by the modern process of *electroplating* (see ELECTRO-METALLURGY, vol. viii. p. 109-10). Objects made of iron or steel must first be coated over with copper, and then treated as if they consisted of that metal.

For *Glass-Silvering*, see MIRROR, vol. xvi. p 523-4.

Inscriptions on linen, consisting of black metallic silver and consequently proof against all ordinary processes of washing, can be produced by using suitably-contrived silver solutions as inks. A mere solution of nitrate of silver (1 to 8 of water)[1] will do, if the surface to which it is applied has been prepared by impregnation with a solution of 6 parts of soda crystals and 17 of gum-arabic in 30 of water, and subsequent ironing. The ink must be applied with a quill or gold pen (compare vol. xiii. p 87).

SILVER COMPOUNDS.—(1) *Nitrate of Silver* ($AgNO_3$) is made by dissolving fine silver in a moderate excess of nitric acid of 1.2 sp. gr., applying heat at the end. The solution on cooling deposits crystals—very readily if somewhat strongly acid. Even a slightly cupriferous solution deposits pure or almost pure crystals. Any admixture of copper in these can be removed by fusing the dry crystals, when the copper salt only is reduced to black oxide of copper insoluble in water and thus removable, or by boiling the solution with a little pure oxide of silver (Ag_2O), which precipitates the CuO and takes its place. Nitrate of silver forms colorless transparent sonorous plates, which, if free of organic matter, remain unchanged in the light,—which agent readily produces black metallic silver if organic matter be in contact with the salt or its solution. One hundred parts of water dissolve, of nitrate of silver

at	0°	11°	19.5°	110° C.
	121.9	127.7	227	1111 parts.

The solution is neutral to litmus. The salt dissolves in 4 parts of cold alcohol. Nitrate of silver fuses at 198° C. into a thin colorless liquid, which stands even higher temperatures without decomposition. At a red heat it is reduced to metal. The fused salt, cast into the form of quill-sized sticks, is used in surgery as a cauterizing agent ("lapis infernalis," or lunar caustic). The sticks gain in firmness if alloyed with a little nitrate of potash.

(2) *Sulphate of Silver* (Ag_2SO_4) forms white crystals solubl

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[1] Preferably blackened for visibility by incorporation of some Chinese ink (carbon).

in 200 parts of cold or 68 of boiling water, but more soluble in dilute sulphuric acid. It stands a red heat without decomposition.

(3) *Oxide of Silver* (Ag_2O) appears as a dark-brown precipitate when a solution of the nitrate is mixed with excess of caustic potash or—preferably for preparative purposes—baryta water. It is slightly soluble in water, forming a very decidely alkaline (to litmus) solution, behaving as if it contained the (unknown) AgOH. It seems to suffer reduction in the light. In hydrogen it loses its oxygen at 100° C. (Wöhler), in air from about 250° C. upwards. Solutions of numerous organic substances and other agents reduce oxide of silver, more or less readily, to metal. Ritter produced what he took to be a *peroxide* of silver by decomposing a solution of the nitrate galvanically, in the form of black metallically-lustrous crystals, which gathered at the positive pole. At 110° C. these decompose almost explosively, with evolution of the 12.77 per cent. of oxygen demanded by Ag_2O_2; yet according to Berthelot the crystals are $4Ag_2O_3.AgNO_3+2H_2O$. But a hydrate of Ag_4O_3 is got by the action of peroxide of hydrogen on Ag_2O.

(4) *Chloride of Silver* (AgCl) comes down as a precipitate when solutions of silver salts are mixed with solutions of chlorides (for preparative purposes $AgNO_3$ with HCl, which is preferable to NaCl). The mixture at first has the appearance of a milk, but on being violently shaken it divides into a curdy, heavy, easily settling precipitate and a clear solution,—more readily if the co-reagents are exactly balanced, or the silver is in excess, than when the precipitant predominates. Chloride of silver is as good as insoluble in water, but hydrochloric acid, and chloride solutions generally, dissolve it perceptibly. In dilute sulphuric and nitric acids it is as insoluble as in plain water. Even boiling oil of vitriol attacks it only very slowly. It is readily soluble in ammonia solution, and reprecipitated therefrom on acidification. It dissolves in aqueous thiosulphate of soda, $Na_2S_2O_3$, forming the very stable salt $NaAg.S_2O_3$, and in cyanide of potassium solution, forming $KAg.(NC)_2$. From either solution the silver is conveniently recoverable only by sulphuretted hydrogen or sulphide of ammonium as an Ag_2S precipitate. Chloride of silver fuses at 260° C. into a yellowish liquid, freezing into a transparent, almost colorless, glass of hornlike consistence (hence the name, "horn-silver." The specific gravity of frozen AgCl is 5.45 (Karsten). It remains undecomposed, but volatilizes appreciably at a red heat. Hydrogen at a dull red heat reduces it to metal. A similar reduction is effected in even the compact chloride by contact with zinc, water, and a little dilute sulphuric acid; the reduction, however, proceeds rather slowly, and is rarely quite complete. *Unfused* chloride of silver, when exposed to sunlight, becomes at first violet, then darker and darker, and at last black, through progressive dechlorination. Yet even the black final product, according to Bibra, yields up no silver to hot nitric acid.

(5) *Bromide of Silver* (AgBr) closely resembles the chloride. The reduction on isolation is prevented by the presence of a trace of free bromine and promoted by that of nitrate of silver. Chlorine converts the hot fused salt into chloride.

(6) *Iodide of Silver* (AgI), while similar on the whole to the other two haloids, presents marked peculiarities. As formed by precipitation it is distinctly yellow; it is insoluble in, but decolorized by, ammonia; it is less soluble in water and dilute nitric acid or other nitrate solutions than even the bromide, this latter exceeding in this sense the chloride. But boiling oil of vitriol decomposes it slowly, with elimination of iodine vapors and formation of sulphate. Hydrogen at a red heat does not act upon it; nor is it at all easily decomposed by zinc and dilute acid. Precipitated iodide of silver is characteristically soluble in solutions of alkaline iodides and in those of nitrate of silver. with formation of double salts, which, however, are all decomposed, more or less completely, by addition of much water. *Pure* iodide of silver, even if recently precipitated, is not changed by sunlight, but if contaminated with nitrate of silver it readily blackens. For action of light on silver haloids, see PHOTOGRAPHY.

ANALYSIS.—In a solution of salts derived from purely oxygenated acids the least trace of silver can be detected by hydrochloric acid, which precipitates the silver as chloride (see above). The precipitate, when produced in a possibly complex solution, may include the chlorides of lead (PbCl) and mercurosum (Hg_2Cl_2). Repeated treatment of the (washed) precipitate with boiling water extracts the lead chloride; then, by pouring ammonia on the precipitate we convert the Hg_2Cl_2 into an insoluble black body, while the chloride of silver dissolves, and, from the filtrate, can be precipitated by acidification. For the *quantitative* determination of silver, the ordinary laboratory method is to bring the metal into solution as nitrate, and then to throw it down as pure chloride. The chloride is washed, collected, dehydrated by fusion, and weighed. According to Stas, if O = 16, Ag = 107.93, and Cl = 35.454; hence, the chloride contains 0.75273 of its weight of metal.

The *assaying* of silver ores is done preferably in the "dry way;" in fact, relatively poor ores cannot be assayed satisfactorily in any other. The general method with sulphureous ores is to mix them, as powders, with (silver-free) oxide of lead and tartar, and fuse in a clay or graphite crucible. The regulus includes all the silver. The fuse is poured into a conical mould of cast-iron, when the metal goes to the bottom of the mould; the ingot, after cooling, is easily separated from the adhering slag. The slag-free regulus is then placed in a little cupel made out of compressed bone-ash, and is heated in a muffle to redness and kept at this temperature in the current of air which pervades the muffle in virtue of its disposition in the furnace, until all the lead and base metals generally have been sucked up by the porous cupel. The remaining "button" of metal is weighed, which gives the conjoint of the silver and gold, which latter metal is rarely absent. For its determination the button is rolled out into a piece of thin sheet, which is "parted" with nitric acid (see GOLD). The gold remains and goes to the balance; the weight of the silver is found by difference. Similarly, to determine the fineness of silver alloys, a known weight of the alloy—customarily 0.5 gramme—is "cupelled," with addition of a proportion of pure lead depending on the weight of base metal to be removed, as shown by the following table, which, however, holds strictly only for copper-silver alloys:

Fineness	1000—900......	80 units of lead per unit of copper.
"	900—850......	64 "
"	800—750......	53 "
"	below 750......	50—40 "

In a well-appointed laboratory, two operators who work into each other's hands can easily make several dozen of such assays in a day. Cupelling, indeed, is the promptest of all methods of analysis, only, the results are not quite as exact as is desirable in the case of precious metal, part of the silver being lost by volatilization, and part by being sucked into the cupel. The error attains its maximum in the case of alloys of about 700 per mille, and with these comes to about $\frac{1}{150}$th of the weight of the silver to be determined. It of course can be, and always is being, corrected to some extent by "blank" assays made with known weights of pure silver and pure copper; but such corrections are not quite safe. Hence cupellation nowadays, in the mints at least, is used only for a first approximation, and the exact fineness determined by the "wet-way" process, invented by Gay-Lussac. See ASSAYING, vol. ii. p. 636.

A most excellent method for the quick determination of a not approximately known weight of dissolved silver has been invented by Volhard. This method rests on the fact that solutions of sulphocyanates (including that intensely red salt $Fe(NCS)_3$, which is produced when, for instance, NCS.H is mixed with ferric sulphate) precipitate silver completely from even strongly acid solutions, as NCS.Ag. A convenient reagent for the method is produced by dissolving $\frac{1}{10}$ $NCS.NH_4$ grammes of (chlorine-free) sulphocyanate of ammonium in water to 1000 c. c. to produce a solution of which 1 c.c. precipitates about $\frac{1}{10}$ Ag = 10.8 milligrammes of silver. To determine the exact "titre," we dissolve, say, 540 milligrammes of pure silver in 1.2 nitric acid, and next boil away every trace of N_2O_3. We then dilute to say 50 c. c., add 5 c. c. of saturated solution of iron alum (not less), and lastly, run in sulphocyanate from the burette, until the red color of ferric sulphocyanate which appears locally from the first, by addition of the last drop of NCS solution, has become permanent on stirring. Supposing 49.3 c. c. of solution to have been required to reach this point, every 1 c. c. of reagent precipitates $\frac{540}{49.3}$ milligrammes of silver, and it, of course, always does so, even, let us add, in the presence of (say) 70 per cent. of copper beside 30 of silver in the alloy under operation. Volhard's method is more exact, and, with a small number of samples, takes even less time than cupellation. (W. D.)

Mode of Occurrence.—Silver is rarely found in the native state, and then only in comparatively small quantities. Most of the ores of silver are difficult to reduce, and it is therefore deemed safe to regard this as the last of the three great coining metals which came into use. Silver is originally as widespread as gold, occurring in nearly all the volcanic rocks, and some of the Primary ones. In the Silver Reef district of Utah it is found in sedimentary sandstone, though this appears to have undergone some change from volcanic action. But gold remains unaltered by the action of the elements, and is often carried away long distances from its original place of occurrence by the breaking down of the rocks which contain it and their formation anew elsewhere, either as other rocks, or as "placers" of gravel or sand, containing gold easily washed out by hand or with rude appliances. Silver, on the contrary, is only to be found in the rocks where it originally occurs. When these are broken down or worn away, the silver is either driven into new mineral combinations, or, more commonly, dissipated and lost. Hence silver is only to be obtained by subterranean mining, and demands the aid of capital and associated labor. The greater rapidity with which gold can be obtained has often influenced the legal relation of value between these two metals, and its bearing upon prices, commerce, and civilization.

Cost of Production.—In nearly all silver ores there is some gold, and in nearly all gold ores some silver. In the £70,000,000 [$340,200,000] worth of metal produced from the Comstock lode of Nevada, nearly one-half in value consisted of gold. For this and other reasons it is impossible to determine the general average cost of producing gold and silver from all the mines during any reasonably long period of time. If recent statistics are to be trusted, both metals are produced on the average at a loss. Such is alleged to have been the case in California, Australia, and Nevada,[1] countries whose combined product has equalled in value nearly £600,000,000 [$2,916,000,000].

Value.—In some ancient states the value of silver appears to have been superior to that of gold.[2] Agatharchides informs us that such was the case in ancient Arabia; and Tacitus says the same of ancient Germany. Strabo alleges that the ratio of value in a country bordering that of the Sabæans was at one time one gold to two silver; and so late as the 17th century silver and gold were valued equally in Japan.[3] Going back to a remote antiquity, silver appears to have been everywhere equal in value to gold until the silver mines showed signs of exhaustion, when, as the principal coins were of copper and silver, and prices were commonly expressed in these coins, the threatened decrease of money was probably averted and a profit secured for the state by raising the legal value of gold coins. In Greece, in the time of Herodotus (*cf.* iii. 95), gold was 13 times the value of silver, at which ratio it appears to have stood for a long period.

When the Romans acquired the placer mines of Pannonia, Dacia, Spain, Gaul, etc., they made their principal coins of gold; and at a later period, when the supplies of this metal fell off, they raised the legal value of silver coins to one-tenth that of gold ones of like weight and fineness. This ratio was afterwards changed to 11, and still later to 12 silver for 1 gold. In the Arabian states of the 7th century the ratio was about 6½ for 1; yet in France at the same time it was 10 for 1; in England during the 12th century it was 9 for 1; in France during the 14th century certain silver and gold coins of like weight bore the same value, hence the ratio was 1 for 1; in Castile and Leon in 1454–74 it was 7½ for 1. Speaking broadly, between the rise of Mohammedanism and the opening of the silver mines of America the value of silver compared with gold gradually rose. It is evident that there were two lines of ratios, the one having an Indo-Arabic, the other a Romano-Germanic origin, and that the conflict of ratios—which only ceased when America was discovered and a great coinage of the precious metals occurred in Spain—gave rise to many of those otherwise inexplicable lowerings of coins, of one or the other metal, which characterize this period.

In Spain, by the edict of Medina (1497), the ratio was 10¾. When America was plundered the first fruits were gold, not silver; whereupon Spain, in 1546, and before the wealth of the silver mines of Potosi was known, raised the legal value of gold to 13⅓, and, as Spain then monopolized the supplies of the precious metals, the rest of the world was obliged to acquiesce in her valuation. During the following century Portugal obtained such immense quantities of gold from the East Indies, Japan and Brazil that the value of her imports of this metal exceeded £3,000,000 [$14,580,000] a year, whilst those of Spain had dwindled to £500,000 [$2,430,000] in gold, and had only increased to £2,500,000 [$12,150,000] in silver. Portugal now governed the ratio, and in 1688 raised the value of gold to 16 times that of silver. Except during a brief period of forty years, this ratio has ever since been maintained in Spanish and British America and the United States. A century later the spoils of the Orient were exhausted, the Brazilian placers began to decline, and Portugal lost her importance. Spain thus again got control of the ratio, and, as her colonial produce was chiefly silver, she raised its value in 1775 from one-sixteenth to one-fifteenth and a half that of gold for the Peninsula, permitting it to remain at one-sixteenth in the colonies. France, whose previous ratio (that of 1726) was 14½, adopted the Spanish ratio of 15½ in 1785, and has adhered to it ever since. These three historical ratios, and the bearing of each upon the others, have influenced all legislation on the subject, and, where there was no legislation, have governed the bullion markets for more than two centuries.

Meanwhile an economical school arose which, while conceding it to be necessary that the state should fabricate coins, denied it the right to limit the number of coins, or to exact payment (seigniorage) for coinage. This school found expression in the Act 18 Charles II. (1666), which permitted private persons to have coined for them an unlimited quantity of gold or silver, at the public mint, free of charge. Similar Acts were passed in Holland, France and other countries. But the crown retained the right to regulate the nominal value of gold and silver coins, the exercise of which has had the greatest influence on the relative market value of those metals.

To check abuses of this prerogative the economical school next directed its efforts towards the adoption of one in place of two metals for full legal tender coins. The principal advocates of this change during the last century were Dutot (1739) and Desrotours (1790), and during the present one Lord Liverpool (1808), De Quincey (1849), and Chevalier (1856). The policy thus advocated was practically adopted in Holland and England during the 18th century, and by the latter definitively in 1816. It was accepted by the Monetary Conference assembled at Paris June 20, 1867, and by the Commercial Convention at Berlin, October 20, 1868. In 1871 it was practically, though not definitively, adopted by Germany, and since that date by several smaller states, including distant Japan. In France (1874) and the United States (1873–78) the policy pursued has been a waiting one. Full legal tender silver coins continue to be employed for money, but the state has ceased to coin silver on private account. Either Germany, France or the United States may, by simple enactment, and without recoinage or change of coins, return to the "bimetallic" basis of money.

The closure of the mints of all important commercial countries to silver, while they have remained open to the free coinage of gold at a fixed valuation, has enhanced the purchasing power of gold, compared with either silver or other commodities, about one-fourth. The price of uncoined silver being usually quoted in gold, this phenomenon appears as a "fall of silver," by which term it is commonly known. This alleged fall, its causes, consequences and remedies, constitute the "Silver Question."

Production.—In the principal producing countries—the United States, Mexico, Chili and Peru—mining is free, and there are no official returns of the production, which is therefore mere matter of conjecture. In the United States it is the custom to value silver bullion at one-sixteenth that of gold. This unduly swells the value of the conjectural product of that country more than one-fourth (see *Report* of the United States Monetary Commission of 1876, Appendix, pp. 1–66). From a careful consideration of the bullion movement, the total annual product of silver throughout the world at the present time is estimated at between 50 and 60 million ounces, at which figure it has remained steady upwards of ten years.

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[1] DelMar, *Hist. Prec. Metals*, chap. xxxi.

[2] Boeckh, *Political Economy of the Athenians*, book I, chap. 6.

[3] Sir Edward J. Reed, *Japan*, chap. xviii.; DelMar, *Money and Civilization*, chap. xx.

Consumption in the Arts.—Direct inquiries as to the quantity of silver used in the arts have met with little success, and the statistics so obtained are defective. But the total production of silver in the Western World, from the discovery of America to the present time, has been, in value, about 1400 million pounds sterling [$6,804,000,000], of which about 300 million pounds [$1,458,000,000] remain in coins. Consequently 1100 millions [$5,346,000,000], or nearly four-fifths, have been consumed in the arts, lost, etc., or exported to Asia. There are estimated to be about 50 or 60 million pounds sterling [$243,000,000 or $291,600,000] worth of silver coins in India,[1] and some trifling amounts each in China, Japan, Persia, etc. On the whole it appears quite safe to estimate the average annual consumption of silver in the arts and through wear, tear and loss as fully equalled to three-fourths of the production. Lowe in 1822 estimated it at two-thirds. Silver is principally used for plate and jewelry; it is also consumed in photography, and in numerous chemical preparations, such as lunar caustic, indelible ink, hair dyes, fulminating powder, etc. (A. DE.)

SILVERIUS, the successor of Pope Agapetus I., was a legitimate son of Pope Hormisdas, born before his father entered the priesthood. He was consecrated on June 8, 536, having purchased his elevation to the see of St. Peter from the Gothic king Theodotus. Six months afterwards (Dec. 9) he was one of those who admitted Belisarius into the city. He opposed the restoration of the patriarch Anthimus, whom Agapetus had deposed and thus brought upon himself the hatred of Theodora, who desired to see Vigilius made pope. He was deposed accordingly by Belisarius in March, 537, on a charge (not improbably well founded) of treasonable correspondence with the Goths, and degraded to the rank of a simple monk. He found his way to Constantinople, and Justinian, who entertained his complaint, sent him back to Rome, but Vigilius was ultimately able to banish his rival to Pandataria, where the rest of his life was spent in obscurity. The date of his death is unknown.

SILVESTER I., bishop of Rome from January, 314, to December, 335, succeeded Melchiades and was followed by Marcus. The accounts of his papacy preserved in the *Liber pontificalis* (7th or 8th century) and in Anastasius are little else than a record of the gifts said to have been conferred on the Roman Church by Constantine the Great. He was represented at the council of Nice, and is said to have held a council at Rome to condemn the heresies of Arius and others. The story of his having baptized Constantine is pure fiction, as almost contemporary evidence shows the emperor to have recieved this rite near Nicomedia at the hands of Eusebius, bishop of that city. According to Döllinger, the entire legend, with all its details of the leprosy and the proposed bath of blood, cannot have been composed later than the close of the 5th century, while it is certainly alluded to by Gregory of Tours (*ob.* 594) and Bebe. The so-called *Donation of Constantine* was long ago shown to be spurious, but the document is of very considerable antiquity and, in Döllinger's opinion, was forged in Rome between 752 and 777. It was certainly known to Pope Hadrian in 778, and was inserted in the false decretals towards the middle of the next century.

SILVESTER II., pope from 999 till 1003, and previously famous under his Christian name of Gerbert, first as a teacher and afterwards as archbishop successively of Rheims and Ravenna, was an Aquitanian by birth, and was educated from his boyhood at the abbey of St. Gerold in Aurillac. Here he seems to have had Gerald for his abbot and Raymond for his instructor, both of whom were among the most trusted correspondents of his later life. From Aurillac, while yet a young man (*adolescens*), he was carried off to the Spanish march by "Borrell, duke of Hither Spain" for the sake of prosecuting his studies in a district where learning, at that time, flourished more luxuriantly than in Aquitania. Borrell entrusted his young protegé to the care of a certain bishop Hatto, under whose instruction Gerbert made great progress in mathematics. In this duke we may certainly recognize Borel, who, according to the Spanish chroniclers, was count of Barcelona from 967 to 993, while the bishop may probably be identified with Hatto, bishop of Vich or Ausona from *c.* 960 to 971 or 972. In company with his two patrons Gerbert visited Rome, where the pope, hearing of the young student's proficiency in music and astronomy, induced him to remain in Italy, and before long introduced him to the emperor Otto I. A papal diploma, still extant, shows that Count Borel and Bishop Octo or Otho of Ausona were at Rome in January, 971, and, as all the other indications point to a corresponding year, enables us to fix the chronology of Gerbert's later life.

When brought before the emperor, Gerbert admitted his skill in all branches of the quadrivium, but lamented his comparative ignorance of logic. Eager to supply this deficiency he seized the opportunity of following Lothaire's ambassador Garamnus, archdeacon of Rheims, to this city, for the sake of studying under so famous a dialectician in the episcopal schools which were then (*c.* 972?) rising into reputation under the care of Archbishop Adalbero (969–989). So promising a scholar soon attracted the attention of Adalbero himself, and Gerbert was speedily invited to exchange his position of learner for that of teacher. At Rheims he seems to have studied and lectured for many years, having amongst his pupils, now or at a later time, Hugh Capet's son Robert, afterwards king of France, and Richer, to whose history we owe almost every detail of his master's early life. According to this writer Gerbert's fame began to spread over Western Europe, throughout Gaul, Germany, and Italy, till it roused the envy of a rival teacher, Otric of Saxony, in whom we may doubtless recognize Octricus of Magdeburg, the favorite scholar of Otto I., and, in earlier days, the instructor of St. Adalbert, the apostle of the Bohemians. Otric, suspecting that Gerbert erred in his classification of the sciences, sent one of his own pupils to Rheims to take notes of his lectures, and, finding his suspicions correct, accused him of his error before Otto II. The emperor, to whom Gerbert was well known, appointed a time for the two philosophers to argue before him; and Richer has left a long account of this dialectical tournament at Ravenna, which lasted out a whole day and was only terminated towards evening at the imperial bidding. The date of this controversy seems to have been about Christmas, 980, and it was probably followed almost immediately by Otric's death, October 1, 981.

It must have been about this time (*c.* 982) that Gerbert received the great abbey of Bobbio from the emperor. That it was Otto II., and not, as formerly supposed, Otto I., who gave him this benefice, seems evident from a diploma quoted by Mabillon (*Annales*, iv. 121). Richer, however, makes no mention of this event; and it is only from allusions in Gerbert's letters that we learn how the new abbot's attempts to enforce his dues waked a spirit of discontent which at last drove him in November, 983, to take refuge with his old patron Adalbero. It was to no purpose that he appealed to the emperor and empress for restitution or redress; and it was perhaps the hope of extorting his reappointment to Bobbio, as a reward for his services to the imperial cause, that changed the studious scholar of Rheims into the wily secretary of Adalbero. It was a time of great moment in the history of Western Europe. Otto II. died in December, 983, leaving the empire to his infant heir, Otto III. Lothaire claimed the guardianship, and attempted to make use of his position to serve his own purposes in Lorraine, which would in all probability have been lost to the empire had it not been for the indefatigable efforts of Adalbero and Gerbert. Into the obscure details of the succeeding years, as they have to be pieced together from the letters of Gerbert and the hints of Richer or the later annalists, there is no need to enter here. Gerbert's policy is to be identified with that of his metropolitan, and was strongly influenced by gratitude for the benefits that he had received from both the elder Ottos.

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[1] R. B. Chapman, *Financial Department of Government of India.*

According to M. Olleris's arrangement of the letters, Gerbert was at Mantua and Rome in 985. Then followed the death of Lothaire (2d March, 986) and of Louis V., the last Carolingian king, in May, 987. Later on in the same year Adalbero crowned Hugh Capet (1st June) and his son Robert (25th December). Such was the power of Adalbero and Gerbert in those days that it was said their influence alone sufficed to make and unmake kings. The archbishop died 23d January, 989, having, according to his secretary's account, designated Gerbert his successor before his decease. Notwithstanding this, the influence of the empress Theophania secured the appointment for Arnulf, a bastard son of Lothaire. The new prelate took the oath of fealty to Hugh Capet and persuaded Gerbert to remain with him. When Charles of Lorraine, Arnulf's uncle, and the illegitimate son of Louis D'Outremer, surprised Rheims in the autumn of the same year, Gerbert fell into his hands and for a time continued to serve Arnulf, who had now gone over to his uncle's side. He had, however, returned to his allegiance to the house of Capet before the fall of Laon placed both Arnulf and Charles at the mercy of the French king (*c.* 30th March, 991). Then followed the council of St. Basle, near Rheims, at which Arnulf confessed his treason and was degraded from his office (17th June, 991). In return for his services Gerbert was elected to succeed the deposed bishop.

The episcopate of the new metropolitan was marked by a vigor and activity that were felt not merely in his own diocese but as far as Tours, Orleans, and Paris. Meanwhile the friends of Arnulf appealed to Rome, and a papal legate was sent to investigate the question. As yet Hugh Capet maintained the cause of his nominee and forbade the prelates of his kingdom to be present at the council of Mouzon, near Sedan (June 2, 995). Notwithstanding this prohibition Gerbert appeared in his own behalf. The events of the next few years are somewhat obscure. Council seems to have followed council, but with uncertain results. At last Hugh Capet died in 996, and, shortly after, his son Robert married Bertha, the widow of Odo, count of Blois. The pope condemned this marriage as adulterous; and Abbo of Fleury, who visited Rome shortly after Gregory V.'s accession, is said to have procured the restoration of Arnulf at the new pontiff's demand. We may surmise that Gerbert left France towards the end of 995, as he was present at Otto III.'s coronation, May 21, 996. Somewhat later he became Otto's instructor in arithmetic, and had been appointed archbishop of Ravenna before May, 998. Early in the next year he was elected pope (April, 999), and took the title of Silvester II. In this capacity Gerbert showed the same energy that had characterized his former life. He is generally credited with having fostered the splendid vision of a restored empire that now began to fill the imagination of the young emperor, who is said to have confirmed the papal claims to eight counties in the Ancona march. Writing in the name of the desolate church at Jerusalem he called upon the warriors of Christendom to arm themselves in defence of the Holy City, once "the light of the world," but now fallen so low. Thus he sounds the first trumpet-call of the crusades, though almost a century was to pass away before his note was repeated by Peter the Hermit and Urban II.[1]

Nor did Silvester II. confine himself to plans on a large scale. He is also found confirming his old rival Arnulf in the see of Rheims; summoning Adalbero or Azelmus of Laon to Rome to answer for his crimes; judging between the archbishop of Mainz and the bishop of Hildesheim; besieging the revolted town of Cesena; flinging the count of Angoulême into prison for an offence against a bishop; confirming the privileges of Fulda abbey; granting charters to bishoprics far away on the Spanish mark; and, on the eastern borders of the empire, erecting Prague as the seat of an archbishopric for the Slavs. More remarkable than all his other acts is his letter to St. Stephen, king of Hungary, to whom he sent a golden crown, and whose kingdom he accepted as a fief of the Holy See. It must, however, be remarked that the genuineness of this letter, in which Gerbert to some extent foreshadows the temporal claims of Hildebrand and Innocent III., has been hotly contested, and that the original document has long been lost. All Gerbert's dreams for the advancement of church and empire were cut short by the death of Otto III., 4th February, 1002; and this event was followed a year later by the death of the pope himself, which took place 12th May, 1003. His body was buried in the church of St. John Lateran, where his tomb and inscription are yet to be seen.

A few words must be devoted to Silvester II. as regards his attitude to the Church of Rome and the learning of his age. He has left us two detailed accounts of the proceedings of the council of St. Basle; and, despite his reticence, it is impossible to doubt that he was the moving spirit in Arnulf's deposition. On the whole it may be said that his position in this question as to the rights of the papal see over foreign metropolitans resembled that of his great predecessor Hincmar, to whose authority he constantly appeals. But it is useless to seek in his writings for any definition of the relationship of these powers laid down with logical precision. He is rather the practiced debater who will admit his opponent's principles for the moment when he sees his way to moulding them to his own purposes, than the philosophical statesman who has formulated a theory from whose terms he will not move. Roughly sketched, his argument is as follows: Rome is indeed to be honored as the mother of churches; nor would Gerbert oppose her judgments except in two cases—(1) where she enjoins something that is contrary to the decrees of a universal council, such as that of Nice, or (2) where, after having been once appealed to in a matter of ecclesiastical discipline and having refused to give a plain and speedy decision, she should, at a later date, attempt to call in question the provisions of the metropolitan synod called to remedy the effects of her negligence. The decisions of a Gregory or a Leo the Great, of a Gelasius or an Innocent, prelates of holy life and unequalled wisdom, are accepted by the universal church; for, coming from such men, they cannot but be good. But who could recognize in the cruel and lustful popes of later days—in John XII. or Boniface VII., "monsters, as they were, of more than human iniquity,"—anything else than "Antichrist sitting in the temple of God and showing himself as God?" Gerbert proceeds to argue that the church councils admitted the right of metropolitan synods to depose unworthy bishops, but contends that, even if an appeal to Rome were necessary, that appeal had been made a year before without effect. This last clause prepares us to find him shifting his position still further at the council of Causey, where he advances the proposition that John XVI. was represented at St. Basle by his legate Seguin, archbishop of Sens, and that, owing to this, the decrees of the latter council had received the papal sanction. Far firmer is the tone of his later letter to the same archbishop, where he contends from historical evidence that the papal judgment is not infallible, and encourages his brother prelate not to fear excommunication in a righteous cause, for it is not in the power even of the successor of Peter "to separate an innocent priest from the love of Christ."

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[1] This letter, even if spurious as now suspected, is found in the 11th-century Leyden MS., and is, therefore, anterior to the first crusade.

Besides being the most distinguished statesman Gerbert was also the most accomplished scholar of his age. But in this aspect he is rather to be regarded as the diligent expositor of other men's views than as an original thinker. Except as regards philosophical and religious speculation, his writings show a range of interest and knowledge quite unparalleled in that generation. His pupil Richer has left us a detailed account of his system of teaching at Rheims. So far as the trivium is concerned, his text-books were Victorinus's translation of Porphyry's *Isagoge*, Aristotle's *Categories*, and Cicero's *Topics* with Manlius's *Commentaries*. From dialectics he urged his pupils to the study of rhetoric; but, recognizing the necessity of a large vocabulary, he accustomed them to read the Latin poets with care. Virgil, Statius, Terence, Juvenal, Horace, Persius, and Lucan are specially named as entering into a course of training which was rendered more stimulating by a free use of open discussion. More remarkable still were his methods of teaching the quadrivium. To assist his lectures on astronomy he constructed elaborate globes of the terrestrial and celestial spheres, on which the course of the planets was marked; for facilitating arithmetical and perhaps geometrical processes he constructed an abacus with twenty-seven divisions and a thousand counters of horn. A younger contemporary speaks of his having made a wonderful clock or sun-dial at Magdeburg; and we know from his letters that Gerbert was accustomed to exchange his globes for MSS. of those classical authors that his own library did not contain. More extraordinary still was his knowledge of music—an accomplishment which seems to have been his earliest recommendation to Otto I. Probably he was beyond his age in this science, for we read of Garamnus, his first tutor at Rheims, whom he attempted to ground in this subject: "Artis difficultate victus, a musica rejectus est." Gerbert's letters contain more than one allusion to organs which he seems to have constructed, and William of Malmesbury has preserved an account of a wonderful musical instrument still to be seen in his days at Rheims, which, so far as the English chronicler's words can be made out, seems to refer to an organ worked by steam. The same historian tells us that Gerbert borrowed from the Arabs (Saraceni) the abacus with ciphers (but see NUMERALS, vol. xvii. p. 642). Perhaps Gerbert's chief claim to the remembrance of posterity is to be found in the care and expense with which he gathered together MSS. of the classical writers. His love for literature was a passion. In the turmoil of his later life he looked back with regret to his student days; and "for all his troubles philosophy was his only cure." Everywhere—at Rome, at Treves, at Moutier-en-Der, at Gerona in Spain, at Barcelona—he had friends or agents to procure him copies of the great Latin writers for Bobbio or Rheims. To the abbot of Tours he writes that he is "laboring assiduously to form a library," and "throughout Italy, Germany, and Lorraine (Belgica) is spending vast sums of money in the acquisition of MSS." It is noteworthy, however, that Gerbert never writes for a copy of one of the Christian fathers, his aim being, seemingly, to preserve the fragments of a fast-perishing secular Latin literature. It is equally remarkable that, despite his residence on the Spanish mark, he shows no token of a knowledge of Arabic, a fact which is perhaps sufficient to overthrow the statement of his younger contemporary Adhemar as to his having studied at Cordova. There is hardly a trace to be found in his writings of any acquaintance with Greek.

So remarkable a character as that of Gerbert left its mark on the age, and fables soon began to cluster round his name. Towards the end of the 11th century Cardinal Benno, the opponent of Hildebrand, is said to have made him the first of a long line of magician popes. Orderic Vitalis improves this legend by details of an interview with the devil, who prophesied Gerbert's threefold elevation in the famous line that Gerbert's contemporaries attributed to the pope himself:

> Transit in R. Gerbertus in R. post papa vigens R.

A few years later William of Malmesbury adds a love adventure at Cordova, a compact with the devil, the story of a speaking statue that foretold Gerbert's death at Jerusalem—a prophecy fulfilled, somewhat as in the case of Henry IV. of England, by his dying in the Jerusalem church of Rome,—and that imaginative story of the statue with the legend "Strike here," which, after having found its way into the *Gesta Romanorum*, has of late been revived in the *Earthly Paradise*.

Gerbert's extant works may be divided into five classes. (*a*) A collection of letters, some 230 in number. These are to be found for the most part in an 11th century MS. at Leyden. Other important MSS. are those of the Barberini Library at Rome (late 16th century), of Middlehill (17th century), and of St. Peter's abbey, Salzburg. With the letters may be grouped the papal decrees of Gerbert when Silvester II. (*b*) The *Acta Concilii Remensis ad Sanctum Basolum*, a detailed account of the proceedings and discourses at the great council of St. Basle; a shorter account of his apologetic speeches at the councils of Mouzon and Causey; and drafts of the decrees of two or three other councils or imperial constitutions promulgated when he was archbishop of Ravenna or pope. The important works on the three above-mentioned councils are to be found in the 11th century Leyden MS. just alluded to. (*c*) Gerbert's theological works comprise a *Sermo de Informatione Episcoporum* and a treatise entitled *De Corpore et Sanguine Domini*, both of very doubtful authenticity. (*d*) Of his philosophical works we only have one, *Libellus de Rationali et Ratione uti*, written at the request of Otto III. and preserved in an 11th century MS. at Paris. (*e*) His mathematical works consist of a *Regula de Abaco Computi*, of which a 12th-century MS. is to be found at the Vatican; and a *Libellus de Numerorum Divisione* (11th and 12th century MSS. at Rome, Montpellier, and Paris), dedicated to his friend and correspondent Constantine of Fleury. A long treatise on geometry, attributed to Gerbert, is of somewhat doubtful authenticity. To these may be added a very short disquisition on the same subject addressed to Adalbold, and a similar one, on one of his own spheres, addressed to Constantine, abbot of Micy. All the writings of Gerbert are collected in the edition of M. Olleris. (T. A. A.)

SILVESTER III. When Boniface IX. was driven from Rome early in January, 1044, John, bishop of Sabina, was elected in his stead and took the title of Silvester III. Within three months Boniface returned and expelled his rival. Nearly three years later (December, 1046) the council of Sutri deprived him of his bishopric and priesthood. He was then sent to a monastery, where he seems to have died.

SIMANCAS, a walled town of Spain, 8½ miles southwest from Valladolid, on the road to Zamora, is situated on the Pisuerga, here crossed by a fine bridge of seventeen arches. The population within the municipal boundaries was 1258 in 1885. In the northwestern angle of the town stands the Archivo General del Reino, originally a fortified castle, to which the national archives of Spain were removed in 1563 (the suggestion was due to Ximenez). The extensive architectural alterations and repairs which were necessary were made under the direction of Herrera, Berruguete and Mora, and the arrangement of the papers was entrusted to Diego de Ayala. They now occupy forty-six rooms and are arranged in upwards of 80,000 bundles (30,000,000 documents), including important private as well as state papers, ambassadors' correspondence, and the like. The archives of the Indies, originally lodged here, were transferred in the 18th century to the Lonja of Seville. Permission to consult the documents at Simancas can now be readily obtained.

SIMBIRSK, a government of eastern Russia, on the right bank of the middle Volga, with Kazañ on the N., Samara on the E., Saratoff on the S., and Penza and Nijni-Novgorod on the W., has an area of 19,110 square miles, and a population (1882) of 1,471,164. It is occupied by the eastern parts of the great central plateau of middle Russia, which slowly rises towards the south, and gently slopes in the north towards the great Oka depression of the middle Volga. Its higher parts range from 750 to 1000 feet above the sea, and form the Zheguleff range of hills, which compel the Volga to make its great bend at Samara; while the numerous valleys and ravines which intersect it, and are excavated to a depth of 700 to 800 feet, give quite a hilly aspect to several parts of it, especially in the east, where it descends with abrupt crags towards the broad valley of the Volga. In the west a broad depression, traversed by numerous rivers and streams, extends along the left bank of the Sura. All geological formations, from the Carboniferous upwards, are met with in Simbirsk. The Volga flows for 300 miles along the eastern boundary, separating Simbirsk from Samara. The shallow Sviyaga rises in the Samarskaya Luka Hills and flows parallel to the Volga, at a distance of 2 to 20 miles, but in an opposite direction. The Sura, also flowing northwards, waters the western part of Simbirsk; it is navigable for more than 270 miles, and, as it is free from ice earlier than the Volga and flows towards central Russia, goods are sometimes transported by land to the Sura to be shipped on it when speedy transport is desired. Its tributaries—the Barysh, Alatyr (100 miles), Piyana, and others—are not navigable. The Usa (80 miles) and the Syzrañ (100 miles) flow east and join the Volga below the Samara bend. A few lakes and marshes are met with in the west of the government. The forests, although rapidly disappearing, still cover 3,894,800 acres, while of the remainder 5,930,600 acres are arable, 1,150,800 acres prairie and pasture land, and 605,600 acres, uncultivable. In the north excellent forests of timber cover large areas, but in the south they are rare. The climate is severe, and the extremes are great. At Simbirsk the average temperature is 38.7°, but the thermometer sometimes reaches 114° F., and frosts of —47° F. are not uncommon; the average rain and snow fall is only 17.6 inches. South of the Samara Hills the climate is much less severe, and gardening, which is prosecuted with great difficulty in the north, flourishes there.

The population, which was but 1,192,510 in 1867, had reached 1,471,164 in 1882, of whom only 100,740 lived in towns. The greater number (about two-thirds) are Great Russians, the remainder being Mordvinians (13 per cent.), Tchuvashes (9.3 per cent.), and Tartars (8.3 per cent.), with about 1000 Jews. The Mordvinians are chiefly settled in the northwest, in Ardatoff and Alatyr (40 and 26 per cent. of population), and on the Volga in Senghilei; the Tchuvashes make about one-third of the population of the districts of Buinsk and Kurmysh, contiguous to Kazañ; the Tartars constitute about 35 per cent. in Buinsk and 18 per cent. in Senghilei. Only the Tartars (about 100,000) are Mohammedans, the remainder being Greek-Orthodox or Dissenters. As in other Volga governments, the villages in Simbirsk are mostly large, many of them having from 3000 to 5000 inhabitants. Agriculture, favored by a fertile soil, is the chief occupation, grain being exported or manufactured into spirit. Linseed and hempseed are cultivated for exportation, as also kitchen-garden produce and some fruit. Bee-keeping is a favorite and remunerative occupation with Mordvinians, and fishing (sturgeon) is carried on in the Volga and the Sura. The timber-trade in the north and the shipbuilding on the Sura are considerable sources of wealth; wooden sledges and wheels are made and exported, as well as bags of lime-tree bast,—the last-named industry giving occupation to whole villages. Other petty trades, also carried on in conjunction with agriculture, are the manufacture of felts and felt hats, linen stuffs (especially among the Mordvinians), cottons, boots, and small metal wares. A characteristic feature of Simbirsk is the trade in wooden vessels, which are exported to Vyatka, Perm, Orenburg, Samara, and the Don, and there exchanged for cat, squirrel and hare skins. Flour mills are numerous. Watered by the Volga and Sura, and moreover traversed in its southern portion by the railway connecting Orenburg and Samara with Penza and Ryazañ, by Batraki and Syzrañ, the government has an active trade. Its exports, however, are much below those of Samara and Saratoff. Batraki and Syzrañ are important centres of traffic, the aggregate amount of merchandise entered and cleared by rail and boat being respectively 2,435,000 and 2,000,000 cwts. (timber not included). The chief ports of lading on the Sura are Alatyr, Promzino-Gorodische, and Berezniki, each with exports valued at about 750,000 roubles [$364,500]. Corn, linseed, woollen stuffs, timber, potash, and wooden wares are the principal articles of trade.

Simbirsk is very backward as regards education. There were in 1882 only 462 schools (17,795 boys and 2663 girls) and 8 secondary schools (497 male and 516 female pupils).

The government is divided into eight districts, the chief towns of which, with their populations in 1880, are—Simbirsk (36,600), Alatyr (15,000), Ardatoff (4740), Buinsk (4130), Karsuñ (3740), Kurmysh (1930), Senghilei (3500), and Syzrañ (24,500). Kotyakoff (580), and Tagai (2400), have municipal institutions. The above-mentioned ports of lading are more important than most of the towns.

The first Russian settlers made their appearance in the Simbirsk region in the 14th century, but did not extend east of the Sura. Not till two centuries later did they cross the Sura and the district begin to be peopled by refugees from Moscow. The Zheguleff Mountains in the south still continuing to be a place of refuge for the criminal and the persecuted, Simbirsk was founded in 1648, and a palisaded earthen wall was built, running southwest of the new town, with small forts extending to the Sura. The region thus protected was soon settled, and, as the Russian villages advanced further south, Syzrañ was founded, and a second line of small forts, extending also towards the Sura, was erected. The colonizers settled rapidly, and the aboriginal Mordvinians soon adopted many of their customs, so as to lose their ethnographical individuality, especially within the last fifty years. Simbirsk received the name of an old Tartar settlement, Sinbir, situated 9 miles south of the present town, on the opposite bank of the Volga.

SIMBIRSK, capital of the above government, is situated 576 miles east-southeast of Moscow, between the Volga and the Sviyaga, here separated by an isthmus only 2 miles broad. The central part of Simbirsk —the Crown (Vyenets), containing the cathedral and the best houses—is built on a hill 560 feet above the Volga, whence there is a beautiful view over the low left bank of the river. Adjoining is the trading part of Simbirsk, while farther down on the slope, towards the Volga, are scattered the store-houses, the shops for the sale of stoneware and other merchandise brought by the steamers and boats, and the poorest suburbs of the city; these last also occupy the western slope towards the Sviyaga. There are three suburbs on the left bank of the Volga, communication with them being maintained in summer by steamers. A great fire having destroyed nearly all the town in 1864, it has been again built on a new plan, still mostly of wood. The cathedral of St. Nicholas dates from 1712. The new one, that of the Trinity, was erected by the nobility in commemoration of 1812. The old church of St. Nicholas on the Karamzin Square is architecturally pleasing. A public garden has been laid out on the top of the Vyenets Hill and another in the outskirts of the city, while no fewer than three hundred private gardens, where fruits are grown for exportation, are scattered throughout the town. The historian Karamzin (born in 1766 in the vicinity of Simbirsk) has a monument here, and a public library bearing his name contains about 15,000 volumes. Gardening and fishing occupy many of the inhabitants. The trade is brisk, corn being the principal item, while next come potash, wool, fruits, wooden wares, and manufactured produce. The Simbirsk fair, having a turnover of some 6 million roubles, still maintains its importance. The population (24,600 in 1867) was 36.600 in 1880.

SIMEON (שִׁמְעוֹן), second son of Jacob by Leah (Gen. xxix. 33). The tribe of Simeon, like that of Levi, was broken up at a very early period, under circumstances of which we have some indication in Gen. xxxiv. and xlix. (see ISRAEL, vol. xiii. p. 411, and LEVITES). In Judges i. the Simeonites appear as sharing the conquests of Judah in the extreme south of Canaan, but there is no mention of them in this region in 1 Sam. xxx., and the tribe is not named at all in the blessing of Moses. It reappears, however, in 1 Chron. iv. 24–43 (*cf.* xii. 25), and is reckoned to the kingdom of Ephraim (2 Chron. xv. 9; xxxiv. 6). The Arabian wars of Simeon spoken of in 1 Chron. iv. have been connected by Hitzig and others with a supposed Israelite kingdom of Massa, which they find in Prov. xxxi. 1, translating "Lemuel, king of Massa," and comparing Gen. xxv. 14 and Isa. xxi. 11 *sq.*, where, however, it is quite gratuitous to suppose an embassy to the prophet from Israelites in Arabia. The whole speculation and the further development of Dozy (*The Israelites in Mecca*) is fanciful; *cf.* Wellhausen, *Prolegomena*, Eng. tr., pp. 212 *sq.* The heroine of the book of Judith is made to be of the tribe of Simeon, but this book is quite unhistorical.

SIMEON OF DURHAM. See SYMEON.

SIMEON STYLITES. See MONACHISM, vol. xvi. p. 727.

SIMFEROPOL, the capital of the Russian government of Taurida, is situated in the southwestern part of the Crimea, on the Salghir (which frequently becomes dry), 900 miles from Moscow. Occupying an admirable site on the northern slopes of the Tchatyrdagh, it has on the eastern side many beautiful gardens, and is divided into two parts,—the European, well built in stone, and the Tartar, which consists of narrow and filthy streets peopled by Tartars and Jews. Although it has grown somewhat since the railway brought it into connection with the rest of the empire, it still remains a mere administrative centre, without either manufacturing or commercial importance. The population was 16,550 in 1866 and 29,030 in 1881.

In the neighborhood stood the small fortress Napoli, erected by Skilur, the ruler of Taurida, some hundred years before the Christian era, which existed until the end of the 3d century. Afterwards the Tartars had here their settlement Ak-metchet, which was in the 17th century the residence of the chief military commander of the khan, and had the name of Sultan-serai. In 1736 it was taken and burnt by the Russians, and in 1784, after the conquest of Crimea by the Russians, it received its present name and became the capital of Taurida.

SIMLA, a small district in the lieutenant-governorship of the Punjab, India, situated among the hills of the lower Himalayan system in 31° 6′ N. lat. and 77° 11′ E. long. It consists of several detached plots of territory, together comprising an area of only 18 square miles. The mountains of Simla and the surrounding native states compose the southern outliers of the great central chain of the eastern Himalayas. They descend in a gradual series from the main chain to the general level of the Punjab plain, forming a transverse southwesterly spur between the great basins of the Ganges and the Indus. A few miles northeast of Simla the spur divides into two main ridges, one following the line of the Sutlej in a northwesterly direction, and the other, crowned by the sanatorium of Simla, trending southeastwards, till it meets at right angles the mountains of the outer Himalayan system. South and east of Simla the hills between the Sutlej and the Tons centre in the great peak of Chor, 11,982 feet above the sea. Throughout all the hills forests of deodar abound, while rhododendrons clothe the slopes up to the limit of perpetual snow. The principal rivers here are the Sutlej, Pabar, Giri Ganga, Chambar, and Sarsa. The scenery of the immediate neighborhood of Simla is very grand and picturesque, presenting a series of magnificent views. The climate is considered highly salubrious and admirably adapted to European constitutions; the district has therefore been selected as the site of numerous sanatoria and cantonments. The average annual rainfall amounts to about 72 inches.

The population of the district in 1881 was 42,945 (males 27,593, females 15,352); Hindus numbered 32,428 Mohammedans 6935, and Christians 3353. Cultivation is widely carried on in all the lower valleys of the hills, and the fields are sown with maize, pulses, or millet for the autumn and with wheat for the spring harvest. Poppy, hemp, turmeric, ginger, and potatoes form the principal staples raised for exportation to the plains. The trade of the district centres mainly in the bazaars of Simla, which forms a considerable entrepôt for the produce of the hills. Another important trade-centre is the town of Rampur on the Sutlej, from which the great part of the shawl-wool (*pashm*) finds its way for exportation to British India.

The acquisition of the patches of territory forming the district dates from various times subsequent to the close of the Gúrkha War in 1815–16, which left the British in possession of the whole tract of hill-country from the Gogra to the Sutlej. Kumáun and Dehra Dun were annexed to the British dominions, but the rest, with the exception of a few localities retained as military posts and a portion sold to the raja of Patiála, was restored to the hill rajas, from whom it had been wrested by the Gúrkhas. Garhwal state became attached to the Northwestern Provinces, but the remaining principalities rank among the dependencies of the Punjab, and are known collectively as the Simla Hill States, under the superintendence of the deputy-commissioner of Simla, subordinate to the commissioner at Ambálá.

SIMLA, the administrative headquarters of the above district, and the summer capital of India, stands at an elevation of 7084 feet above sea level. Since the administration of Sir John Lawrence (1864) it has been the resort, during the hot weather, of the successive governors general of India, with their secretaries and headquarters establishments. In 1881 it had a population of 13,258.

SIMMS, WILLIAM GILMORE (1806–1870), an American poet, novelist, and historian, was born at Charleston, S. C., April 17, 1806, of Scoto-Irish descent. His mother died during his infancy, and his father having failed in business, and joined Coffee's brigade of mounted Indian fighters, which kept him in the Seminole country, young Simms was brought up by his grandmother, who gave him as good an education as her limited means would allow. He was clerk in a drug store for some years, and afterwards studied law, the bar of Charleston admitting him to practice in 1827, but he soon abandoned his profession for literature. At the age of eight he wrote verses, and in his 19th year he produced a *Monody on Gen. Charles Cotesworth Pinckney*. Two years later, in 1827, *Lyrical and Other Poems* and *Early Lays* appeared; and in 1828 he began journalism, editing with conspicuous ability and partly owning the *City Gazette*—a paper opposed to the doctrine of nullification. The enterprise failed, and the editor devoted his attention entirely to letters, and in rapid succession published *The Vision of Cortes, Cain, and other Poems* (1829), *The Tricolor, or Three Days of Blood in Paris* (1830), and his strongest poem, *Atalantis*, a story of the sea (1832). *Atalantis* established his fame as an author, and *Martin Faber*, the story of a criminal, his first tale, written in the following year, was warmly received. From this time forward his writings became very abundant; a classified list is given below. Though sensational and full of excessive coloring, they are held in good repute in the Southern States. During the American Civil War Simms espoused the side of the Secessionists in a weekly newspaper, and suffered damage at the hands of the Federal troops when they entered Charleston. He held a seat in the State legislature for some years, and the university of Alabama conferred on him the degree of LL.D. He died at Charleston on 11th June, 1870.

In addition to the works mentioned above, Simms published the following poetry: *Southern Passages and Pictures*, lyrical, sentimental, and descriptive poems, 1839; *Donna Florida*, 1843; *Grouped Thoughts and Scattered Fancies*, sonnets, 1845; *Areytos, or Songs of the South*, 1846; *Lays of the Palmetto*, 1848; *The Eye and the Wing*, 1848; *The Cassique of Accabee, a Tale of Ashley River*, with other pieces, 1849; *The City of the Silent*, 1850. To dramatic literature he contributed *Norman Maurice, or the Man of the People; Michael Bonham, or the Fall of the Alamo;* and a stage adaptation of *Timon of Athens*, all of which have been acted with success. His revolutionary romances are—*The Partisan*, 1835; *Mellichampe*, 1836; *Katherine Walton, or the Rebel of Dorchester*, 1851; *The Scout* (originally *The Kinsman*), *or the Black Riders of the Congaree*, 1841; *Woodcraft* (originally named *The Sword and the Distaff*), and *Eutaw*, 1856. These tales describe social life at Charleston, and the action covers the whole revolutionary period, with faithful portraits of the political and military leaders of the time. Of border tales the list includes *Guy Rivers, a Tale of Georgia*, 1834; *Richard Hurdis*, 1838; *Border Beagles*, 1840; *Beauchampe*, 1842; *Helen Halsey*, 1845; *The Golden Christmas*, 1852; and *Charlemont*, 1856. The historical romances are *The Yemassee*, 1835, by far the greatest of his works, and dealing largely with Indian character and nature; *Pelayo*, 1838; *Count Julien*, 1845; *The Damsel of Darien*, 1845; *The Lily and the Totem; Vasconselos*, 1857, which he wrote under the assumed name of "Frank Cooper"; and *The Cassique of Kiawah*, 1860. Other novels, belonging to the series of which *Martin Faber* was the first, and treating principally of domestic life and motive, are *Carl Werner*, 1838; *Confession of the Blind Heart*, 1842; *The Wigwam and the Cabin*, a collection of short tales, 1845–46; *Castle Dismal*, 1845; and *Marie de Berniere*, 1853. Simms's other writings comprise a *History of South Carolina*, 1840; *South Carolina in the Revolution*, 1854; *A Geography of South Carolina;* lives of *Francis Marion, Capt. John Smith, The Chevalier Bayard* and *General Greene; The Ghost of my Husband*, 1866; and *War Poetry of the South*,—an edited volume,—1867. Simms was also a frequent contributor to the magazines and literary papers, six of which he founded and conducted. He wrote on a great variety of subjects, and discussed with spirit and boldness the leading political, social, and literary topics of the day. In the discussion on slavery he upheld the views of the pro-slavery party. He edited the seven dramas ascribed to Shakespeare, with notes and an introduction to each play. In the capacity of lecturer and orator, he was in frequent request on public occasions. His principal orations are *The Social Principle the True Secret of National Permanence*, 1842; *The True Sources of American Independence*, 1844; *Self-Development*, 1847; *Poetry of the Practical; The Battle of Fort Moultrie;* and *The Moral Character of Hamlet*.

SIMON MAGUS. In the extant documents of the first three centuries we meet with Simon Magus in a threefold aspect: (1) as Samaritan Messiah attempting by the aid of Christianity to establish a new religion; (2) as founder of a school of Gnostics and as father of heresy; (3) as a caricature of the apostle Paul. The Tübingen critics (Baur, Volkmar, Zeller, Lipsius, and until the year 1878 Hilgenfeld also) have tried to show that the oldest accounts are those in which Simon is represented in the last-named aspect; they have accordingly denied his existence, maintaining that all the features attributed to him in the oldest sources are accounted for by the life and personality of Paul. In particular they would explain Simon's visit to Rome by the apostle's journey thither, and further would have it that the church tradition of Peter's having gone to Rome arose solely out of the supposition that the great apostle who had withstood the Paul-Simon everywhere else must have followed up his victory in the capital of the world also. According to this view, Simon Magus is an invention of the Jewish Christians, a distorted Paul, whom the church at large partly accepted as historical and partly catholicized, adding fresh touches to the picture of Simon, making him the father of all the heresies, the head of all the magi, a pseudo-Messiah, and so forth, but at last destroying the whole point of the story by adding that Peter and Paul had jointly overcome the magian in Rome.

Were this view of the Tübingen critics established, their whole conception of apostolic and post-apostolic times would also be proved; it would have been made out (1) that legends of an anti-Pauline tendency form the basis of the tradition of the church; (2) that the Acts of the Apostles is a compromise and rests upon Jewish-Christian myths in part no longer understood; (3) that the ecclesiastical tradition about Peter's journeyings had its origin merely in those of Paul; and (4) there would be established an indisputable example of the production of biassed and fabricated history within primitive Christianity so remarkable that upon the ground of it alone we should be justified in simply regarding the greater part of the historical statements of the first two Christian centuries as deliberate inventions.

But on no other point are the proofs of the Tübingen school weaker than in this. Only by inverting the historical order of the original documents, by dint of violent assertion, and by declaring with reference to the most important arguments that they existed in writings which now are lost, has it been possible for them to give even the appearance of stability to their hypothetical structure. The three assertions of the Tübingen critics—(1) that the written sources of the pseudo-Clementine *Homilies* and *Recognitions* go back to the 1st century, (2) that already in these Paul has become distorted into Simon Magus and Peter is represented as having combated the Simon-Paul in Rome, and (3) that the Acts of the Apostles, Justin, and other church fathers in their statements about Simon and about Peter's stay in Rome depend upon these Jewish-Christian writings—can none of them be proved. On the other hand,—apart from the Acts of the Apostles,—the existence of a Samaritan magus, Simon, in apostolic times, as well as of a sect of Simonians in the 2d century (in Samaria, and elsewhere in the Roman empire), is quite conclusively attested through Justin Martyr, and also through Celsus, Clement, Hippolytus, and Origen.[1] Even the Tübingen critics themselves could not deny the existence of a sect of Simonians; they have therefore been obliged to advance the desperate theory that the sect arose solely on the basis of the Jewish-Christian romance of Simon.

The oldest account of Simon Magus occurs in the Acts of the Apostles. When Philip the evangelist came to Samaria about 37 A.D. he found a great religious movement going on. One named Simon had given himself out for some great person, and by dint of his extraordinary works had stirred up and gained over the whole population, who took him for the exalted manifestation of the Divine Power itself. Philip converted the majority of Simon's adherents; and Simon himself, amazed at the deeds wrought by Philip, received baptism and joined the evangelist's society. Peter and John then came to Samaria to impart to the baptized the Holy Ghost by the laying on of hands; and Simon offered the apostles money to invest him with a like power of conferring the gift. But Peter sternly rebuked him, exhorting him to repent and beseech God that the evil thought of his heart might be forgiven him. Simon thereupon begged the apostles to pray on his behalf. We have no means of checking this account, since we possess no other independent source. The author of the Acts seems to have known nothing of Simon Magus from other quarters, else he would hardly have closed the narrative as we have it. Simon is not yet viewed as hostile to Christianity. There is no justification for doubt as regards the main points of this account. That in the fourth decade of the 1st century a pseudo-Messiah, named Simon, appeared in Samaria; that he gained a considerable following; that he tried to effect a union with the Christian missionaries, who, however, soon perceived his real character and shook him off,—these facts must be treated as historical.[2] They are vouched for by Justin, whose statement is not borrowed from the Acts.[3] Justin, it is true, makes no direct statement about any relations whatever between Simon and Christianity, but represents him as one who gave himself out for God and as the founder of an entirely new religion; but, since on the other hand he groups him with Menander and Marcion, and thinks of him as the devil-sent father of heretics, it is plain that he knew quite well of some relation between Simon and the Christians.

The conception of Simon as the father of heresy within the church is in no way suggested in the Acts; nor has Justin in the writings which we possess given any hint of a reason why Simon should be viewed in such a light. But the testimony of the Acts (viii. 13) that Simon received baptism, and for a while joined himself to the Christians, enables us at least in some degree to understand how he afterwards got the reputation alluded to. We shall see presently, moreover, that Simon must have introduced certain Christian elements into his teaching.[1]

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[1] The testimony of Justin derives its great importance from the fact that he was himself a Samaritan; he says expressly (*Apol.*, ii. 15; see also *Dial.*, 120), τοῦ ἐν τῷ ἐμῷ ἔθνει ἀσεβοῦς καὶ πλάνου Σιμωνιανοῦ διδάγματος κατεφρόνησα. In *Apol.*, i. 26 he makes direct reference to Simon (see also i. 56), and remarks, καὶ σχέδον πάντες μὲν Σαμαρεῖς, ὀλίγοι δὲ καὶ ἐν ἄλλοις ἔθνεσιν, ὡς τὸν πρῶτον θεὸν Σίμωνα ὁμολογοῦντες, Σίμωνα καὶ προσκυνοῦσι. Celsus (quoted in Orig., *C. Cels.*, v. 62) alludes to a sect of Simonians, and says they were also called Helenians; Irenæus (*Adv. Hær.*, i. 23) is acquainted with the ritual and writings of this sect: Hippolytus (*Philosoph.*, vi. 7-20) gives extracts from a Simonian book 'Απόφασις μεγάλη. Particularly interesting is the testimony of Origen (*C. Cels.*, i. 57; *cf.* vi. 11): "Also Simon Magus, the Samaritan, wished to gain disciples by his magical arts. His impositions were virtually without result at the time, while at present, in my belief, the number of his adherents throughout the world does not amount to thirty. And perhaps this estimate is too high. At most there are only a few in Palestine, while in the other parts of the world where he desired to make his name illustrious it is quite unknown. Where it is known, the fact is entirely due to the Acts of the Apostles. Christians alone still speak of him." Some would fain find a testimony in Josephus also; but the Jewish conjurer Simon, of Cyprus, mentioned in *Ant.*, xx. 7 has nothing whatever to do with the Samaritan. Renan would recognize Simon Magus in the second beast of Rev. xiii.; but this hypothesis is utterly baseless.

[2] The same historical certainty cannot be claimed for the meeting of Peter and Simon, because in the Acts (ch. i.-xv.) Peter is throughout pushed to the front, and because the motive assigned for his journey to Samaria is open to some suspicion. Still, the fact that even in the Jewish-Christian Acts of the Apostles Peter and Simon have personal dealings affords presumptive evidence that they did meet.

[3] Unfortunately, Justin's *Syntagma* against the heretics, in which he dealt at greater length with Simon, is no longer extant: we are therefore limited to the meagre references in his *Apology* and *Dialogue* and the statements of later writers who had read the *Syntagma*.

Justin has a good deal more about Simon that is not to be found in Acts: (1) he gives his birthplace as Gittha in Samaria; (2) he states that Simon came to Rome in the reign of Claudius, and there by his magical arts gained some followers and was taken for a god, and that a statue was erected to him on the Tiber Island with the inscription SIMONI DEO SANCTO; and (3) he states that the adherents of Simon passed off a woman named Helena, whom he brought to Rome with him, and who had previously been a prostitute in Tyre,[2] as the "first idea" (πρώτη ἔννοια) of Simon.

As regards the first of these statements we may point to a Samaritan village "Gît" (Karjet-Gît) not quite 3 miles south-southwest from the town of Samaria.[3] Justin's account in this particular seems trustworthy. On the other hand, the allegation that a statue was erected to Simon in Rome is not authentic,[4] and consequently most critics have regarded the narrative of Simon's journey to Rome as legendary. Some suppose that Justin was led only through the words of the inscription which he has wrongly referred to Simon to believe that Simon himself was in Rome; others (the Tübingen critics) think, on the contrary, that Justin had been already acquainted with the Jewish-Christian Acts of the Apostles, and had thence learned that Simon (Paul) had gone to Rome and that the inscription, therefore, only confirmed him in the belief of Simon's presence there. But in either case the distinct assertion of Justin that Simon went to Rome in the time of Claudius remains unexplained; for the hypothesis that Justin added the arrival of Simon under Claudius because he already knew and credited the legend of Peter's having lived twenty-five years in Rome deserves no refutation. Consequently we may assume—seeing there is absolutely no trace of any influence of the Jewish-Christian legend upon Justin—that in the Roman community, in the time of that author, a tradition was current that Simon Magus visited Rome in the reign of Claudius. We are no longer in a position to test the trustworthiness of this tradition; but, seeing there is no indication of any tendency out of which it could have arisen, we have no ground for declaring it incredible. The fact attested by Justin, Celsus, and Origen, that there were Simonians also beyond the limits of Samaria (ἐν ἄλλοις ἔθνεσιν), favors the view that Simon had travelled. With reference, lastly, to the statement about Helena, we have to observe that here Justin has reported a doctrine not of Simon but of the Simonians. Simon, we are to understand, came to Rome with a woman named Helena, and his adherents afterwards took her for the æon mentioned. Justin gave fuller accounts of Helena and the doctrines of the Simonians in his *Syntagma*; and we know their substance from Hegesippus, Irenæus, Tertullian, pseudo-Tertullian, Epiphanius, and Philastrius. Simon, it would appear, declared himself to be "the highest power"—the Supreme God Himself; he taught that among the Jews he manifested himself as the Son, in Samaria as the Father, and among other nations as the Holy Spirit. Helena, whom he had purchased in a brothel at Tyre, he gave out to be his πρώτη ἔννοια, the mother of all, by whom he had called the angels and archangels into being. She had proceeded from him, had been initiated into his purposes, had voluntarily come down from heaven and become the mother of the angels and powers who created this world; but after the completion of her work she had been laid under bonds by her own children, the world-creating angels, who desired to be independent, and who knew not the first father Simon; they imprisoned her in a human body, and subjected her to every affront; she had to migrate out of one body into another; she became, *e.g.*, that Helen on whose account the Trojan War was waged; finally she found herself in a brothel, out of which Simon at length rescued her, thereby fulfilling the parable of the lost sheep. The supreme god—Simon—had come down in order to redeem his πρώτη ἔννοια, and to bring salvation to all men through the knowledge of himself. He decided upon this descent on seeing that the angels, from their desire for supremacy, were in conflict with each other and were misgoverning the worlds. He assumed every form necessary for the restoration of lost harmony: to men he appeared as man, without being really a man, and in appearance he suffered in Judæa. Henceforth it was a duty to believe in Simon and Helena, but to disbelieve the prophets, who were inspired by the world-creating angels, and not by Simon. Believers in Simon are at liberty to do what they will, for by the grace of Simon should men be blessed—but not on account of good works. Should a Simonian do anything wicked he is nevertheless undeserving of punishment, for he is not wicked by nature but only of his free-will; the law proceeded from the world-creating angels, who thought thereby to enslave their subjects; Simon, however, will bring the world to nought along with the dominion of those angels, and save all who believe on him. To this it is added that the Simonians live dissolutely, vie with each other in the practice of magic, make use of exorcisms, charms, mystic formulas, etc., and further that they worship images of Simon (as Zeus) and of Helena (as Athene), under the names of "The Lord" and "The Lady."

We may regard this account, which, according to Irenæus, is partly based upon direct statements of the Simonians themselves, as essentially derived from the *Syntagma* of Justin.[5] That we have here before us, not the genuine teaching of Simon, but the gnosis of the Simonians is very evident; this gnosis, however, is just as much bound up with the person of Simon as is the Christian gnosis with the person of Jesus Christ. Simon is the manifested Deity Himself; but—and herein lies the Christian, or more properly the anti-Christian element—Simon is at the same time represented as Christ, *i.e.*, is identified with Christ. The fusing together of Simon and Christ, a syncretistic-gnostic conception of the world and its creation, and an ethical antinomianism are the distinctive features of this new universal religion. That we have here an attempt to found a new religion, and that a world-religion, upon the principle of embodying all important articles of the older ones, appears also from the fact that Simon is identified not only with Christ but also with Zeus, and that Greek legends and mythologies are utilized for the system. We have, therefore, in Simonianism a rival system to Christianity, in which the same advantages are offered, and in which accordingly Christian elements are embodied, even Christ

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[1] Justin repeatedly and emphatically says that Simon pretended to be a god, and was regarded by his adherents as the Supreme God; see *Dial.*, 120.

[2] This does not come directly from the extant manuscript of Justin's *Apology*, but from Eusebius's quotations (Euseb., *H. E.*, ii. 13).

[3] See Lipsius, *Quellen der röm. Petrussage*, p. 34.

[4] A happy accident of the rarest kind has put us in a position to correct Justin's statement. In 1574 a stone which had once served as the base of a statue was dug out upon the Tiber Island. It bore the following inscription: SEMONI SANCO DEO . FIDIO SACRVM (see Orelli, *Inscr.*, vol. i. p. 337 n., 1860). "Semo Sancus" is a Sabine god (Ovid, *Fast.*, vi. 213 *sq.*; Lactantius, *Inst. Div.*, i. c. 15). The inscription having been found in the very place where, according to Justin, Simon's statue must have stood, most scholars suppose, and rightly, that Justin by mistake confounded "Semo Sancus" with "Simon Sanctus."

[5] This work must also have had something to say about the relations of Simon to other Samaritan pseudo-Messiahs, viz., to Dositheus, Cleobulus, and Menander (see Hegesippus, quoted by Eusebius, *H.E.*, iv. 22); but the nature of its statements can no longer be with certainty ascertained. We are in the dark especially as to the relation between Simon and Dositheus. But the mere fact that in Samaria, in the time of the apostles, so many Messiahs purporting to be founders of religions should have appeared on the scene is extremely interesting. It is a very noteworthy circumstance also that Justin, Hegesippus, and Irenæus knew nothing about Peter having met Simon in Rome, and having withstood him there.

Himself being identified with the Supreme God (Simon). The attempt to establish such a system in that time of religious syncretism has nothing incredible about it; and in view of the religious conditions then prevailing in the locality it can easily be understood that it proceeded from a Samaritan. The basis of it was laid by Simon himself, who claimed to be a god and yet derived something from the Christian missionaries, but the development was due to his followers in the 2d century, who may have borne to the original Simonians exactly the same relation as did the Valentinians to the first Christians. From the circles of these later Simonians, who worshipped Simon especially under the mysterious name of "The Standing,"[1] a book was issued bearing the title 'Η *ἀποφάσις ἡ μεγάλη*, from which Hippolytus has given us extracts in the *Philosophumena*. From these it appears—as indeed might have been expected from the statements of Irenæus (Justin)—that the later Simonianism combined the worship of Simon with a complicated Gnostic system, for which it utilized the Greek mythology, as well as isolated sayings of the Old Testament, of the Gospels, and of the apostolic epistles. In point of form, design, medium, and relationship to Christianity, Simonianism bears a striking resemblance to Manichæism, which sprang up two centuries later; but Mani did not so bluntly as Simon lay claim to be a god, and the Manichæans never had the hardihood to proceed to absolute identification of Mani with Christ; as regards their tenets, however, and viewed as attempts to found a universal religion, Simonianism and Manichæism are widely different.

We can understand, then, how it was that the Christians in the 1st and 2d centuries regarded Simon as the emissary of devils and the father of all heresy; and we can also understand why—apart from Samaria—this effort to establish a new religion bore little fruit. It rests upon falsifications and a wild jumbling of religions, while it is lacking in religious elements of its own.

Until about the year 220 ecclesiastical tradition knows Simon only as a devil-inspired founder of a religion, and as father of heresy; it sees in him a caricature of Christ, not of the apostle Paul, and it knows nothing about Peter having again confuted him after what is narrated in Acts viii. It knows indeed that Simon came to Rome in the time of Claudius, but previous to the 3d century no ecclesiastical writer mentions his having met with Peter there, although all state that Peter went to the capital. The first ecclesiastical author to combine the two traditions was Hippolytus (*Philos.*, vi. 20). Having referred to the events narrated in Acts viii., he proceeds: "Simon even went to Rome, and there met with the apostles. As he led many astray through his sorceries, Peter frequently withstood him. He came at last . . .[2] and taught sitting under a plane tree. When after lengthened reasoning Simon was on the point of being worsted, he declared that if he were to be buried alive he would on the third day rise again. He actually caused a grave to be dug for him by his disciples, and gave orders that he should be buried. The disciples did as they were bid; he remains in the grave, however, unto this day, for he was not Christ." This legend is found only in Hippolytus; it evidently corresponds with the idea that Simon was a false Christ, but has no relation whatever with the notion that he was Paul. Hippolytus, moreover, does not say that in Rome Simon met with Peter only, but with the apostles, *i.e.*, with Paul and Peter. The origin of the legend is very intelligible from what we know of the historical premises. Given that Simon alleged himself to be Christ, that in Samaria he met with Peter, that he as well as Peter afterwards travelled to Rome, then we can very easily explain the origin of a legend which brings Peter once more into personal contact with Simon in Rome, and alleges that Simon became the victim of his nefarious mimicry of Christ.

At the same time the expression *Πρὸς Σίμωνα πολλὰ Πέτρος ἐν Ῥώμῃ ἀνακατέστη* makes it seem a probable thing to many that Hippolytus already knew of that legend about Simon in which the Tübingen critics think they have found the key to all traditions about him. In the pseudo-Clementine *Recognitions* and *Homilies*, or rather in their documentary sources, Simon plays a very important part. He appears as the representative of all possible heresies, and as the great antagonist of Peter, who followed him up throughout Samaria and the east coast of the Mediterranean, engaging him in great disputations, and always coming off the victor. Some of the features attributed in these legends to Simon are indisputably borrowed from the apostle Paul, others from Marcion, others from Valentinus and Basilides. These legends therefore arose in strict Jewish-Christian anti-Pauline circles; we find them, however, in the *Recognitions* and *Homilies* already subjected to catholic revision. This revision cannot have taken place before the first half of the 3d century, and probably is of much later date. The age of the documentary sources cannot be exactly determined; they may be very old; but what is of most importance is (1) that their influence upon church tradition cannot be traced before the 3d century, and (2) that in those Jewish-Christian sources, as well as in the *Homilies* and *Recognitions* themselves, only disputations between Peter and Simon in Samaria and adjacent countries are narrated, nothing whatever being said of any controversies between Simon and Peter in Rome. Even if, therefore, the Simon of the Jewish-Christians bears unmistakable traces of Paul, it is also true on the other hand that these Jewish-Christians knew nothing of a journey of Simon to Rome. Hence all the combinations of the Tübingen critics as to the origin of the "Peter tradition," and as to the origin of the statement that Simon came to Rome, completely fall to the ground. Hippolytus was the first to combine "Peter in Rome" and "Simon in Rome," without knowing anything whatever of a Simon-Paul legend. Not until after his day, after the Jewish-Christian legends had become naturalized in the catholic church through the medium of the *Recognitions* and *Homilies*, did these legends become current within the church, and only there. It now began to be told that Paul and Peter[3] had gone to Rome to withstand Simon. Simon was now represented partly in accordance with those Jewish-Christian legends, the tendency of which was not understood. Much, however, that was new was added, such as that Simon appeared before the emperor, that he miserably perished in attempting to fly, and so on. From the 3d (or rather 4th) century the Simon of church tradition becomes invested with some features of Paul in a distorted form. The *Recognitions*, as translated by Rufinus, were extensively read in the East, and, along with the Acts of the Apostles, kept fresh the memory of the great magian and his Helena in the Middle Ages. Simon also came to figure in popular literature. "Doctor Faustus" has preserved several traits of the ancient magian. Neither are Pauline characteristics wanting in the legendary Faustus: they are traceable even in the *Faust* of Goethe, the "homunculus" of the Simon Faust being originally a travesty of the "new man" who according to Paul is created through the Gospel. It was not only as the great magian, however, that Simon remained known to the Middle Ages, but also as the first who attempted to purchase spiritual gifts with money, an association made permanent in the word "simony."

Sources.—Acts viii. 5-24; Justin, *Apol.*, i. 26-56, ii. 14, and *Dial. c. Tryph.*, 120; Hegesippus, ap. Euseb., *H. E.*, iv. 23; Celsus, ap. Orig., *C. Cels.*, v. 62; Irenæus, *Adv. Hær.*, i. 23, *et al.*; Tertullian, *De Idolol.*, 9, *Apolog.*, 13, *De Præscript.*, 10-33, *De Anima*, 34-57, *De Fuga*, 12; Clement Alex., *Strom.*, ii. 11, 52, vii. 17, 107; Hippolytus, *Syntagma* (Pseudo-Tertull., Philastr., 29, Epiph., *Hær.*, 21), *Philos.*, vi. 7-20; Origen, *C. Cels.*, i. 57, vi. 11, and vv. ll.; Eusebius, *H. E.*, ii. 1, 14 *sq.*; Arnobius, *Adv. Gentes*, ii. 12; Pseudo-Cyprian, *De Rebapt.*, 16, 17; Pseudo-Ignatius, *Ad. Trall.*, 11; *Homil. Pseudo-Clementis*, vv. ll.; *Recognit. Pseudo-Clem.*, vv. ll.; Cyril, *Catech.*, vi. 15; Jerome, *De Vir. Ill.*, 1, *Com. in Matth.*, c. 24; *Constit. Apost.*, vi. 809; Ambrose, *Hexaem.*, iv. 8; Sulpicius-Severus, *Hist.*, ii. 41; Theodoret, *H. F.*, i. 1; *Acta Petri et Pauli*, 49; *Acta Pseudo-Marcelli*, *Pseudo-Lini*. *Pseudo-Abdiæ*, etc.

Sources for Samaritan Pseudo-Messiahs contemporary with Simon.—(1) For Dositheus: Hegesippus, ap. Euseb., *H. E.*, iv. 22; Hippolytus, *Syntagma* (Pseudo-Tertull., Philast., 4, and Epiph., *Hær.*, 13); *Recognit. Pseudo-Clementis*, i. 54, ii. 8-11; Origen, *C. Cels.*, i. 57, vi. 11, *De Princip.*, iv. 17, *Comm. in Matth.*, ser. 32, *Hom.* 25 *in Luc.*, *in Joh.*, xiii. 27; *Constit. Apost.*, vi. 8; Eusebius, in *Luc.*, see Mai. *Vet. Script. Nova Collect.*, i. 1, p. 155; *Opus imperfect. in Matth.*, hom. 48; Macarius Magnus, *Apocrit.*, iii. 43, iv. 15, 21. (2) For Menander: Justin, *Apol.* i. 26, 56; Hegesippus, ap. Euseb., *H. E.*, iv. 22; Irenæus, *Adv. Hær.*, i. 23, iii. 4; Tertullian. *De Anima*, 30, 50, *De Resurr.*, 5; Hippolytus, *Syntagma*, etc. (3) For Cleobulus (Cleobius): Hegesippus, ap. Euseb., *H. E.*, iv. 22; *Constit. Apost.*, vi. 8, 16; Pseudo-Chrysostom, *Hom.* 48 *in Matth.*, opp. vi. p. cxcix; Pseudo-Ignat., *Ep. ad Trall.*, ii.; Epiphanius, *Hær.* 51, 6; Theodoret, *H. F.*, l. i. præf., l. ii. præf.; *Ep. Apocr. Pauli ad Cor.*, etc.

Literature.—Baur, "Die Christusparthei in Korinth," in the *Tübinger Zeitschrift*, 1831, part 4, p. 116 *sq.*; Baur, *Paulus*, 1st ed. (1845), p. 85 *sq.*, 218 *sq.*, 2d ed., p. 85 *sq.*; Baur, *Das Christenthum der drei ersten Jahrhunderte*, 2d ed., p. 85 *sq.*; Simson, "Leben und Lehre des Simons des Magiers," in the *Zeitschrift f. Hist. Theol.*, 1841, part 3; Schlurick, *De Simonis M. fatis romanis*, Meissen, 1844; Hilgenfeld, *Die Clementinischen Recognitionen und Homilien*, 1848,

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[1] Clem., *Strom.*, ii. 11, 52; Hippol., *Philosoph.*, vi. 7 *sq.*: ὁ ἑστώς, στάς, στησόμενος.

[2] A hiatus occurs in the text here.

[3] See *Acta Pauli et Petri*.

p. 317 *sq.*; Zeller, *Apostelgeschichte*, 1854, p. 158 *sq.*; Uhlhorn, *Die Homilien und Recognitionen des Clemens Romanus*, 1854, p. 80 *sq.*, 281 *sq.*; Grimm, *Die Samaritaner*, 1854, p. 151 *sq.*; Volkmar, "Ueber den Simon Magus der Apostelgeschichte," in the *Tübing. Theol. Jahrb.*, 1856, p. 279 *sq.*; Noack, "Simon der Magier," in *Psyche*, 1860, p. 257 *sq.*; F. K., "Ueber das Denkmal des Magiers Simon zu Rom," in the *Historisch-Polit. Blätter*, vol. xlvii., 1861, p. 530 *sq.*; Ginzel, in the *Oestr. Vierteljahrschr. f. Kathol. Theol.*, vol. vi. 1867, p. 455 *sq.*; see also his *Kirchenhist. Schriften*, Vienna, 1872, vol. i. p. 76 *sq.*; Renan, *Les Apôtres* and *L'Antechrist*; Hilgenfeld, "Der Magier Simon," in the *Zeitschr. f. wiss. Theol.*, 1868, p. 357 *sq.*, 1874, p. 294 *sq.*, 1878, p. 32 *sq.*, 1881, p. 16; Huelsen, *Simonis Magi vita doctrinaque*, Berlin, 1868; Lipsius, *Die Quellen der römischen Petrus-Sage*, 1872; Harnack, *Zur Quellenkritik der Geschichte des Gnosticismus*, 1873; Joh. Delitzsch, "Zur Quellenkritik der ältesten Berichte über Simon Petrus und Simon Magus," in *Theol. Studien und Kritiken*, 1874, part 2, p. 213 *sq.*; Lipsius, "Simon Magus," in Schenkel's *Bibel-lexicon*, vol. v., 1875, p. 301 *sq.*; Ibid., "Petrus in Rom," in the *Jahrbb. f. Protest. Theol.*, 1876, p. 561 *sq.*; Hilgenfeld, *Die Ketzergeschichte des Urchristenthums*, 1884, p. 163 *sq.*, 453 *sq.*; Moeller, "Simon Magus," in Herzog's *R. Encykl.*, 2d ed., vol. xiv. p. 246 *sq.*; Hase, *Kirchengeschichte auf der Grundlage akadem. Vorles.*, part 1, 1885, p. 156 *sq.*; also the commentaries to the Acts of the Apostles by Meyer, Overbeck, Wendt, and others; the accounts of Gnosticism by Neander, Baur, Möller, Lipsius, Mansel, and others; and the numerous investigations with reference to the sojourn of Peter in Rome. (A. HA.)

SIMON, ABRAHAM (1622–1692), medallist and modeller, was born in Yorkshire in 1622. He was originally intended for the church, but turned his attention to art, and, after studying in Holland, proceeded to Sweden, where he was employed by Queen Christina, in whose train he travelled to Paris. He returned to England before the outbreak of the Civil War, and attained celebrity by his medals and portraits modelled in wax. During the Commonwealth he executed many medals of leading Parliamentarians, and at the Restoration he was patronized by Charles II., from whom he received a hundred guineas for his portrait designed as a medal for the proposed order of the Royal Oak. Having incurred the displeasure of the duke of York, he lost the favor of the court, and died in obscurity in 1692. Among the more interesting of his medals are those of the second earl of Dunfermline, the second earl of Lauderdale, and the first earl of Loudon; that of the duke of Albemarle, and many other fine medals, were modelled by Abraham Simon and chased by his younger brother Thomas, noticed below.

SIMON, RICHARD (1638–1712), the "father of Biblical criticism," was born at Dieppe on the 13th May, 1638. His early studies were carried on at the College of the Fathers of the Oratory in that city. He was soon, by the kindness of a friend who discerned the germs of those talents which were afterwards to render him so celebrated, removed to Paris and enabled to enter upon the study of theology, where he early displayed a taste for Hebrew and other Oriental languages. He was allowed great indulgence in the prosecution of his studies by the authorities of the Congregation of the Oratory, being exempted from those exercises of piety which for an entire year were binding on the other students. This dispensation aroused the ill-will and jealousy of the other Oratorian novitiates. Simon was charged with reading "heretical" books, this designation being applied to *Walton's Polyglott*, the *Critici Sacri*, and other works of a similar kind. But this jealous opposition proved abortive. Simon, after investigation, was allowed and encouraged to continue his favorite pursuits. At the end of his theological course he was sent, according to custom, to teach philosophy at Juilly, where there was one of the colleges of the Oratory. But he was soon recalled to Paris, and employed in the congenial labor of preparing a catalogue of the Oriental books in the library of the Oratory. This gave him full access to those works, the fruits of the study of which appear so fully in his after writings. His first essay in authorship was the publication of a work entitled *Fides Ecclesiæ Orientalis, seu Gabrielis Metropolitæ Philadelphiensis Opuscula, cum interpretatione Latina, cum notis* (Paris, 1671), the object of which was to demonstrate that the belief of the Greek Church regarding the Eucharist was the same as that of the Church of Rome. Simon entered the priesthood in 1670, and the same year wrote a pamphlet in defence of the Jews of Metz, who had been accused, as they have so often been before and since, of having murdered a Christian child. It was shortly before this time that there were sown the seeds of that enmity with the Port Royalists which filled Simon's after-life with many bitter troubles. The famous Arnauld had written a work on the *Perpetuity of the Faith*, the first volume of which treated of the Eucharist. M. Diroys, a doctor of theology, and a friend of Arnauld's, asked Simon his opinion of the book. Simon replied that it was one of the best works which had been published by the Port Royalists, but that it nevertheless required correction in several important passages, and agreed reluctantly, and after some delay, at Diroys's request, to write a letter referring to these passages, on the understanding that the original was to be returned to him. The criticisms of Simon excited great indignation among the friends and admirers of Arnauld, and he felt the effects of their vindictiveness to the latest hour of his life. Another matter was the cause of inciting against him the ill-will of the monks of the Benedictine order. A friend of Simon's, one of the Oratorians, was engaged in a lawsuit, in his capacity as grand vicar of Prince Neubourg, abbé of Fécamp, with the Benedictine monks of that establishment. Simon lent to his friend the aid of his powerful pen, and composed a memorandum in which he employed pretty strong language against the opponents of his friend. They were greatly exasperated, and made loud complaints to the new general of the Oratory that they were virulently assailed by a member of the brotherhood, with which they had always been on friendly terms. The charge of Jesuitism was also brought against Simon, apparently on no other ground than that his friend's brother was an eminent member of that order. The commotion in ecclesiastical circles was great, and it was seriously contemplated to remove Simon not only from Paris but from France. A mission to Rome was proposed to him, but he saw through the design, and, after a short delay dictated by prudential motives, declined the proposal. He was engaged at the time in superintending the printing of his *Histoire Critique du Vieux Testament*. He had hoped, through the influence of Père la Chaise, the king's confessor, and the Duc de Montausier, to be allowed to dedicate the work to Louis XIV., but as His Majesty was absent in Flanders at the time the volume could not be published until the king had accepted the dedication, though it had passed the censorship of the Sorbonne, and the chancellor of the Oratory had given his *imprimatur*. The printer of the book, in order to promote the sale, had caused the titles of the various chapters to be printed separately, and to be put in circulation. These, or possibly a copy of the work itself, had happened to come into the hands of his ever-watchful enemies—the Port Royalists. It seems that, with a view to injure the sale of the work, which it was well known in theological circles had been long in preparation by Simon, the Messieurs de Port Royal had undertaken a translation into French of the Prolegomena to *Walton's Polyglott*. To counteract this proceeding Simon announced his intention of publishing an annotated edition of the Prolegomena, and actually added to the *Critical History* a translation of the last four chapters of that work, which had formed no part of his original plan. Simon's announcement prevented the appearance of the projected translation, but his enemies were all the more irritated against him on that account. They had now obtained the opportunity, which they had long been seeking, of gratifying their hatred of the bold Oratorian. The freedom with which Simon expressed himself on various topics, and especially those chapters in which he declared that Moses could not be the author of much in the writings attributed to him, especially aroused their opposition. The powerful influence of Bossuet, at that time tutor to the dauphin, was invoked; the chancellor Le Tellier lent his assistance; a decree of the council of state was obtained, and after a series of paltry intrigues the whole impression, consisting of 1300 copies, was seized by the police and destroyed, and the animosity of his colleagues in the Oratory rose to so great a height against Simon for having so seriously compromised their order by his work that he was declared to be no longer a member of their body. Full of bitterness and disgust Simon retired to the curacy of Bolleville, to which he had been lately appointed by the vicar-general of the abbey of Fécamp.

The work thus confiscated in France it was proposed to republish in Holland. Simon, however, at first opposed this, in hopes of overcoming the opposition of Bossuet by making certain changes in the parts objected to. The negotiations with Bossuet lasted a considerable time, but finally failed, and the *Critical History* appeared, with Simon's name on the title page, in the year 1685, from the press of Reenier Leers in Rotterdam. An imperfect edition had previously been published at Amsterdam by Daniel Elzevir, based upon a MS. transcription of one of the copies of the original work which had escaped destruction and had been sent to England, and from which a Latin and an English translation were afterwards made. The edition of Leers was a reproduction of the work as first printed, with a new preface, notes, and those other writings which had appeared for and against the work up to that date.

The work which had excited so much controversy and opposition consists of three books, the first of which deals with questions of Biblical criticism, properly so called, such as the text of the Hebrew Bible and the changes which it has undergone down to the present day, the authorship of the Mosaic writings and of other books of Scripture, with an exposition of his peculiar theory of the existence during the whole extent of Jewish history of recorders or annalists of the events of each period, whose writings were preserved in the public archives, and the institution of which he assigns to Moses. The second book gives an account of the principal translations, ancient and modern, of the Old Testament, and the third contains an examination of the principal commentators. He had, with the exception of the theory above mentioned, contributed nothing really new on the subject of Old Testament criticism, for previous critics, as Cappellus, Morinus, and others, had established many points of importance, and the value of Simon's work consisted chiefly in bringing together and presenting at one view the results of Old Testament criticism. The work is written in a clear style, and its tone is confident and frequently sarcastic. He displays great contempt for tradition and the opinions of the fathers. This latter peculiarity it was which specially aroused the enmity of Bossuet and other leading Romanists. But it was not only from the Church of Rome that the work encountered strong opposition. The Protestants felt their stronghold—an infallible Bible—assailed by the doubts which Simon raised against the integrity of the Hebrew text. Le Clerc ("Clericus"), the distinguished Dutch divine and critic, in his work *Sentimens de quelques Theologiens de Hollande*, controverted the views of Simon, and was answered by the latter in a tone of considerable asperity in his *Réponse aux Sentimens de quelques Theologiens de Hollande*, which he signed under the name of Pierre Ambrun, it being a marked peculiarity of Simon rarely to give his own name, but to assume *noms de guerre* at various times.

The remaining works of Simon may be briefly noticed. In 1689 appeared his *Histoire Critique du Texte du Nouveau Testament*, consisting of thirty-three chapters, in which he discusses the origin and character of the various books, with a consideration of the objections brought against them by the Jews and others, the quotations from the Old Testament in the New, the inspiration of the New Testament (with a refutation of the opinions of Spinoza), the Greek dialect in which they are written (against Salmasius), the Greek MSS. known at the time, especially Codex D (Cantabrigiensis), etc. This was followed in 1690 by his *Histoire Critique des Versions du Nouveau Testament*, where he gives an account of the various translations, both ancient and modern, and discusses the manner in which many difficult passages of the New Testament have been rendered in the various versions. In 1693 was published what in some respects is the most valuable of all his writings, viz., *Histoire Critique des principaux Commentateurs du Nouveau Testament depuis le commencement du Christianisme jusques à notre temps*. This work exhibits immense reading, and the information it contains is still valuable to the student. The last work of Simon that we shall mention is his *Nouvelles Observations sur le Texte et les Versions du Nouveau Testament* (Paris, 1695), which contains supplementary observations upon the subjects of the text and translations of the New Testament.

Simon is described as a man of middle stature, with somewhat unprepossessing features. His temper was sharp and keen, and as a controversialist he displayed a bitterness of tone and an acerbity of expression which tended only to aggravate the unpleasantness of controversy. He was entirely a man of intellect, free from all tendency to sentimentality, and with a strong vein of sarcasm and satire in his disposition. His reading was immense, and his memory powerful and retentive. He is said to have usually prosecuted his studies lying on the floor of his apartment, on a pile of carpets or cushions. Few men have written more that is worth reading on Biblical subjects than he, considering the hardships and vicissitudes of his chequered life. He died at his native city of Dieppe on the 11th April, 1712, at the age of seventy-four.

The principal authorities for the life of Simon are the life or "éloge" by his grand-nephew De la Martinière in vol. i. of the *Lettres Choisies*, 4 vols., Amsterdam, 1730; Graf's article in the first vol. of the *Beitr. zu. d. Theol. Wissensch.*, etc., Jena, 1851: Reuss's article in Herzog's *Encyklopädie*, vol. xiv., new ed.; *Richard Simon et son Vieux Testament*, by A. Bernus, Lausanne, 1869. For the bibliography, see, in addition to the various editions of Simon's works, the very complete and accurate account of Bernus, *Notice Bibliographique sur Richard Simon*, Basel, 1882. (F. C.)

SIMON, Thomas (1623 ?–1665), medallist, was born, according to Vertue, in Yorkshire about 1623. He studied engraving under Nicholas Briot, and about 1635 received a post in connection with the Mint. In 1645 he was appointed by the Parliament joint chief engraver along with Edward Wade, and, having executed the great seal of the Commonwealth and dies for the coinage, he was promoted to be chief engraver to the mint and seals. He produced several fine portrait medals of Cromwell, one of which is copied from a miniature by Cooper. After the Restoration he was appointed engraver of the king's seals. On the occasion of his contest with the brothers Roettiers, who were employed by the mint in 1662, Simon produced his celebrated crown of Charles II., on the margin of which he engraved a petition to the king, setting forth the excellence of his own productions and praying for redress. This is usually considered his masterpiece. An impression of the coin fetched £225 [$1093.50] at an auction in 1832. This admirable medallist is believed to have died of the plague in London in 1665.

A volume of *The Medals, Coins, Great Seals, and other Works of Thomas Simon, engraved and described by George Vertue*, was published in 1753.

SIMONIDES (or Semonides, as some write the name) of Amorgos stands midway both in time and reputation between the other two iambic poets of Greece—Archilochus and Hipponax. A native of Samos, he led a colony to the island of Amorgos in the Archipelago, and lived there about 660 B.C. in Minoa, a town of his own founding. Besides two books of iambics, we are told that he wrote elegies, and a poem on the early history of the Samians; but only one insignificant elegy has been with any degree of plausibility attributed to him. We possess about thirty fragments of his iambic poems, written in clear and vigorous Ionic, with much force and no little harmony of versification. With Simonides, as with Archilochus, the iambic is still the vehicle of bitter satire, interchanging with melancholy, but in Simonides the satire is rather general than individual, and in other respects, especially in his gnomic and reflective tendency, he paves the way for the tragic trimeter. One of his two longer fragments dwells pathetically upon the misery of our lot, in which, as he says elsewhere, "we have many years of death, but of life only a few sad years;" the other, far his most famous poem, is a "Pedigree of Women," tracing their descent from different animals according to their different characters. The idea may have been suggested by the beast fable, as we find it in Hesiod and Archilochus; it is clear at least that Simonides knew the works of the former. The same conception recurs a century later in Phocylides. Simonides derives the dirty woman from a hog, the cunning from a fox, the fussy from a dog, the apathetic from earth, the capricious from sea-water, the stubborn from an ass, the incontinent from a weasel, the proud from a high-bred mare, the worst and ugliest from an ape, and the good woman from a bee. The remainder of the poem (vv. 96–118) is undoubtedly spurious. There is much beauty and feeling in Simonides's description of the good woman; and the skilful portraits of character and judicious selection of prominent features prove him to have been a keen observer and a real artist. The date of his death is unknown.

See Bergk, *Poetæ Lyrici Græci*, vol. ii. Leipsic, 1882, pp. 441-459. There is a translation in English verse of part of the poem on women in Mure's *Hist. of Gr. Lit.*, iii. p. 181.

SIMONIDES of Ceos (556–469 B.C.), one of the greatest poets and most accomplished men of antiquity, was born at Iulis in the island of Ceos, 556 B.C. Few poetic natures have ever been planted in more congenial soil. His native island was devoted to the worship of Apollo, the god of song; poetry had been cultivated in his family for generations; his youth coincided with the period succeeding the first great burst of Æolian and Doric lyric poetry; his manhood saw the heroic struggle with Persia, when Greece first awoke to the consciousness of her national unity; and he died before the inevitable disintegration had begun. Among his friends were all the foremost men of the day—kings and princes like Hipparchus and Hiero and the Aleuadæ and Scopadæ, statesmen like Pausanias and Themistocles, and poets like Æschylus, Epicharmus, and his own nephew Bacchylides. Pindar alone among his contemporaries seems to have depreciated Simonides, perhaps not without a touch of jealousy; by all the rest he was revered as the poet laureate of emancipated Greece. He lived for the most part with his friends, whose praises he had sung for money; we hear of him at the court of Hipparchus in Athens, with the Scopadæ in Thessaly, and finally at the court of Hiero of Syracuse, where he died in 469 B.C.

His reputation as a man of learning and ingenuity is shown by the tradition that he added two new letters to the alphabet—η and ω—the truth being probably that he was one of the first authors to use these symbols, before the archonship of Euclides. So unbounded were his popularity and influence that he was felt to be a power even in the political world; we are told that he reconciled Thero and Hiero on the eve of a battle between their opposing armies. For his poems he could command almost any price: later writers, from Aristophanes onwards, accuse him of avarice, probably not without some reason. From the numerous anecdotes preserved about him we see that he was what we should infer from his poems, a genial and courtly man, "dwelling with flowers,—like the bee, seeking yellow honey" (Fr. 47), yet not without a vein of gentle irony. To Hiero's queen, who asked him whether it was better to be born rich or a genius, he replied "Rich, for genius is ever found at the gates of the rich."

Of his poetry we possess two or three short elegies (Fr. 85 seems from its style and versification to belong to Simonides of Amorgos, or at least not to be the work of our poet), several epigrams, and about ninety fragments of lyric poetry. The epigrams written in the usual dialect of elegy, Ionic with an epic coloring, were intended partly for public and partly for private monuments. There is strength and sublimity in the former, with a simplicity that is almost statuesque, and a complete mastery over the rhythm and forms of elegiac expression. Those on the heroes of Marathon and Thermopylæ are the most celebrated. In the private epigrams there is more warmth of color and feeling, but here it is hard to decide which are genuine and which spurious; few of them rest on any better authority than that of the Palatine anthology. One interesting and undoubtedly genuine epigram of this class is upon Archedice, the daughter of Hippias the Pisistratid, who, "albeit her father and husband and brother and children were all princes, was not lifted up in soul to pride." The lyric fragments vary much in character and length: one is from a poem on Artemisium, and celebrates those who fell at Thermopylæ; another is an ode in honor of Scopas; the rest represent odes on victors in the games, hyporchemes, dirges, hymns to the gods, and other varieties. The poem on Thermopylæ is reverent and sublime, breathing an exalted patriotism and a lofty national pride; the others are full of tender pathos and deep feeling, such as evoked from Catullus the line "Mæstius lacrimis Simonideis," with a genial worldliness befitting one who had "seen the towns and learnt the mind of many men." For Simonides requires no standard of lofty unswerving rectitude. "It is hard," he says (Fr. 5), "to become a truly good man, perfect as a square in hands and feet and mind, fashioned without blame. Whosoever is bad, and not too wicked, knowing justice, the benefactor of cities, is a sound man. I for one will find no fault with him, for the race of fools is infinite. . . . . I praise and love all men who do no sin willingly; but with necessity even the gods do not contend." Virtue, he tells us elsewhere in language that recalls Hesiod, is set on a high and difficult hill (Fr. 58); let us seek after pleasure, for "all things come to one dread Charybdis, both great virtues and wealth" (Fr. 38), and "what life of mortal man, or what dominion, is to be desired apart from pleasure, without which even the gods' existence is not to be envied" (Fr. 71). Yet Simonides is far from being a hedonist; his morality, no less than his art, is pervaded by that virtue for which Ceos was renowned—*σωφροσύνη* or self-restraint. His most celebrated fragment, and one of the most exquisite and touching remains of ancient poetry, is a dirge, in which Danae, adrift with the infant Perseus on the sea in a dark and stormy night, takes comfort from the peaceful slumber of her babe. Simonides here illustrates his own saying that "poetry is vocal painting, as painting is silent poetry" (one of the opening remarks in Lessing's *Laocoon*): from the picture of the sleeping child, standing out as if in relief against the background of surging waves, and Danae in tears, we can well understand how Longinus should have commended this power of vivid presentation as a distinguishing feature in another of Simonides's poems. This poem has been often translated. One of the best translations is that by Symonds, in the first series of his *Studies on the Greek Poets.*

See Bergk, *Poetæ Lyrici Græci*, vol. iii., Leipsic, 1882, pp. 382–535. Welcker was the first who clearly separated the fragments of the Cean Simonides from those of his namesake. Sterling (*Essays and Tales*, vol. i. pp. 188 *sq.*) has a poetical translation of most of them.

SIMONY is an offence against the law of the church. The name is taken from Simon Magus (*q.v.*). In the canon law the word bears a more extended meaning than in English law. "Simony according to the canonists," says Ayliffe in his *Parergon*, "is defined to be a deliberate act or a premeditated will and desire of selling such things as are spiritual, or of anything annexed unto spirituals, by giving something of a temporal nature for the purchase thereof; or in other terms it is defined to be a commutation of a thing spiritual or annexed unto spirituals by giving something that is temporal." An example of the offence occurs as early as the 3d century in the purchase of the bishopric of Carthage by a wealthy matron for her servant, if the note to Gibbon (vol. ii. p. 457) is to be believed. The offence was prohibited by many councils, both in the East and in the West, from the 4th century onwards. In the *Corpus Juris Canonici* the Decretum (pt. ii. cause i. quest. 3) and the Decretals (bk. v. tit. 3) deal with the subject. The offender, whether *simoniacus* (one who had bought his orders) or *simoniace promotus* (one who had bought his promotion), was liable to deprivation of his benefice and deposition from orders if a secular priest,—to confinement in a stricter monastery if a regular. No distinction seems to have been drawn between the sale of an immediate and of a reversionary interest. The innocent *simoniace promotus* was, apart from dispensation, liable to the same penalties as though he were guilty. Certain matters were simoniacal by the canon law which would not be so regarded in English law, *e.g.*, the sale of tithes, the taking of a fee for confession, absolution, marriage, or burial, the concealment of one in mortal sin or the reconcilement of an impenitent for the sake of gain, and the doing homage for spiritualities. So grave was the crime of simony considered that even infamous persons could accuse of it. English provincial and legatine constitutions continually assailed simony. Thus one of the heads in Lyndewode (bk. v.) is, "Ne quis ecclesiam nomine dotalitatis transferat vel pro præsentatione aliquid accipiat." In spite of all the provisions of the canon law it is well established that simony was deeply rooted in the mediæval church. Dante places persons guilty of simony in the third bolgia of the eighth circle of the Inferno:

> "O Simon mago, O miseri seguaci,
> Che le cose di Dio che di bontate
> Deono esser spose, voi rapaci
> Per oro e per argento adulterate."—*Inf.*, xix. 1.

The popes themselves were notorious offenders. In the canto just cited Pope Nicholas III. is made by the poet the mouthpiece of the simoniacs. He is supposed to mistake the poet for Boniface VIII., whose simoniacal practices, as well as those of Clement V., are again alluded to in Par. xxx. 147. At a later period there was an open and continuous sale of spiritual offices by the Roman curia which contemporary writers attacked in the spirit of Dante. A pasquinade against Alexander VI. begins with the lines:

> "Vendit Alexander claves, altaria, Christum.
> Emerat ille prius; vendere jure potest."

Machiavelli calls luxury, simony and cruelty the three dear friends and handmaids of the same pope.[1] The colloquy of Erasmus, *De Sacerdotiis Captandis* bears witness to the same state of things. And, best proof of all, numerous decisions as to what is or is not simony are to be found in the reported decisions of the Roman rota.[2] That part of the papal revenue which consisted of first fruits (*primitiæ* or *annates*) and tenths (*decimæ*) must have been theoretically simoniacal in its origin. In England this revenue was annexed to the crown by Henry VIII. and restored to the church by Queen Anne (see **QUEEN ANNE'S BOUNTY**).

For the purposes of English law simony is defined by Blackstone as the corrupt presentation of any person to an ecclesiastical benefice for money, gift or reward. The offence is one of purely ecclesiastical cognizance, and not punishable by the criminal law. The penalty is forfeiture by the offender of any advantage from the simoniacal transaction, of his patronage by the patron, of his benefice by the presentee. An innocent clerk is under no disability, as he might be by the canon law. Simony may be committed in three ways,—in promotion to orders, in presentation to a benefice and in resignation of a benefice. The common law (with which the canon law is incorporated, as far as it is not contrary to the common or statute law or the prerogative of the crown) has been considerably modified by statute. Where no statute applies to the case, the doctrines of the canon law may still be of authority. Both Edward VI. and Elizabeth promulgated advertisements against simony. The Act of 31 Eliz. c. 6 was intended to reach the corrupt patron as well as the corrupt clerk, the ecclesiastical censures apart from the statute not extending to the case of a patron. The first part of the Act deals with the penalties for election or resignation of officers of churches, colleges, schools, hospitals, halls and societies for reward. The second part of the Act provides that if any person or persons, bodies politic and corporate, for any sum of money, reward, gift, profit or benefit, directly or indirectly, or for or by reason of any promise, agreement, grant, bond, covenant or other assurances, of or for any sum of money, etc., directly or indirectly present or collate any person to any benefice with cure of souls, dignity, prebend or living ecclesiastical, or give or bestow the same for or in respect of any such corrupt cause or consideration, every such presentation, collation, gift and bestowing, and every admission, institution, investiture and induction shall be void, frustrate and of none effect in law; and it shall be lawful for the queen to present, collate unto, or give and bestow every such benefice, dignity, prebend and living ecclesiastical for that one time or turn only; and all and every person or persons, bodies politic and corporate, that shall give or take any such sum of money, etc., directly or indirectly, or that shall take or make any such promise, etc., shall forfeit and lose the double value of one year's profit of every such benefice, etc., and the person so corruptly taking, procuring, seeking or accepting any such benefice, etc., shall be adjudged a disabled person in law to have or enjoy the same benefice, etc. Admission, institution, installation or induction of any person to a benefice, etc., for any sum of money, etc., renders the offender liable to the penalty already mentioned. But in this case the presentation reverts to the patron and not to the crown. The penalty for corrupt resigning or exchanging of a benefice with cure of souls is that the giver as well as the taker shall lose double the value of the sum so given or taken, half the sum to go to the crown and half to a common informer. The penalty for taking money, etc., to procure ordination or to give orders or license to preach is a fine of £40 [$194.40]; the party so corruptly ordained forfeits £10 [$48.60]; acceptance of any benefice within seven years after such corrupt entering into the ministry makes such benefice merely void, and the patron may present as on a vacancy; the penalties are divided as in the last case. The Act is cumulative only, and does not take away or restrain any punishment prescribed by ecclesiastical law. The Act of 1 Will. and M. sess. 1, c. 16, guards the rights of an innocent successor in certain cases. It enacts that after the death of a person simoniacally presented, the offence or contract of simony shall not be alleged or pleaded to the prejudice of any other patron innocent of simony, or of his clerk by him presented, unless the person simoniac or siamoniacally presented was convicted of such offence at common law or in some ecclesiastical court in the lifetime of the person simoniac or simoniacally presented. The Act also declares the validity of leases made by a simoniac or simoniacally-presented person, if *bona fide* and for valuable consideration to a lessee ignorant of the simony. By 13 Anne c. 11, if any person shall for money, reward, gift, profit or advantage, or for any promise, agreement, grant, bond, covenant or other assurance for any money, etc., take, procure or accept the next avoidance of or presentation to any benefice, dignity, prebend or living ecclesiastical, and shall be presented or collated thereupon, such presentation or collation and every admission, institution, investiture and induction upon the same shall be utterly void; and such agreement shall be deemed a simoniacal contract, and the queen may present for that one turn only; and the person so corruptly taking, etc., shall be adjudged disabled to have and enjoy the same benefice, etc., and shall be subject to any punishment limited by ecclesiastical law. 3 and 4 Vict. c. 113, § 42, provides that no spiritual person may sell or assign any patronage or presentation belonging to him by virtue of any dignity or spiritual office held by him; such sale or assignment is null and void. This section has been construed to take away the old archbishop's "option," *i.e.*, the right to present to a benefice in a newly appointed bishop's patronage at the option of the archbishop. By canon 40 of the canons of 1603 an oath against simony was to be administered to every person admitted to any spiritual or ecclesiastical function, dignity or benefice. By 28 and 29 Vict. c. 122 a declaration was substituted for the oath, and a new canon incorporating the alteration was ratified by the crown in 1866. By the canon law all resignation bonds were simoniacal, and in 1826 the House of Lords held that all resignation bonds, general or special, were illegal. Special bonds have since, however, been to a limited extent sanctioned by law. 9 Geo. IV. c. 94 makes a written promise to resign valid if made in favor of some particular nominee or one of two nominees, subject to the conditions that, where there are two nominees, each of them must be either by blood or marriage an uncle, son, grandson, brother, nephew or grandnephew of the patron, that the writing be deposited with the registrar of the diocese open to public inspection, and that the resignation be followed by presentation within six months of the person for whose benefit the bond is made. Cases of simony have come before the courts in which clergy of the highest rank have been implicated. In 1695, in the case of Lucy *v.* The Bishop of St. David's, the bishop was deprived for simony. The Queen's Bench refused a prohibition (1 Lord Raymond's Rep. 447). As lately as 1841 the dean of York was deprived by the archbishop for simony, but in this case the Queen's Bench granted a prohibition on the ground of informality in the proceedings (In the Matter of the Dean of York, 2 *Queen's Bench Rep.*, 1). The general result of the law gathered from the statutes and decisions may be exhibited as follows: (1) it is not simony for a layman or spiritual person not purchasing for himself to purchase while the church is full an advowson or next presentation, however immediate the prospect of a vacancy; (2) it is not simony for a spiritual person to purchase for himself a life or any greater estate in an advowson, and to present himself thereto; (3) it is not simony to exchange benefices under an agreement that no payment is to be made for dilapidations on either side; (4) it is not simony to make certain assignments of patronage under the Church Building and New Parishes Acts (9 and 10 Vict., c. 88, 32 and 33 Vict. c. 94), (5) it is simony for any person to purchase the next presentation while the church is vacant; (6) it is simony for a spiritual person to purchase for himself the next presentation, though the church be full; (7) it is simony for any person to purchase the next presentation, or in the case of purchase of an advowson the next presentation by the purchaser will be simoniacal if there is any arrangement for causing a vacancy to be made; (8) it is simony for the purchaser of an advowson while the church is vacant to present on the next presentation; (9) it is simony to exchange otherwise than *simpliciter;* no compensation in money may be made to the person receiving the less valuable benefice. The law on the subject of simony has been for some time regarded as unsatisfactory by the authorities of the church. The archbishop of Canterbury has undertaken to introduce into the House of Lords a bill for the amendment of the law, the heads of which have recently (February, 1886) been under the consideration of convocation. The bill proposes *inter alia* to prohibit the sale of next presentations and of advowsons unless under certain limitations, to abolish resignation bonds, and to substitute for the present declaration against simony declarations that the presentee has not committed certain specific acts.

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[1] See Roscoe, *Life of Leo X.*, vol. i. p. 463.

[2] Compare the fine distinctions drawn by the casuists and attacked by Pascal in the twelfth of the *Provincial Letters*.

In Scotland simony is an offence both by civil and ecclesiastical law. The rules are generally those of the canon law. There are few decisions of Scottish courts on the subject. By the act of 1584, c. 5, ministers, readers, and others guilty of simony provided to benefices were to be deprived. An Act of Assembly of 1753 declares pactions simoniacal whereby a minister or probationer before presentation and as a means of obtaining it bargains not to raise a process of augmentation of stipend or demand reparation or enlargment of his manse or glebe after induction.

(J. W.†)

SIMPLICIUS, the successor of Pope Hilarius or Hilarus, was a native of Tibur, and was consecrated bishop of Rome on February 25, 468. He died March 2, 483, and was succeeded by Felix III. His extant letters, which date from the banishment of Romulus Augustulus and the early years of Odoacer's reign, relate almost entirely to the ecclesiastical and court intrigues of Alexandria and Constantinople in connection with the Monophysite controversy.

SIMPLICIUS, a native of Cilicia, a disciple of Ammonius and of Damascius, was one of the last of the Neoplatonists. From 400 to 529 A.D. the Neoplatonic school at Athens was the centre of pagan opposition to victorious Christianity, and, as such, fell a victim to imperial persecution. The subvention which it had received from the state was withdrawn; its private property was confiscated; and at last in 529 the teaching at Athens of philosophy and jurisprudence was forbidden (Malalas, p. 451, ed. Bonn). Disestablished, disendowed, and silenced, the scholarch Damascius, Simplicius, Priscianus, and four others resolved in 531 or 532 to seek the protection of Khosrau Anósharván (or Chosroes), who had ascended the throne of Persia in the former of these years. To his court they went; but, though from this patron of Greek learning they received a hearty welcome, they found themselves unable to support a continued residence amongst barbarians. Before two years had elapsed they returned to Greece, Khosrau, in his treaty of peace concluded with Justinian in 533, expressly stipulating that the seven philosophers should be allowed "to return to their own homes, and to live henceforward in the enjoyment of liberty of conscience" (Agathias, ii. 30, 31). After his return from Persia Simplicius wrote commentaries upon Aristotle's *De Cœlo*, *Physica*, *De Anima*, and *Categoriæ*, which, with a commentary upon the *Enchiridion* of Epictetus, have survived. In his writings Simplicius, who had small pretensions to originality of doctrine, devotes himself to the exposition and reconciliation of his authorities. His respect at once for Plato and for Aristotle is so great that he refuses to acknowledge any real difference between them, even in regard to their theories of universals and of matter. His remarks are, however, thoughtful and intelligent, and his learning is prodigious. To the student of Greek philosophy his commentaries are invaluable, as they contain many fragments of the older philosophers as well as of his immediate predecessors.

The editions of the Greek text of the commentaries are as follows: on the *De Cœlo*, Utrecht, by S. Karsten, 1865 (the Greek text published at Venice in 1526 is no more than a retranslation from Guil. de Moerbeka's Latin version); on the *Physica*, Venice, 1526, Berlin (by H. Diels), vol. i. 1882; on the *De Anima* (a disappointing work), Venice, 1527, Berlin (by M. Hayduck), 1882; on the *Categoriæ*, Venice, 1499, Basel, 1551; on the *Enchiridion*, Venice, 1528, Paris (Didot), 1842, etc. On the life and writings of Simplicius, see J. A. Fabricius, *Bibliotheca Græca*, ix. 529 *sq.;* Ch. A. Brandis's excellent article in Smith's *Dict. of Greek and Roman Biography;* E. Zeller, *D. Phil. d. Gr.*, III. ii. 851 *sq.;* also Ch. A. Brandis, "Ueber d. Griech. Ausleger d. Aristot. Organons," in *Abh. Berl. Akad.*, 1833, and C. G. Zumpt, "Ueber d. Bestand d. phil. Schulen in Athen," *ibid.*, 1842.

SIMPSON, SIR JAMES YOUNG, BART. (1811–1870), physician, was born in the town of Bathgate, Linlithgow, Scotland, on the 7th of June, 1811. His father was a baker in that town, who largely owed a moderate success in business to a shrewd and managing wife. James was the youngest of a family of eight, and for the furtherance of his worldly prospects the others struggled and sacrificed. At the age of fourteen he entered the university of Edinburgh as a student in the arts classes. Two years later he began his medical studies. At the age of nineteen he obtained the license of the College of Surgeons, and two years afterwards took the degree of doctor of medicine. Dr. Thomson, who then occupied the chair of pathology in the university, impressed with the graduation thesis, "On Death from Inflammation," presented by Simpson, offered him his assistantship. The offer was accepted, and during the session 1837–38 he acted as interim lecturer on pathology during the illness of the professor. The following winter he delivered his first course of lectures on obstetric medicine in the extra-academical school. On February 4, 1840, he was elected to the professorship of medicine and midwifery in the university. Towards the end of 1846 he was present at an operation performed by Liston on a patient rendered unconscious by the inhalation of sulphuric ether. The success of the proceeding was so marked that Simpson immediately began to use it in midwifery practice. He continued, however, to search for other substances having similar effects, and in March, 1847, he read a paper on chloroform to the Medico-Chirurgical Society of Edinburgh, in which he fully detailed the history of the use of anæsthetics from the earliest times, but especially dwelt upon the advantages of chloroform over ether. He advocated its use, not only for the prevention of pain in surgical operations, but also for the relief of pain in obstetrical practice. His strong and uncompromising advocacy of its use in the latter class of cases gave rise to one of the angriest and most widespread controversies of the time, and although his views may not have been generally indorsed by later professional practice, anæsthetics in surgical operations have from that time held an indisputed place, and Simpson's anæsthetic still continues the favorite in the practice of the Edinburgh school. In 1847 he was appointed a physician to the queen in Scotland. In 1859 he advocated the use of acupressure in place of ligatures for arresting bleeding; his views on this subject have, however, given place to improvements in the ligature and to a better knowledge of the conditions influencing its efficiency. His contributions to the literature of his profession and to archæology, in which latter he took an active interest, were very numerous, and embrace *Obstetric Memoirs and Contributions* (2 vols.), *Homœopathy*, *Acupressure*, *Selected Obstetrical Works*, *Anœsthesia and Hospitalism*, *Clinical Lectures on the Diseases of Women*, and three volumes of essays on archæological subjects. Simpson, who had been created a baronet in 1866, died on May 6th, 1870, and was accorded a public funeral; his statue in bronze now stands in West Princes Street Gardens, Edinburgh.

Simpson was a man of strong individuality and somewhat hasty temper, an uncompromising and aggressive opponent when he believed himself in the right, yet so tender and sympathetic that he endeared himself to an immense circle of friends and patients. Endowed with great mental power, activity, and receptivity, he performed a very large amount of literary work, much of which was of great value at the time and still continues to be of interest. He will, however, be chiefly remembered in the annals of medicine as a great personality, who brilliantly fought and won the battle for anæsthetics, and introduced chloroform.

SIMPSON, THOMAS (1710–1761), mathematician, was born at Market Bosworth in Leicestershire on the 20th of August, 1710. His father was a stuff weaver, and, intending to bring his son up to his own business, took little care of the boy's education. Young Simpson, however, was eager for knowledge, and so ardent was he in pursuit of it that he neglected his weaving, and in consequence of a quarrel was forced to leave his father's house. He settled for a short time at Nuneaton, where he met a peddler who practiced fortune-telling. By the encouragement and assistance of this man Simpson was induced to make a profession of casting nativities himself, and he soon became the oracle of the neighborhood. But he was not long in discovering the imposture of astrology, and his conscience, as well as an accident which happened to him in the practice of his art, compelled him to abandon this profession. After a residence of two or three years at Derby, where he worked as a weaver during the day and taught pupils in the evenings, he went up to London and pursued the same course, but with more success. The number of his pupils increased; his abilities became more widely known; and he was enabled to publish by subscription his *Treatise of Fluxions* in 1737. His treatise, as was afterwards acknowledged, abounded with errors of the press, and contained several obscurities and defects incidental to the author's want of experience and the disadvantages under which he labored. His next publications were *A Treatise on the Nature and Laws of Chance*, 1740; *Essays on Several Curious and Useful Subjects in Speculative and Mixed Mathematicks*, 1740; *The Doctrine of Annuities and Reversions deduced from General and Evident Principles*, 1742; and *Mathematical Dissertations on a Variety of Physical and Analytical Subjects*, 1743. Soon after the publication of his *Essays* he was chosen a member of the Royal Academy at Stockholm; in 1743 he was appointed professor of mathematics in the Royal Military Academy at Woolwich; and in 1745 he was admitted a fellow of the Royal Society of London. In 1745 he published *A Treatise of Algebra*, with an appendix containing the construction of geometrical problems, and in 1747 the *Elements of Plane Geometry*. The latter book, unlike many others with the same title, is not an edition of Euclid's *Elements*, but an independent treatise. Though it can hardly be said that as an introduction to geometry it is preferable to Euclid, yet the solutions of problems contained in it (and in the appendix to the *Algebra* as well) are in general exceedingly ingenious. In his *Trigonometry, Plane and Spherical, with the Construction and Application of Logarithms*, which appeared in 1748, there is a tolerably uniform use of contractions for the words sine, tangent, etc., prefixed to the symbol of the angle. *The Doctrine and Application of Fluxions*, which he issued in 1750, was more full and comprehensive than his earlier work on the same subject, and altogether was so different that he wished it to be considered as a new book and not as a second edition of the former. In 1752 appeared *Select Exercises for Young Proficients in the Mathematicks*, and in 1757 his *Miscellaneous Tracts on Some Curious and Very Interesting Subjects in Mechanics, Physical Astronomy, and Speculative Mathematics*, the last and perhaps the greatest of all his works. From the year 1735 he had sometimes under his own name, sometimes under fictitious names, been a frequent contributor to the *Ladies' Diary*, an annual publication partly devoted to the solution of mathematical problems, and from 1754 till 1760 inclusive he was the editor of it. From first to last Simpson seems to have had his own share of the cares and anxieties of this world, and it is astonishing how under such circumstances he contrived to accomplish what he did. His unremitting application and the want of proper regimen gradually undermined his health, and he died on the 14th of May, 1761, at his native village. His name will probably be considered the most illustrious in the long roll of the non-academical mathematicians of Britain.

SIMROCK, KARL (1802–1876), German poet and student of mediæval literature, was born on the 28th August, 1802, at Bonn, where his father was a music seller. He studied law at the universities of Bonn and Berlin, and in 1823 entered the Prussian civil service, from which he was expelled in 1830 for having written a poem in praise of the July revolution. Afterwards he was permitted to lecture at the university of Bonn, and in 1850 he was made a professor of Old German literature. He died on the 18th July, 1876.

Simrock established his reputation by his excellent modern rendering of the *Nibelungenlied* (1827), and of the works of Walther von der Vogelweide (1833). Among other works translated by him into the German of to-day were the *Arme Heinrich* of Hartmann von Aue (1830), the *Parzival* and *Titurel* of Wolfram von Eschenbach (1842), the *Tristan* of Gottfried of Strasburg (1852), the *Edda*, *Beowulf*, and *Heliand*. In the *Heldenbuch* (1843–49) he offered a complete representation of the heroic legends of Germany, partly by means of translations, partly by means of independent poems. Before the publication of this work he had given evidence of an original poetical faculty in *Wieland der Schmied* (1835); and in 1844 he issued a volume of *Gedichte* in which there are many good lyrics, romances, and ballads. In 1850 appeared *Lauda Sion*, and in 1857 the *Deutsche Sionsharfe*, collections of Old German sacred poetry. Of his republications the most popular and the most valuable were the *Deutschen Volksbücher*, of which fifty-five were printed between 1839 and 1867. His best contribution to antiquarian science was his *Handbuch der deutschen Mythologie* (1853–55). At an early stage of his career Simrock took a high place among students of Shakespeare by his *Quellen des Shakespeare in Novellen, Märchen und Sagen* (1831); and afterwards he translated Shakespeare's poems and a considerable number of his dramas. Another important book was *Novellenschatz der Italiener* (1832). Among the rest of his works may be mentioned *Die Rheinsagen*, *Das malerische und romantische Rheinland*, and his *Deutschen Kriegslieder*.

See Hocker, *Karl Simrock* (1877).

SIMSON, ROBERT (1687–1768), mathematician, was the eldest son of a Glasgow merchant, John Simson of Kirktonhill in Ayrshire, and was born on the 14th of October, 1687. He was intended for the church, and passed with distinction through the usual course of study for that profession at the university of Glasgow. The bent of his mind, however, was towards mathematics, not theology; and, when a prospect was opened up to him of succeeding to the mathematical chair, he proceeded to London in order to become acquainted with some of the eminent mathematicians there and to increase his stock of mathematical knowledge. After a year's residence in London he returned to Glasgow, and in 1711 was appointed by the university to the professorship of mathematics. The duties of this office he discharged for half a century. During that time he published several works on pure geometry, and carried on an extensive mathematical correspondence. In 1746 the university of St. Andrews, wishing to confer on him an honorary degree, chose, according to his biographer Dr. William Trail, that of doctor of medicine, because in his youth he had made a careful study of botany. He never married, and his long life was spent within the walls of his college. His habits were exceedingly regular, his hours of work and of amusement being rigorously fixed. A studious man of science, he had no relish for the promiscuous intercourse of society, and his manner of living was simple and inexpensive. In person he was tall, with a handsome countenance and an affable manner, and he used always to dress in light-colored clothes. Though, like some other distinguished mathematicians, he was rather absent-minded, in matters of business he was very circumspect. He was a man of the strictest integrity, ready to do justice to the merits of others, and not too sensible of his own. He enjoyed a long course of uninterrupted health, and was seriously indisposed only for a few weeks before his death, which took place on the 1st of October, 1768.

The first of Simson's published writings is a paper in the *Philosophical Transactions* of the Royal Society of London (vol. xl. p. 330, 1723) on the subject of Euclid's *Porisms*, the nature of which he was the first to elucidate (see PORISMS). Then followed *Sectionum Conicarum Libri V.* (Edinburgh, 1735), a second edition of which, with additions, appeared in 1750. The first three books of this treatise were translated into English, and several times printed, with the title *The Elements of the Conic Sections.* In 1749 was published *Apollonii Pergæi Locorum Planorum Libri II.*, a restoration of one of Apollonius's lost treatises, founded on the lemmas given in the seventh book of Pappus's *Mathematical Collection.* In 1756 appeared, both in Latin and in English, the first edition of his Euclid's *Elements.* This work, which contained only the first six and the eleventh and twelfth books, and to which in its English version he added the *Data* in 1762, has become the standard text of Euclid in England. The additions and alterations which Simson made by way of restoring the text to its "original accuracy" are certainly not all of them improvements, and the notes he appended show with what an uncritical reverence he regarded the great geometers of antiquity. Two other works, restorations of Apollonius's treatise *De Sectione Determinata* and Euclid's treatise *De Porismatibus*, which Simson was too distrustful of himself to publish during his lifetime, were printed for private circulation in 1776 at the expense of Earl Stanhope, in a volume with the title *Roberti Simson, M.D. . . . . Opera Quædam Reliqua.* The volume contains also two additional books, *De Sectione Determinata*, two small dissertations on *Logarithms* and on the *Limits of Quantities and Ratios*, and a few problems illustrative of the ancient geometrical analysis. How far these restorations represent the lost originals will probably always be a matter of conjecture. The *De Porismatibus* certainly cannot be coextensive with Euclid's three books; but, if it is only a restored fragment, the credit due to Simson's perseverance and penetration in recovering from oblivion the nature and some of the contents of one of the most interesting treatises of antiquity will always be such as to keep his name in the remembrance of geometers.

SIMSON, WILLIAM (1800–1847), portrait, landscape, and subject painter, was born at Dundee in 1800. He studied under Andrew Wilson at the Trustees' Academy, Edinburgh, and his early pictures—landscape and marine subjects—were executed with great spirit and found a ready sale. He next turned his attention to figure painting, producing in 1829 the Twelfth of August, which was followed in 1830 by Sportsmen Regaling and a Highland Deerstalker. In the latter year he was elected a member of the Scottish Academy; and, having acquired some means by portrait-painting, he spent three years in Italy, and on his return in 1838 settled in London, where he exhibited his Camaldolese Monk Showing Relics, his Cimabue and Giotto, his Dutch Family, and his Columbus and his Child at the Convent of Santa Maria la Rabida. He died in London on the 29th of August, 1847.

Simson is greatest as a landscapist; his Solway Moss—Sunset, exhibited in the Royal Scottish Academy in 1831 and now in the National Gallery, Edinburgh, ranks as one of the finest examples of the early Scottish school of landscape.

His elder brother George (1791–1862), portrait-painter, was also a member of the Royal Scottish Academy, and his younger brother David (d. 1874) practiced as a landscape-painter.

SINAI. In judging of the points of controversy connected with Sinai we are brought face to face with the question of the historicity of the Hebrew records involved. Though new attempts to fix the stations of the wilderness wandering appear every year, critics have long agreed that the number of forty for the years of wandering and for the stations are round numbers, and that the details are not based on historical tradition of the Mosaic age. This does not exclude the possibility that the names of some or all of the stations belong to real places and are based on more or less careful research on the part of the writers who record them. As regards the Mountain of the Law in particular, if the record of Exod. xix. *sq.* is strictly historical, we must seek a locality where 600,000 fighting men, or some two million souls in all, could encamp and remain for some time, finding pasture and drink for their cattle, and where there was a mountain (with a wilderness at its foot) rising so sharply that its base could be fenced in, while yet it was easily ascended, and its summit could be seen by a great multitude below. In the valley there must have been a flowing stream. The peninsula of Sinai does not furnish any locality where so great a host could meet under the conditions specified, and accordingly many investigators give up the statistics of the number of Hebrews and seek a place that fulfils the other conditions. But when we consider that the various records embodied in the PENTATEUCH (*q.v.*) were composed long after the time of Moses, and that the authors in all probability never saw Sinai, and had no exact topographical tradition to fall back on, but could picture to themselves the scene of the events they recorded only by the aid of imagination, the topographical method of identifying the Mountain of the Law becomes very questionable. The Pentateuchal writers are not at one even about the name of the mountain. It used to be thought that Horeb was the name of the mountain mass as a whole, or of its southern part, while Sinai was the Mountain of the Law proper, but it has been shown by Dillmann that the Elohist and Deuteronomy always use the name Horeb for the same mountain which the Jahvist and the Priestly Code called Sinai. The Elohist belonged to Northern Israel, but Judges v. 5 shows that even in Northern Israel the other name Sinai was not unknown. And it might be shown, though that cannot be done here, that the several accounts vary not only as regards the name but in topographical details. Thus all that can be taken as historically fixed is that after leaving Goshen the Hebrews abode for some time near a mountain called Sinai or Horeb (*cf.* ISRAEL, vol. xiii. p. 407), and that this mountain or range was held to be holy as a seat of the Deity (Exod. xix. 1–3, 1 Kings xix).

Where, then, was this mountain? The Midianites, of whom according to one source Jethro was priest, probably always lived east of the Gulf of 'Aḳaba; yet we can hardly follow Beke in seeking Sinai beyond that gulf, but must rather think of some point in the so-called peninsula of Sinai, which lies between the Gulfs of 'Aḳaba and Suez, bounded on the N. by the Wilderness el-Tíh, which slopes gently towards the Mediterranean. To the south of this wilderness rises the Jebel el-Tíh, a mass composed mainly of Nubian sandstone and cretaceous limestone, which attains in fantastic forms an altitude of some 3000 feet; its ridges converge towards the south and are cut off by great valleys from the mass now known as Mount Sinai. The latter is composed of primitive rocks,—granite, porphyry, diorite, gneiss, etc. The sandstones of Jebel el-Tíh are rich in minerals; inscriptions of Amenophis III. and Thothmes III. found on the spot show that the ancient Egyptians got emerald, malachite, and kupfergrün at Sarbút al-Khádem; and still older are the turquoise and copper mines of Maghâra, where inscriptions occur bearing the names of kings from Senefru and Cheops down to Rameses II. These mines were worked by criminals and prisoners of war, and the waste products of copper foundries indicate that the peninsula was once better wooded than now, of which indeed we have express testimony of post-Christian date. At present the dominant feature is bare walls of rock, especially in the primitive formations; the steep and jagged summits have a striking effect, which is increased by the various colors of the rock and the clearness of the atmosphere. The deep-cut valleys are filled by rushing torrents after rain, but soon dry up again. In the south the centre of the main mountain mass is Mount Catherine (8540 feet), Omm Shômar to the southeast being little lower; this peak and north of it Mount Serbâl (6750 feet), which rises more immediately from the plain, dominate the Kâ'ah, a waste expanse of sand strown with pebbles, which occupies the southwest margin of the peninsula. In the Kâ'ah is the village of Ṭúr, and at the southern promontory (Ras Mohammed) is the little hamlet of Sherm. The Sinai group as a whole is called by the Arabs Jebel al-Ṭúr; the name Sînâ in Arabic comes only from books. The area of the peninsula is about 11,200 square miles, the population is four to five thousand souls, chiefly Bedouins of various tribes, whose common name, derived from Ṭúr, is Ṭowâra. They have sheep and goats, with which they retire in summer to the high lands, where there is good pasture ground, and where springs are comparatively common. On the chalk and sandstone water is scarcer than among the primitive rocks, and often brackish. Though the rocks are bare, there is always vegetation in the dales, especially acacias and tamarisks; from the latter (*T. mannifera*) manna is still derived in quantities that vary with the rainfall. On the hills grow aromatic plants, especially *Thymaceæ*. The fauna includes the ibex, hyrax, and hyena; the panther too is sometimes found. Flights of quail have been observed. In some valleys there are well-kept gardens and good date-palms; the most noted oasis is that of Feiran, in the northwest of the peninsula, which is watered by a perennial stream. Whether Feiran is the Rephidim of Exod. xvii. is a question which, like the identification of the other stations of the Israelites, depends on the localization of the Mountain of the Law.

There is no genuine pre-Christian tradition on this subject. The chief authority for the ancient sanctity of Mount Sinai is Antoninus Martyr (end of the 6th century), who tells that the heathen Arabs in his time still celebrated a moon feast there. As *sín* means "moon," this feast has been connected with the name of Sinai, but the proposed etymology is not certain. Of heathen origin, too, are the many Nabatæan inscriptions (see NABATÆANS) of Sinai, found especially in the Wády Mokatteb (in the northwest), and sometimes accompanied by rude drawings. The language and character are Aramaic, but the proper names are mainly those of Arabs, who passing by graved their names on the rocks. That they were pilgrims to Sinai cannot be made out with certainty. The inscriptions date from the early years of the Christian era, when the Nabatæan kingdom was at its height.

In early Christian times many anchorites inhabited Sinai, living for the most part in the caves, which are numerous even in the primitive rocks. Then monasteries were built, the most famous being the great one of St. Catherine in Wády el-Dér (the valley of the monastery). On Serbál, too, there were many granite dwellings, and in the neighboring Pharan (Phœnicion), which was a bishop's see, there were, as the ruins show, churches and convents.

The question then is whether when the hermits first settled in the peninsula there existed a tradition as to the place of the Mountain of the Law, and whether they chose for their residence a spot which was already traditionally consecrated by memories significant to the Christian as well as to the Jew. No assertion of the existence of such a tradition is to be found in Josephus, who only says that Sinai was the highest mountain of the district—a description which might apply to Serbál as seen from the plain below. Eusebius uses expressions which may also seem to point to Serbál as the place of the law-giving, and it must be admitted that the tradition which seeks the holy site in the group of Jebel Músá (*i.e.*, the mass of which Mount Catherine is the highest peak) is not older than the time of Justinian, so that the identification with Mount Serbál seems to have greater antiquity in its favor. In later times Jebel Músá and Serbál had each its own tradition, and the holy places were pointed out at each; thus from the monastery of St. Catherine a path of granite steps was constructed up to "the Mountain of the Law," but similar steps are found at Serbál. That these traditions are not decisive, however, is admitted, more or less, even by those moderns who, like Lepsius, Ebers, Bartlett, give their voice for Serbál. Most authorities still prefer Jebel Músá or some point in that group, but they again differ in details. First of all there is much difficulty in determining the route by which the Hebrews approached the mountain. Then comes the question of finding a suitable plain for their encampment under the mountain, which is best met if, with Robinson, Stanley, Palmer, and others, the plain is taken to be that of al-Ráḥe and the overhanging mountain to be Jebel Sufsáfeh. The latter is over 6300 feet high, and consists of pasture ground; it does not fit all the details in Exodus, but this objection is quite as strong against the traditional site on Jebel Músá (Mount Moses), which lies farther to the south. Jebel Músá has been accepted by Tischendorf, Laborde, Ritter, Strauss, Farrar, and many others; on this view the Israelites must have encamped in the narrow Wády al-Seba'íyeh, north of the mount. But the absence of exact topographical detail on the part of the Biblical narrators, who always speak of Sinai as if it were a single summit and give no hint about several summits of which it is one, shows that in their time there was no real tradition on the matter, and that all attempts at identification are necessarily vain.

Literature.—Burckhardt, *Travels in Syria, etc.*, London, 1822; Leon de Laborde, *Voyage de l'Arabie Petrée*, Paris, 1830–36; Robinson, *Biblical Researches*, London, 1841; Lepsius, *Reise*, Berlin, 1845; Stanley, *Sinai and Palestine;* Fraas, *Aus. d. Orient*, Stuttgart, 1867; *Ordnance Survey of the Pen. of Sinai*, Southampton, 1869, 3 vol.; Palmer, *Desert of the Exodus*, Cambridge, 1871; Ebers, *Durch Gosen zum Sinai*, 2d ed., Leipsic, 1881; Baker Greene, *The Hebrew Migration*, London, 1883; Hull, *Mount Seir, Sinai, and West Palestine*, London, 1885. See also the Palestine's Society's *Quarterly Statement, passim.* (A. SO.)

SINCLAIR, SIR JOHN, BART. (1754–1835), a voluminous Scottish author, was descended from the Sinclairs of Ulbster, a branch of the noble house of Caithness. He was the eldest son of George Sinclair and Janet, daughter of William, Lord Strathnaver, and was born at Thurso Castle, 10th May, 1754. For a short time he had Logan the poet as a private tutor, and, after studying Greek and Latin at the high school of Edinburgh, entered the university in his thirteenth year. He was admitted a member of the faculty of advocates in 1775, and was subsequently called to the English bar (Lincoln's Inn), but, preferring politics to law, was in 1780 elected member of parliament for his native county. As Caithness was then only alternately represented with Bute, he was in 1784 chosen for Lostwithiel, Cornwall, and in 1796 for Petersfield, Hampshire, his parliamentary career extending almost uninterruptedly over thirty years till July, 1811. In 1782 he began the issue of those pamphlets on various subjects connected with the welfare of the nation which made him perhaps the most voluminous author of his time, his separate publications, as given in his *Memoirs*, amounting in all to three hundred and sixty-seven.

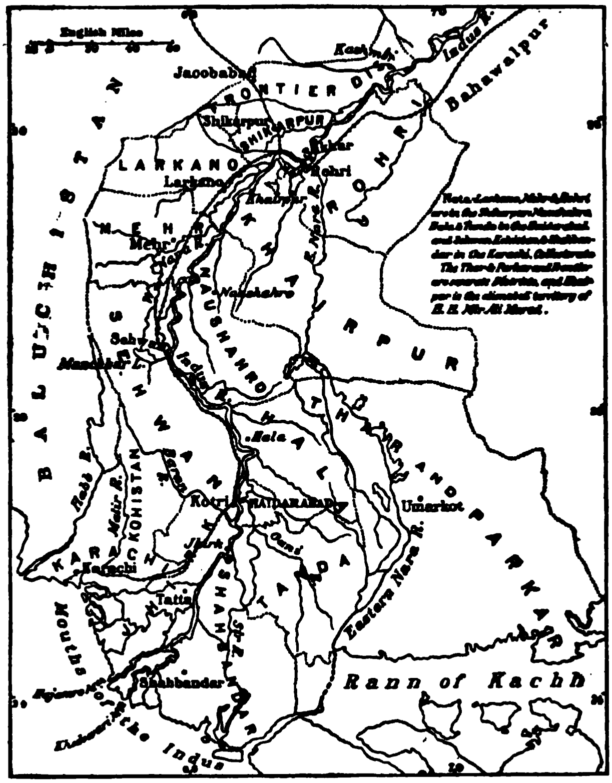
His reputation as a financier and political economist was firmly established by his publication in 1784 of the *History of the Public Revenue of the British Empire*, to subsequent editions of which was added a *Review of the Financial Administration of the Right Hon. William Pitt.* The adoption of his plan for the issue of exchequer bills during the great commercial stagnation of 1793 prevented the ruin of a large number of merchants and manufacturers; and in 1797 Pitt consulted him when the treasury threatened to become exhausted, with the result that the scheme known as the "loyalty loan" was established. On 4th February, 1786, Sinclair was created a baronet of Great Britain. After succeeding his father in 1770 he had set himself to improve the family estates, thus changing in a great degree the aspect of Caithness and affording employment to a largely increased number of the population. In 1791 he established at Edinburgh a society for the improvement of breeds of sheep; and in 1793 he circulated a plan for a board of agriculture and internal improvement. When the board was shortly afterwards established by a charter from the crown he was nominated its first president. From the agricultural reports published by this society he compiled his *Code of Agriculture*, published in 1819. About 1790 he conceived a plan for a *Statistical Account of Scotland*, and the work was published in twenty-one volumes, 1791–1799.

Sir John Sinclair was also the author of a number of tracts on naval and military subjects; and in 1794 he raised for the defence of the kingdom a regiment of a thousand men, at first called the "Caithness Fencibles," afterwards the "Rothesay and Caithness Fencibles"; a second battalion of a thousand men was raised by him in 1795, which took part in suppressing the rebellion in Ireland in 1798. Though originally a supporter in parliament of the war policy of Pitt, he afterwards joined the "armed neutrality" party, which advocated retrenchment and reform. In 1805 he was appointed by Pitt a commissioner for superintending the construction of roads and bridges in the north of Scotland. He was a member of most of the agricultural societies of the Continent, and held as many as twenty-five foreign diplomas. He was a fellow of the Royal Societies of London and Edinburgh, a fellow of the Antiquarian Society of London and President of the Highland Society of London. No man of his time took a more comprehensive and enlightened interest in the general welfare of the country or conferred on it more substantial benefits. He enjoyed the esteem and intimate friendship of many eminent contemporaries both at home and abroad, with several of whom he kept up an extensive correspondence. He died 21st December, 1835.

By his first wife, a daughter of Alexander Maitland of Stoke Newington, near London, he had two daughters, of whom the elder, Hannah, was the authoress of a work on the *Principles of the Christian Faith*. By his second wife, the Hon. Diana Macdonald, only daughter of Alexander, first Lord Macdonald, he had thirteen children, of whom the eldest son, George (1790–1860), who succeeded to the baronetcy, was a schoolfellow of Byron and Peel at Harrow, and is styled by Byron the "prodigy of our school days"; the third son, John (1797–1875), became archdeacon of Middlesex, and besides the *Memoirs* of his father, wrote several theological works; and the fourth daughter, Catherine (1800–1864), who for many years acted as his secretary, after his death achieved some distinction as an authoress, her principal works being *Modern Accomplishments*, 1836; *Scotland and the Scotch*, 1840; *Modern Flirtation*, 1841; and *Popular Legends and Bible Truths*, 1852.

See *Correspondence of the Right Hon. Sir John Sinclair, Bart., with Reminiscences of Distinguished Characters*, 2 vols., London, 1831; and *Memoirs of the Life and Works of the Right Hon. Sir John Sinclair*, 2 vols., Edinburgh, 1837.

SIND, the westernmost territorial subdivision of India, and a frontier province of considerable importance in a geographical and political aspect, lies between the 23d and 28th parallels of N. latitude and between the 66th and 71st meridians of E. longitude. Its length from north to south is estimated at 360 miles, and the average of its breadth from east to west at 170. On the north it is bounded by the Khelat state (see BALUCHISTAN), the Punjab, and Baháwalpúr; on the E. by Jaisalmir and Mulani, or generally the more desert tracts of Western Rajputana; on the S. by the Runn of Cutch (Rann of Kachh) and the Indian Ocean; and on the W. by Khelat, which overlaps it on the north. Including the alienated district of Khairpur and the extensive tract to the south called the political superintendency of the Thar and Parkar, its area is set down as between 56,000 and 57,000 square miles.



Map of Sind.

The one great geographical feature in Sind is the lower Indus, passing, as it does, through the entire length of the province, first in a southwesterly direction, then turning somewhat to the east, then returning to a line more directly south, and finally inclining to the west, to seek an outlet at the sea. Though there is much similarity in the appearance of the landscape on the two sides of the broad river, the distant line of mountains between Sakhar and Sehwan, the steep pass overhanging the water at Lakki, and the hill country below Sehwan give a distinctive character to the right bank, and lend it special attraction when contrasted with the flat lowlands, merging into desert, on the left. Sind has been aptly likened to Egypt. If the one depends for life and fertility on the Nile, so does the other on the Indus. The cities and towns are not so readily to be compared. Hyderabad, notwithstanding its remarkable fortress and handsome tombs, can scarcely vie in interest as a native capital with Cairo; nor can Kurrachee, as a Europeanized capital, be said to have attained the celebrity of Alexandria. Yet there are some respects in which this particular province would not be wholly eclipsed, even in its outside pictures. It contains many monuments of archæological and architectural interest, and to the traveller descending the river from the Punjab, or ascending it from Kotri, the *coup d'œil* on the approach to Rohri is at times singularly striking. The beautiful little island of Khwája Kidhr is a gem in itself; and there is at certain seasons undoubted poetry in the very dreariness of Sakhar and Bakhar.

Owing to the deficiency of rain, the continuance of hot weather in Sind is exceptional. Lying between two monsoons, it just escapes the influence of both. The southwest monsoon stops short at Lakhpat Bandar, the northwest monsoon at Kurrachee, and even here the annual rainfall is not reckoned at more than six or eight inches. At times there is no rainfall for two or three years, while at others there is a whole season's rainfall in one or two days. The average temperature of the summer months rises to 95° F., and the winter average is 60°, the summer maximum being 120° and the winter minimum 32°. The temperature on the sea-coast is much more equable than elsewhere. In Northern Sind we find frost in winter, while both there and in Lower Sind the summer heat is extreme and prolonged. This great heat, combined with the poisonous exhalations from the pools left after the annual inundation and the decaying vegetable deposits, produces the fever and ague with which the name of the country is associated, and to which even the natives themselves fall a prey.

Soil and cultivation.

The soil is largely dependent on the river overflow. This grand provision of nature is, however, uncertainly exercised; and not only is the actual volume of water supplied from the upper Indus liable to fluctuation, but the particular lands inundated or untouched by inundation vary according to the caprices of the river. Questions of alluvion and diluvion are therefore of frequent occurrence; and it is often as hard to say whether newly-thrown-up lands belong to the state or an individual proprietor as it is to decide who is the loser in the case of lands newly submerged. In the lands which, as a rule, are reached annually and in fair proportion by the inundation, the soil is so rich as to produce two crops or even more in the year without the assistance of manure. Salt is present in great quantity. The two principal yearly crops are the vernal, known as *rabi*, sown in autumn and reaped in spring, and the autumnal, known as *kharif*, sown in summer while the river is high and reaped from October to December. In some districts there is a distinct third crop called *peshras*, sown in March and reaped in July and August. The implements of husbandry are the plough (*har*), drawn by two bullocks; the harrow (*sahar*), a heavy log of wood drawn by four bullocks, a man standing on each end; the seed-sower (*nári*), a tube fixed to the plough with a wooden funnel on the top, used while the ground is being ploughed for the last time; a curved hook (*dátro*) with teeth like a saw, for reaping; and a hoe (*kúriah*), for weeding.

Products.

The principal products are *bájri* (a well-known Indian grain), and *juári* (the Indian millet), rice, cotton, sugar-cane, tobacco, oil-seeds, wheat, barley, and indigo. Of these, wheat may be considered the staple produce of Upper, and *bájri* and *juári* of Middle and Lower Sind. Dates, plantains, mangoes, limes, oranges, pomegranates, citrons, figs, grapes, apples, tamarinds, mulberries, and melons are said to be fruits common to the country; and it is added that of late years nectarines, peaches, apricots, and other fruit trees have been successfully introduced, but the statement must be received with some reservation in respect of quantity and quality. There is no doubt that the fruits imported by the Afghan traders find more favor than any home products.

Manufactures.

Among the chief manufactures may be mentioned the gold, silver, and silk embroideries, carpets, cloths, lacquered ware, horse-trappings and other leather-work, paper, pottery, tiles, swords, and matchlocks, and the boxes and other articles of inlaid work introduced more than a century ago from Shíráz. The lac work, a widely extended industry in India, is also in vogue in Sind. Variously colored lac is laid in succession on the boxes, etc., while turning on the lathe, and the design is then cut through the different colors. Hyderabad has long been famous for its silks and cottons, silver and gold work, and lacquered ornaments, and the district could once boast of skilled workmen in arms and armor; but unless the demand for the products of its industries increase, it is to be feared that its old reputation will not long be maintained. In the cloths called *sudi*, silk is woven with the striped cotton—a practice possibly due to the large Mohammedan population of the country, as no Moslem can wear a garment of pure silk without infraction of the law. As regards the carpets, Sir George Birdwood states that those from Sind are the cheapest, coarsest, and least durable of all made in India. Formerly they were fine in design and coloring, but of late years they have greatly deteriorated. The cheap rugs, which sell for about 9s [$2.18] each, are made with the pile (if not altogether) of cow hair, woven upon a common cotton foundation, with a rough hempen shoot. The patterns are bold and suited to the material, and the dyes good and harmonious.

Fauna.

In 1837 the zoology of Sind was reported by Burnes to comprise of genera and species 20 mammals, 191 birds, 36 fishes, 11 reptiles, besides 200 in other departments of natural history. Of wild animals we find the tiger (in the jungles of Upper Sind), the hyena, the *gúrkhar* or wild ass (in the south part of the Thar and Parkar district), the wolf, jackal, fox, wild hog, antelope, *pharho* or hog deer, hares, and porcupines. Of birds of prey, the vulture and several varieties of falcon may be mentioned. The flamingo, pelican, stork, crane, and Egyptian ibis frequent the shores of the delta. Besides these there are the *ubára* (bustard) or *tilúr*, the rock-grouse, quail, partridge, and various kinds of parrots. Waterfowl are plentiful; in the cold season the lakes or *dhandhs* are covered with wild geese, *kulang*, ducks, teal, curlew, and snipe. Among other animals to be noted are scorpions, lizards, centipedes, and many snakes.

The domestic animals include camels (one-humped), buffaloes, sheep and goats, horses and asses (small but hardy), mules, and bullocks. Of fish there are, on the sea-coast, sharks, saw-fish, rays, and skate; cod, *sir*, *cavalho*, red-snapper, *gassir*, *begti*, *dangára*, and *buru* abound. A kind of sardine also frequents the coast. In the Indus, the finest flavored and most plentiful fish is the *palo*, generally identified with the *hilsa* fish of the Ganges. *Dambhro* (*Labeo rohita*) and mullet, *moráko* (*Cirrhina mrigala*) *gandan* (*Notopterus kapirat*), *khago* or catfish (*Rita buchanani*), *popri* (*Barbus sarana*) *shakúr*, *jerkho*, and *singhári* (*Macrones aor*) are also found. Otter, turtle, and porpoise are frequently met with; so too are long-snouted alligators and water-snakes.

Forests.

The extent of forest land is relatively small. The forests (about eighty-seven in number) are situated for the most part on the banks of the Indus, and extend southward from Ghotki in the Rohri deputy collectorate to the middle delta. They are described as narrow strips of land, from two to three miles in length, and ranging from two furlongs to two miles in breadth. The largest are between 9000 and 10,000 acres in area, but are subject to diminution owing to the encroachments of the stream. The wood is principally *bábul* (*Acacia arabica*), *bahan* (*Populus euphratica*), and *kandi* (*Prosopis spicigera*). The *táli* (*Dalbergia Sissú*) grows to some extent in Upper Sind; the iron-wood tree (*Tocoma undulata*) is found near the hills in the Mehar districts. There are, besides, the *nim* (*Melia Azadirachta*), the *pipal* (*Ficus religiosa*), the *bér* (*Zisyphus Jujuba*). The delta has no forests, but its shores abound with mangrove trees. Of trees introduced by the forest department we have the tamarind (*Tamarindus indica*), several Australian wattle trees, the *aula* (*Emblica officinalis*), the *bahera* (*Terminalia Bellerica*), the carob tree (*Ceratonia Siliqua*), the China tallow (*Stillingia sebifera*), the *bél* (*Ægle Marmelos*), and the mahuá (*Bassia latifolia*), as well as the water chestnut (*Trapa natans*). There is a specially organized forest department.

Territorial divisions.

For administrative purposes the province has five well-understood divisions:—(1) *Frontier, Upper Sind*, of which the principal town is Jacobabad, named after the late General John Jacob, C.B., its founder; the hamlet which occupied its site in 1843 was a mere speck in the desert, and its name, Khangarh, can hardly be associated with the fine canal and abundant vegetation now marking the locality; (2) *Shikarpur*, with its capital of the same name and Sakhar, both notable places on the right bank of the Indus; in this division also are the towns of Larkhána and Rohri, the last on the left bank of the river; (3) *Hyderabad* (*Haidarabad*), of which the chief town, having the same name, was the capital of the province prior to the British occupation; (4) *Kurruchee* (*Karachi*), with its modern Europeanized capital and harbor and Tattha, a town of interesting local associations; (5) *Thar and Parkar*, an outlying district on the southeast, more or less part of the desert tract extending far and wide in that particular quarter. Besides these there is the territory of Mir 'Ali Murad, Talpur, greatly curtailed of its original dimensions, but still forming a large land alienation in Upper Sind.

Revenue.

Where cultivation depends so much on the character of the year's inundation, it is natural that the revenue should be uncertain. In 1883-84, for instance, the river was abnormally low. Consequently the area of cultivation was contracted, and, while considerable remissions had to be granted, collections were with difficulty carried out. The rainfall, moreover, except in the Thar and Parkar district, was not only scanty but unseasonable. In Thar and Parkar the rainfall was especially favorable, and owing to an early inundation and wise preparations lands never before cultivated were brought under the plough.

The gross canal revenue in Sind amounted in 1883–84 to Rs. 3,686,754 [$1,791,762.45], and the land revenue to Rs. 1,171,925 [$569,555.55]. In round numbers and English figures—without reference to the deterioration of the rupee—the total is about £487,000 [$2,366,820], of which three-fourths is due to canal irrigation.

Population. The population may be roughly reckoned at two millions and a half, an estimate which is borne out by the census of 1881. Kurrachee is now the most populous of the capitals, and its numbers far exceed those of Shikarpur and Hyderabad. But the character of its inhabitants differs from that of other large towns in Sind. They are for the most part foreign and migratory, and do not represent the true Sindis.

Races and castes. Of the two great divisions of the people in Sind the Mohammedans comprise about two-thirds of the whole, the Hindus the remaining third. The Mohammedans may be divided into two great bodies—the Sindis proper and the naturalized Sindis. The Sindi proper is a descendant of the original Hindu. In religion he is a Súni, though some of the Sindis belong to the Shia sect. There are probably more than three hundred families or clans among the Sindis. There is, as a rule, no distinction of caste, except that followers of certain vocations—such as weavers, leather-workers, sweepers, huntsmen—are considered low and vile. The six different classes of naturalized Sindis are—the four families of the Saiyids (the Bokhári, Mathari, Shirázi, and Lakhiráyi); the Afghans, from Khorasan; the Baluchis; the slaves or Sídís—originally Africans; the Memans; and the Khwájas. The Hindu population of Sind may be divided into the following principal castes: the Brahmans, Kshatrias, Waishias, and Súdras, with their subdivisions. Besides these there are the Sikhs, and the religious mendicants—the Sanási, Jogi, Gosáín, and Ogar,—all of Brahman origin.

Education. The educational progress made in Sind during the quarter of a century succeeding the mutiny has been very great. In 1858 there was but one Government English school, with 82 boys, at Kurrachee, and one, with 25 boys, at Hyderabad; and of the 82 only 8 of the pupils were Sindi. In 1884–85 Sind could boast of a Government high school at Kurrachee with 400 pupils, of another high school at Hyderabad with 338 pupils, and of a third at Shikarpur with 228 boys. The three passed 39 out of 48 candidates for matriculation at the Bombay university. Of vernacular or Sindi-Persian schools under native masters there were 34 which came under Government supervision in 1858, whereas there were in 1884–85 no less than 23 middle schools—teaching the vernacular and English—with 1165 pupils; and in the primary schools the number of pupils was nearly 20,000.

Language and literature. Captain (now Sir Richard) Burton has given a clear and instructive account of the language and literature of Sind. The large proportion of Sanskrit and Arabic words admitted, the anomalous structure of the grammar, and the special sounds of certain letters of its alphabet render the first remarkable; and the original romantic poems and translations of Arabic religious works command the attention of scholars to the second. Among the more celebrated of the native writers are Makhdum Háshim, Makhdum Abdullah, and Saiyid Abdu'l-Latif.

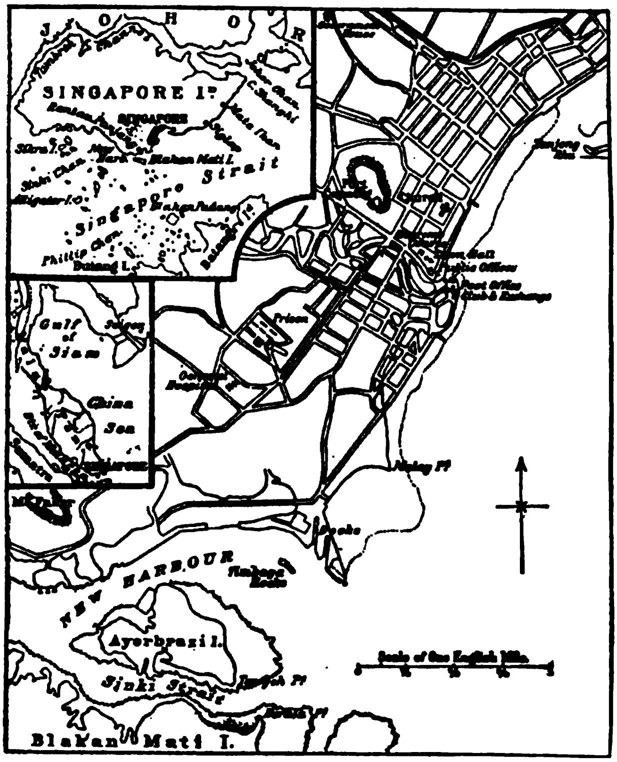
History. The leading features of the two years' campaign of Alexander the Great in the Punjab and Sind have been touched on elsewhere (see INDIA, vol. xii. p. 826). About 711 A.D. the Hindus of Sind were conquered by Muhammad Kasim, the young general of the caliph Walid, but his successors were unable to hold their ground. In reality it was the overwhelming irruption of Mahmúd of Ghazni three centuries later which finally subjugated the province. Nearly six centuries later still, Sind was annexed by the great Akbar to Delhi. In the meanwhile it had been governed by princes and petty chiefs, all of whom are celebrated in local history. After Akbar, and up to the time of Nadir Shah's invasion of India, there is little historically important to distinguish the province, separated from the other divisions of the Mughal empire, though its governors possessed a certain delegated power which might well have tempted the more ambitious to revolt. When Nadir took possession of the lands west of the Indus, one Núr Muhammad Kalhora was the *quasi* ruler in Sind. The tribe to which he belonged claimed lineal descent from Abbas, uncle of the prophet, and had a widely-spread repute for sanctity. Their political influence had been, moreover, increasing for many years, and in the person of one or two of their stronger chiefs they had on sundry occasions risen in arms against the imperial troops. In 1701, or thirty-eight years before the Persian invasion, Yar Muhammad Kalhora had obtained possession of Shikarpur, and managed to get from the Mughal emperor a firman conferring upon him the "subahdári" of the Déra districts, with the title of "Khuda Yár Khan." On his death in 1719 he had extended his territory by the acquisition of the Kandiára and Larkhána districts, and of Síbi, a vast tract of country then including within its limits Sakhar as well as Shikarpur. He was succeeded by his son Núr Muhammad, who, as above shown, was in the unenviable position of having to account for his actions to no less notable an antagonist than Nadir himself. The latter was eventually appeased by an annual tribute of 20 lakhs of rupees, and on his return to Persia conferred upon the Kalhora prince the title of "Shah Kuli Khan." On Nadir's death the Sind lands of Núr Muhammad became tributary to Ahmad Shah of Kandahar, the transfer being sealed by the bestowal of a new title. "Shah Nawáz Khan." This occurred in 1748, from which date till 1783—when Abdul Nabi, the last of the Kalhora princes, was defeated by Mir Fath Ali Khan, and the ruling dynasty forcibly superseded by the Talpúr Baluch chiefs—the local history is a mere record of conflicts and reconciliations, treaties and evasions of treaty, as regards outside powers, and of revolution and bloodshed within. The seat of government had become established at Hyderabad, founded by Ghulam Shah Kalhora in 1768. We now come to the Talpúrs. These Baluchis had immigrated to Sind from their native hills under Mir Shahdad in the early part of the 18th century, and had taken service under Núr Muhammad Kalhora. Shahdad, raised to rank and influence, died, leaving four sons, the third of whom, Mir Bahram, succeeded as head of the tribe. His murder by a grandson of Núr Muhammad was one of the main causes of the ill-feeling which had culminated in bitter hostility when later acts of treachery and barbarism sealed the fate of the tyrant rulers. The Talpúrs entered Hyderabad as conquerors; but unfortunately for the consolidation of their sovereignty the suspicious nature of Mir Fath Ali, the head of the house, alarmed his near relatives. His nephew Sohrab fled to Upper Sind, and founded the principality of Khairpur, while Tára, moving eastward, became the independent chief of Mirpur. Later on, Mir Fath Ali, undeterred by divisions which he had no power to prevent, admitted to a share of his own government of Hyderabad his three younger brothers, Ghulam Ali, Karm Ali, and Murad Ali. On the death of Fath Ali in 1801 the three continued to rule together; and when Ghulam Ali was killed in 1811 the duumvirate remained supreme; but, on the death of Karm Ali in 1828 and Murad Ali a few years later, the old system was revived, and a government of four again instituted. Such was the state of things when British relations with the province had become necessarily an urgent consideration, owing to the Afghan expedition of 1838 (see vol. xii. pp. 846–47).

During this crisis of Anglo-Indian history the political officers in Sind and Baluchistan had a difficult task to perform, and it is infinitely to their credit that more mischief did not ensue in these countries from the many and heavy British disasters in the north. But the amírs of Sind were to be dealt with for infractions of treaty if not for open hostility; and Sir Charles Napier had to call them to account soon after his arrival at Sakhar in the autumn of 1842. The long and complex narrative need not be here repeated. Suffice it to state that the outcome was the conquest of Sind,—the immediate result of the battle of Miáni, fought in the vicinity of Hyderabad in February, 1843. A course of wise, firm, and kindly administration inaugurated by Sir Charles Napier himself, and continued by Messrs. Pringle, Frere, Inverarity, Gen. John Jacob, Sir W. Merewether, and later commissioners, has since made the province an important section of the western presidency of India. The story of the eight years' rule of Sir Bartle Frere in Sind has yet to be written, but his name is associated with numerous matters of paramount importance,—in relation especially to the position and fortunes of the deposed amírs, the rights and immunities of the old privileged landholders, the organization of municipal institutions, the promotion of systematic education, the due administration of justice, and the erection of public works of utility.

See Hughes's *Gazetteer of Sind*; Burton's *History of Sind*; *Bombay Government Records*, No. xvii.; *Bombay Educational Report*, 1885; *Annual Report on Administration of Sind*; *Report of Director of Public Instruction, Bombay*, 1857–58; Birdwood's *Handbook to Indian Court*, Paris, 1873. (F. J. G.)

SINGAN, a form of the name SE-GAN FOO (*q.v.*).

SINGAPORE, a British dependency, commercially and administratively the most important of the **Straits Settlements** (*q.v.*), which form a separate colonial government. It consists principally of an island 27 miles long by 14 broad, lying off the south end of the Malay Peninsula, but also includes upwards of 70 insignificant islets to the south and west within a radius of 10 miles. From the mainland of Johor, as this part of the peninsula is called, Singapore island is separated by a strait, Salat Tabras or Tambrosh, less than half a mile wide at the narrowest point, which was formerly the main channel of navigation to the Chinese seas. The name of Singapore Strait is given to the much wider channel which separates the island on the south from the various islands of Butang, Batang, Bintang, etc., belonging to the Dutch East Indies. The surface of Singapore is undulating, and diversified by hills ranging from 70 to rather less than 400 feet, the highest point being Bukit Timah, to the northwest of the town (about 519 feet). Geologically the core of the island consists of crystalline rocks; but in the west there are shales, conglomerates, and sandstones; and all round the island the valleys are filled with alluvial deposits on a much more extensive scale than might be looked for where none of the streams have a course of more than six miles, or attain to any considerable size except after heavy rains (see details in J. R. Logan's "Local and Relative Geology of Singapore," in *Jour. Beng. Asi. Soc.*, vol. xvi., and "The Geology of the Straits of Singapore," in *Lond. Geol. Jour.*, 1851, vol. vii.). The southwestern shores are fringed with coral reefs, and living coral fields are found in many parts of the strait. Being chiefly composed of red clays and laterite, the soil is not generally rich, and requires careful and liberal husbandry to make it really productive. When it was first occupied by the English the whole island was covered with forest and jungle; and, although this was largely cleared off subsequent to 1837, when a mania for nutmeg plantations set in, the moisture and warmth of the climate have kept it clothed with luxuriant and perpetual verdure, in which palms, ferns, and orchids are conspicuous forms. "Near the shore, by the mouths of creeks, are grouped quaint dwellings of fishermen, built of wood or palm leaf standing on piles over the water. In the smooth sandy bays cocoanut palms shelter the picturesque Malay houses. More inland we find groves of fruit trees, small patches of sugar-cane, Chinese gardens, tapioca and indigo fields. Neat bungalows—the residences of officials, merchants, and rich Chinese and Arabs—diversify the scene, particularly in the vicinity of the town. In the remote parts of the island more especially there are waste spaces which were formerly gambier plantations and are now covered with coarse lalang grass" (Governor Wild). The nutmeg trees which had for twenty years been a main source of wealth were blighted in 1860; the plantations were completely given up; and, though many of the abandoned trees recovered and nutmegs can still be gathered in Singapore, they have never again been cultivated. Cotton planting was the next tried, but without success, and though cinnamon grows well the labor necessary for its cultivation and manufacture is too expensive. Gutta percha, originally introduced to England from Singapore, was so much run upon that all the trees of that kind in the island were exterminated. Gambier and pepper, both at one time largely grown, have for many years been of little account. Liberian coffee, pine-apples, cocoa-nuts, and aloes are now the most important objects of cultivation. Quite recently districts have been inclosed for reforestation and the eucalyptus and other trees have been planted. Almost all kinds of fruits do well in the island,—the custard-apple, pine-apple, sour-sop, lime, orange, and plantain being in season nearly all the year, and the durian, blimbing, duku, langsat, mangosteen, rambutan, tarrup, tampang, etc., in July and August and also for all or some of the months between November and February. The botanical and Zoological gardens at Singapore, connected with the Agri-Horticultural Society, have been devoted to the introduction of economic plants, such as China and Assam tea, saltbush or *Rhagodia*, which forms excellent fodder, etc.



Singapore and its Environs.

In climate Singapore is wonderfully fortunate for a country within one degree of the equator. There is hardly any seasonal change, and the annual range of temperature is generally only from 70° to 90°. "The nights especially are very cool and refreshing, and enable people to sleep without difficulty." The atmosphere is almost uniformly serene, and the face of the ocean is only disturbed by the swell of distant tempests in the China Sea or the Bay of Bengal. The northeast monsoon is the master wind from November to April, but is generally neither persistent nor powerful, and the southwest monsoon is even less regular in its action. The southerly winds in May and June known as Java winds have very much the character of land and sea breezes, but are considered very enervating in spite of the pleasant feeling of freshness which they at first produce. Rapid squalls (sumatras) also occur during the southwest monsoon and beneficially clear the air. Instead of periodical rains there are (on a sixteen years average) 167 wet days distributed throughout the year. The annual rainfall is 92.27 inches; 1885, a very dry year, showed only 69 inches, according to Dr. Rowell's report. The mean maximum temperature in the shade is 86.7°, the mean minimum in the shade 73°. The highest temperature observed during the sixteen years was 94° in April, 1878, and the lowest 65° in February, 1874. Most of the domestic animals of Europe have been introduced, but not in great numbers. Deer, wild hogs, sloths, monkeys, and squirrels are the more noteworthy mammals; and tigers, which formerly committed serious depredations among the natives, still occasionally find their way across the strait from the mainland. When the first census was taken in 1824 the settlement of Singapore was found to contain 10,603 inhabitants, and by 1850 this number had increased to nearly 60,000. The following figures show the more important components of the population in 1860, 1871, and 1881,—the totals for those years being 80,792, 97,111, and 139,208 respectively:

	1860.	1871.	1881.
Europeans and Eurasians.....	2,445	3,207	2,769
Malays........................	10,888	19,250	22,155
Klings, etc......................	......	10,244	12,058
Chinese.........................	50,043	54,098	86,766
Javanese.......................	3.408	3,239	5,881

The total is estimated to be now well over 150,000. The preponderance and rapid increase of the Chinese is a most striking feature, mainly due, however, to a steady stream of immigration. The death-rate in Singapore is very much higher than the birth-rate—4473 being the average number of deaths in 1881–83 against 1919 births. This is largely to be ascribed to the paucity of women—33,785 females to 105,423 males in 1881. In the small number of Europeans proper—1283—there are nineteen nationalities represented.

The only town in the settlement is the city of Singapore, the general capital of the Straits settlements. It lies on the south side of the island in 1° 16′ N. lat. and 103° 53′ E. long., a bright, picturesque, prosperous, and progressive place, with a sea frontage extending for about 6 miles from New Harbor northeast to the Rochore and Kallang suburbs. Under the control of its municipality, which has a yearly revenue of more than 300,000 dollars, a great variety of improvements have been effected—the river dredged and deepened, foreshores reclaimed, bridges built, trees planted, and public buildings erected—within the last six or seven years. The principal churches, the court-house, and the European quarters generally are situated on the north side of the river, while on the south side extend the warehouses and shops of the European and Chinese traders. On Peel Hill, 170 feet high, stands a citadel; and on Government Hill is the Government house—a palatial residence in park-like grounds. The cosmopolitan character of the population gives great brightness of color to the crowded streets and is reflected in the architectural peculiarities of the native quarters—where Mohammedan mosques, Chinese joss-houses, and Hindu temples are equally at home. Among the more important European edifices are St. Andrew's cathedral (first consecrated in 1838, present building erected in 1861, became cathedral in 1870), the Roman Catholic cathedral, the supreme court-house, the new post-office (1883–84), the new police courts (1884), the European hospital, the jail, the Tanglin barracks, and the Raffles school (dating from 1823). The Raffles public library and museum had 320 subscribers in 1885 and 34,250 visitors, the books issued numbering 16,348. Several English papers, as well as one Chinese and one Malay, are published at Singapore. As a trading-port Singapore has great advantages over and above its position on the Straits. The harbor is safe and has good anchorage, and it can be approached without the assistance of pilots from three directions. New Harbor is the name of the channel which lies between the southern projection of the main island and the small island of Blakan Mati, and is divided by the still smaller island of Ayer Brazi. It is there that the Peninsular and Oriental Steam Navigation Company and the Messageries Maritimes have their docks and depôts. At Tanjong Pagar there are two graving docks,—Victoria Dock having a length of 450 feet, a breadth of 65 feet, and a sill-depth at spring-tides of 20 feet, and the corresponding figures for Albert Dock being 470 feet, 60 feet, and 21 feet. The two New Harbor Docks are respectively 415 and 459 feet long, and 42 and 62 feet broad, and have sill-depths of 14–15½ and 19–20 feet. At Pulo Brani, Bon Accord Dock has a length of 330 feet, a breadth of 50, and a sill-depth of 17. A large admiralty dock for the use of ships of the British navy is being constructed. Opposite Singapore proper the sea shallows to a few fathoms. The tides (tables of which were first published in 1884) are as yet imperfectly registered, but in general they consist of a principal high-water and low-water succeeded by a secondary high water and low water of the most limited range. The commercial movement of the port has rapidly attained vast dimensions. While in 1851–52 the total exports and imports amounted to £5,739,556 [$27,894,242.16], they reached £10,371,300 [$50,404,518] in 1859–60, £18,292,180 [$88,899,994.80] in 1870, £23,050,943 [$112,027,582.98] in 1880, and £25,931,930 [$126,029,179.80] in 1883. There is no railway in the island; but in 1886 a steam tramway was opened from Tanjong Pagar to Elgin Bridge. Till quite recently the town was practically without defences; but since 1885 the colony has constructed a series of batteries at Serapong, Blakan Mati, Mount Palmer, etc., at a cost of £75,000 [$364,500], and the home Government has expended £90,000 [$437,400] on the ordnance.

The name Singapore or Sinhapura, *i.e.*, Lion City, was originally given to a town founded by Hinduized Malay or Javanese settlers from Sumatra at an early date in the Christian era. The commercial importance of the place in the 14th century is attested by Barros, but the Sanskrit origin of the name had by his time been forgotten, and he was taught to derive it from Malay words. Not long afterwards the town must have fallen into decay, and at the beginning of the present century the only trace of its existence was certain rock inscriptions in a very old character, and the whole island had not more than 150 inhabitants. Alexander Scott recognized the excellent position of the island in the 18th century, and Sir Stamford Raffles, whose attention was called to it by Captains Ross and Crawford of the Bombay marine, fixed on it as the site of the great commercial emporium which he determined to found for the encouragement of British trade in the East. In 1819 permission was obtained to build a British factory on the south coast; and in 1824 the island was purchased from the sultan of Johor for 60,000 Spanish dollars (£13,500 [or $65,610]) and a life annuity of 24,000 dollars (£5400 [or $26,244]). The city became the capital of the Straits Settlements instead of Prince of Wales Island in 1832.

See Belcher, *Voyage of the Samarang;* Collingwood's *Naturalist's Rambles in the Chinese Seas; The Directory of the Straits Settlements for* 1886; the *Journal of the Straits Branch of the Royal Asiatic Society*, published at Singapore; and other works quoted under the heading STRAITS SETTLEMENTS.

SINGBHUM, a British district in the lieutenant-governorship of Bengal, lying between 21° 59′ and 22° 53′ N. lat. and between 85° 2′ and 86° 56′ E. long. It has an area of 3753 square miles, and is bounded on the N. by the districts of Lohárdagá and Mánbhúm, on the E. by Midnapur, on the S. by the tributary states of Orissa, and on the W. by Lohárdagá and the tributary states of Chutiá Nágpur. Its central portion consists of a long undulating tract of country running east and west, and enclosed by great hill ranges. The depressions lying between the successive ridges comprise the most fertile part, which varies in elevation above sea-level from 400 feet near the Subarnarekhá on the east to 750 feet around the station of Cháibásá. South of this an elevated plateau of 700 square miles rises to upwards of 1000 feet. In the west of the district is an extensive mountainous tract, sparsely inhabited by the wildest of the Kols; while in the extreme southwest corner is a still grander mass of mountains, known as "Saranda of the seven hundred hills," rising to a height of 3500 feet. From the Layádá range on the northwest of Singbhúm many rocky spurs strike out into the district, the more prominent of them attaining an elevation of 2900 feet. Among other ranges and peaks are the Chaitanpur range, reaching an elevation of 2529 feet, and the Kápargádi range, a conspicuous ridge rising abruptly from the plain and running in a southeasterly direction until it culminates in Tuiligár Hill (2492 feet). The principal rivers are the Subarnarekhá, which with its affluents flows through the eastern portion of the district; the Koel, which rises west of Ranchi and drains the Saranda region; and the Baitarani, which touches the southern border for 8 miles. About two-thirds of Singbhúm district is covered with primeval forest, containing some valuable timber trees; in the forests tigers, leopards, bears, buffaloes, and several kinds of deer abound, and small herds of elephants occasionally wander from the Meghásani Hills in Morbhanj. The climate is dry, and the hot season is extremely trying, the thermometer frequently registering 106° F. in the shade; the average annual rainfall is about 57 inches.

The census of 1881 disclosed a population of 453,775 (226,681 males and 227,094 females); Hindus numbered 447,810, Mohammedans, 2329, and Christians, 2988. The only town containing a population of more than 5000 is Cháibásá, the civil station and administrative headquarters of the district, with 6006 inhabitants. The staple crop of Singbhúm is rice, and the other chief crops are wheat, Indian corn, pease, gram, mustard, sugar-cane, cotton, and tobacco. The principal manufactures are coarse cotton cloths, brass and earthenware cooking utensils, and soapstone platters. Cereals, pulses, oil-seed, stick-lac, and iron comprise the chief exports; and the imports include salt, cotton thread, English cloth goods, tobacco, and brass utensils.

Colonel Dalton, in his *Ethnology of Bengal*, says that the Singbhúm Rajput chiefs have been known to the British Government since 1803, when the marquis of Wellesley was governor-general of India; but there does not appear to have been any intercourse between British officials and the people of the Kolhán previous to 1819. The Hos or Larka Kols, the characteristic aboriginal race of Singbhúm district, would allow no stranger to settle in, or even pass through, the Kolhán; they were, however, subjugated in 1836, when the head-men entered into engagements to bear true allegiance to the British Government. The country remained tranquil and prosperous until 1857, when a rebellion took place among the Kols under Parahat Rájá. After a tedious campaign they surrendered in 1859, and the capture of the raja put a stop to their disturbances.

SINGING. See VOICE.

SINHALESE. See CEYLON.

SINIGAGLIA, or SENIGALLIA (the official form), a city of Italy, in the province of Ancona, in 43° 43′ 16″ N. lat., on the coast of the Adriatic, 17 miles by rail north of Ancona. It is well built, with broad and well-paved streets, and has the general appearance of a thriving commercial town. A modern cathedral, erected subsequent to 1787, a large Jewish synagogue, a theatre, the communal buildings, and the old palace of the dukes of Urbino are the more notable buildings. The communal library was founded by Cardinal Nicola Antonelli in 1767; and the principal hospital and one of the orphanages date from 1534. The port is formed by the lower reaches of the Misa, a small stream which flows through the town between solid embankments constructed of Istrian marble. Between July 20 and August 8 Sinigaglia annually holds one of the largest fairs in Italy, which dates originally from 1200, when Sergius, count of Sinigaglia, received from the count of Marseilles, to whose daughter he was affianced, certain relics of Mary Magdalene. The fair has diminished in importance since the opening of the railway, but formerly it used to be visited by merchants from France, Switzerland, Austria, Germany, and especially the Levant. The population, exclusive of the suburbs, was 10,501 in 1861 and 6634 (commune 22,499) in 1881.

Sinigaglia is the ancient *Sena* (Σήνη) or (to distinguish it from Sena Julia, *i.e.*, Siena) *Sena Gallica*, a town of the Galli Senones (Σήνωνες), whose name appears as Senogallia as early as Pliny. Sena was made a Roman colony immediately after the conquest of the Senones in 289 B.C. It was the rendezvous of the consuls Livius and Nero before the battle of the Metaurus, also known as the battle of Sena, in which Hasdrubal was defeated (207 B.C.). The sack of the town by Pompey, Sulla's lieutenant, in 82 B.C., is the only other notable fact in its ancient annals. Ravaged by Alaric, fortified by the exarch Longinus, and again laid waste by the Lombards in the 8th century and by the Saracens in the 9th, Sinigaglia was at length brought so low by the Guelf and Ghibelline wars, and especially by the severities of Guido de Montefeltro, that it was chosen by Dante as the typical instance of a ruined city. In the 15th century it was captured and recaptured again and again by the Malatesta and their opponents. Sigismond Malatesta of Rimini erected strong fortifications round the town in 1450–1455. The lordship of Sinigaglia was bestowed by Pius II. on his nephew Antonio Piccolomini, but the people of the town in 1464 placed themselves anew under Paul II., and Giacomo Piccolomini in 1472 failed in his attempt to seize the place. Sixtus VI. assigned the lordship to the Della Rovere family, from whom it was transferred to Lorenzo di Medici in 1516. After 1624 it formed part of the legation of Urbino.

SINKING FUND. See NATIONAL DEBT, vol. xvii. p. 252.

SINOPE, or in Turkish SINÛB, a town and seaport on the north coast of Asia Minor, on the isthmus and peninsula of Boztepeh, which forms part of the most northerly projection of the Anatolian seaboard. Though it possesses the finest natural harbor save one in the Black Sea, defective communication with the interior, and the consequent rivalry of Ineboli (since about 1848), have prevented Sinope taking its natural position as a great commercial centre. But between 1882 and 1885 roads have been constructed which give direct access southward to Cæsarea and even to Tarsus, near the south coast. The town still bears the stamp of its former importance. On the isthmus stands a huge but for the most part ruined castle, originally Byzantine and afterwards strengthened by the Seljuk sultans; and the old town is surrounded by Byzantine walls. Of early Roman or Greek antiquities there is little trace; but the ancient local coinage furnishes a very beautiful and interesting series of types (see M. J. P. Six's paper in *The Numismatic Chronicle*, 1885). The population has not greatly changed since 1868, when it was found to be 9668 inhabitants, of whom 7299 were Mohammedans and 2369 Greeks and others.

Sinope (Σινώπη), whose origin was mythically assigned by its own ancient inhabitants to Autolycus, a companion of Hercules, was colonized by the Milesians, and ultimately became the most flourishing Greek settlement on the coast of the Euxine. In the 5th century B.C. it received a colony of Athenians; and by the 4th it had extended its authority over a considerable tract of country and become itself the mother of several colonies—Cerasus (Kerasûn), Trapezus (Trebizond), Cotyora, etc. Its fleet was practically dominant in the Euxine, except towards the west, where it shared the field with Byzantium. When in 220 B.C. Sinope was for the first time attacked by the king of Pontus, the assistance of the Rhodians enabled it to maintain its independence. But where Mithradates IV. failed Pharnaces succeeded; and the city, taken by surprise in 183 B.C., became the capital of the Pontian monarchy. Under Mithradates the Great, who was born in Sinope, it had just been raised to the highest degree of prosperity, with fine buildings, naval arsenals, and well-built harbors, when the Romans under Lucullus and Pompey effected the subjugation of Pontus. In 64 B.C. the body of the self-slain Mithradates was brought home to the royal mausoleum. Under Julius Cæsar the city received a Roman colony. In the Middle Ages it became subject to Trebizond, and in 1470 it passed into the hands of the Turks. In November, 1853, the Russian vice-admiral Nakhimoff destroyed here a division of the Turkish fleet and reduced a good part of the town to ashes.

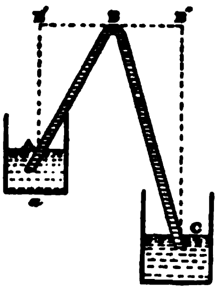
SIOUX CITY, a city of the United States, the capital of Woodbury county, Iowa, lies 156 miles northwest of Des Moines, on the sloping banks of the Missouri river. It is a great railway centre (Chicago, Milwaukee, and St. Paul Railway, Sioux City and Pacific Railway, etc.), has an extensive trade, and contains an opera house, foundry and machine shops, pork-packing factories, and mills. The population of the city (which was laid out in 1854 and incorporated in 1857) was 3401 in 1870 and 7366 in 1880 (township 7845).

SIPHANTO, SIPHENO, or SIPHNO (ancient Greek Σίφνος), an island of the Greek Archipelago, in the nomarchy of the Cyclades, 30 miles southwest of Syra. It has an area of 28 square miles, and the population in 1879 was 5762. A ridge of limestone hills—whose principal summits, Mount Elias and St. Simeon, are crowned by old Byzantine churches—runs through the island; for about 2 miles along the western slope stretches a series of villages, each whitewashed house with its own garden and orchard. Apollonia, one of the five (so-called because built on the site of a temple to Apollo), is the modern capital; formerly this rank belonged to Kastro (also called Seraglio), an "old-world Italian town" with mediæval castle and fortifications, and an old town-hall bearing date 1365. Inscriptions found on the spot show that Kastro stands on the site of the ancient city of Siphnos; and Mr. Bent identifies the other ancient town of Minoa (see the Περὶ πόλεων of Stephanos Byzantios) with the place on the coast where a Hellenic white marble tower is distinguished as the Pharos or lighthouse and another as the tower of St. John. Churches and convents of

Byzantine architecture are scattered about the island. One building of this class is especially interesting—the school of the Holy Tomb or school of Siphnos, founded by Greek refugees from Byzantium at the time of the iconoclastic persecutions, and afterwards a great centre of intellectual culture for the Hellenic world. The endowments of the school are now made over to the gymnasium of Syra. In ancient times Siphnos was famous for its gold and silver mines, the site of which is still easily recognized by the excavations and refuse-heaps. A French company has started mining operations at Kamara. As in antiquity so now the potters of the island are known throughout the Archipelago.

The wealth of the ancient Siphniotes was shown by their treasury at Delphi, where they deposited the tenth of their gold and silver; but, says the legend, they once sent Apollo a gilded and not a golden bull, and he in his anger flooded their mines. That the mines were invaded by the sea is still evident; and by Strabo's time the inhabitants of the island were noted for their poverty. During the Venetian period it was ruled first by the Da Corogna family and after 1456 by the Gazzadini, who were expelled by the Turks in 1617.

SIPHON, or **Syphon**, an instrument usually in the form of a bent tube for conveying liquid over the edge of a vessel and delivering it at a lower level, or in a position of less hydrostatic pressure. The principle on which it acts (see Hydromechanics) may be understood from the accompanying diagram. ABC is a tube filled with liquid, the shorter limb dipping under the surface of the liquid in jar *a*, the longer in jar *b*. The pressure in the tube at A is atmospheric pressure minus that of the vertical column AB′, while that at C is atmospheric pressure minus that of the column CB″. When CB″ is longer than AB′ the pressure at C is, of course, less than that at A, and a current flows in the direction ABC through the siphon. When AB′=B″C, that is, when the liquid stands at the same level, pressure is equal in the two limbs, and the current ceases. The siphon has practically a certain minimum diameter for each liquid, as capillarity prevents a fluid from flowing out of tubes of very small bore unless under the influence of electricity, heat, or great pressure. The instrument is largely employed for chemical work, both in the laboratory and in manufacturing processes; it is formed of glass, india-rubber, lead, or other substance, according to the purpose for which it is intended. The simple siphon (see Fig.) is used by filling it with the liquid to be decanted, closing the longer limb with the finger and plunging the shorter into the liquid, and it must be filled for each time of using. Innumerable forms have been devised adapted for all purposes, and provided with arrangements for filling the tube, or for keeping it full and starting it into action automatically when required. The former purpose is usually effected by blowing into the vessel through a second opening in the stopper through which the siphon passes, or by means of a sucking or blowing tube attached to the longer limb, or by pouring in liquid through a flexible tube attached at the bend. The second plan is frequently realized by having a stopcock on the longer limb and a valve opening upwards on the shorter, or by having both limbs of equal length and each standing in a cup, in which case when the level changes in either cup the siphon tends to equalize it by conveying liquid from the higher to the lower. Many other forms are in constant use in the arts, and the siphon is also employed in some of its modifications in surgery, in engineering, and in other sciences.



Siphon.

SIRACHIDES. See Jesus, the Son of Sirach.

SIRÁJGANJ, a town in the district of Pabna, Bengal, and the most important river-mart in that province, is situated near the Jamuná or main stream of the Brahmaputra in 24° 26′ 58″ N. lat. and 89° 47′ 5″ E. long., with a population of 21,037 (11,213 males and 9824 females) in 1881. The business of Sirájganj is that of a changing station; the agricultural produce of the surrounding country is brought in in small boats and transferred to wholesale merchants for shipment to Calcutta in steamers or large cargo boats, and in return piece goods, salt, hardware, and all sorts of miscellaneous articles are received from Calcutta for distribution. Sirájganj is also the centre of the jute trade of Eastern Bengal.

SIR-DARIA. See Syr-Darya.

SIREDON. At the end of last century specimens of a kind of branchiate tailed Amphibian were brought to Europe from the lakes of Mexico; they were examined by the zoologists of Paris and described by Cuvier in Humboldt's *Recueil d' Observations de Zoologie*, vol. i., and by Daudin in *Hist. des Reptiles* (Paris, 1802–1804), under their native name of "Axolotls." The animals were named *Siren pisciformis* by Shaw (*Zool.*, vol. iii.). Wagler, in his *Natürliches System der Amphibien* (Stuttgart, 1828–1833), separated the axolotl from the Linnæan genus *Siren* and called it *Siredon axolotl*, and later writers have often referred to the animal under the name *Siredon pisciforme*, Shaw.

The axolotl of Mexico is about 6 or 7 inches in length; it has four pairs of gill-slits and three pairs of long feather-like external branchiæ. The branchial apertures are between the hyoid arch and the first branchial arch, and between the first-second, second-third, and third-fourth branchial arches. The branchiæ are attached to the first, second and third branchial arches. The body is cylindrical, and a median membranous fin extends along the trunk dorsally, is continued along the tail, passes round the end of the latter and terminates ventrally at the anus. It has four limbs, which are short and somewhat stout; the anterior terminate in four and the posterior in five digits. The color of the axolotl is a uniform black.

The animal is therefore, except in size, very similar to the aquatic larva of *Triton*, or other Salamandroid, and Cuvier expressed the opinion that it was a larval form which for some unknown reason was unable to attain the adult condition. That it could not be considered simply as the larva of an unknown species of Salamandroid was evident from the fact that it possessed fully developed sexual organs in both sexes. There was every reason to believe that it bred freely in the branchiate condition in which it was discovered. The animal is so common in the lakes near the city of Mexico that it is brought regularly to market and used largely by the Mexicans as food (9).[1]

If nothing more than the above were known about the axolotl it would be classed among the *Perennibranchiata*, in the family *Proteidæ*, having its nearest ally in the genus *Menobranchus*. Up till the year 1865 no actual observations had been made by zoologists on the breeding of the axolotl; all that was known was that the genital organs in many of the specimens examined were in perfectly mature condition. In that year, on January 18, 6 axolotls, 5 males and 1 female,—which had been living for a year in the menagerie of reptiles of the Musée d'Histoire Naturelle at Paris,—began to breed, and the deposition and hatching of the eggs was carefully studied by Prof. A. Duméril (1). The eggs were 2 mm. in diameter, and the period of development within the egg was 28 to 30 days; the larvæ were hatched in February, and were 14 mm. to 16 mm. in length. In the beginning of September, when the larvæ had almost reached the size of the parents, it was noticed that one of them was undergoing a metamorphosis similar to that of the larval *Triton* to the adult. In a short time yellow spots appeared on the skin, the branchiæ disappeared, the gill-slits closed up, the median fin disappeared, the animal began to breathe air and permanently quitted the water. The same process of metamorphosis was repeated by several of the larvæ, until finally out of several hundred about thirty reached the salamandroid condition. The parents in the meantime were still alive, and had undergone no change. When the structure of the transformed specimens was examined, they were found to resemble in all generic characters the genus *Amblystoma*, of which several species were known, inhabiting various parts of North America.[1] The consideration of Duméril's discovery gives rise to several perplexing questions, which have been discussed by many zoologists experienced in the study of the *Amphibia*, and even now can scarcely be said to be completely settled. The first question is—To what species of *Amblystoma* did the transformed axolotls of Duméril belong? Duméril himself, in the full account (**2**) which he published concerning the animals and their metamorphosis, was unable to give a decided opinion concerning the identification of the species of his *Amblystoma*, but on a subsequent occasion he confirmed the suggestion of Prof. E. D. Cope (**10**) that the specific characters were those of *A. mavortium*, Cope (described in *Proc. Ac. Philad.*, 1867).

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[1] These numerals refer to the "Literature" *infra*

The publication of Duméril's discovery excited a great deal of interest among European naturalists, and for a time experiments and observations on axolotls in captivity were carried on with great earnestness. The metamorphosis in the case of Duméril's specimens had taken place quite unexpectedly, but the case seemed to offer an opportunity for ascertaining the action of definite conditions in producing definite processes of growth. Marie von Chauvin (**6**), at Freiburg, at the instigation of Prof. Weissmann, attempted and with perfect success, to transform young axolotls into the *Amblystoma* form by gradually bringing the animals from water into air.

The transformed axolotls observed by Duméril were kept alive in the Paris Museum, and for ten years showed no symptoms of breeding or sexual activity. It was currently believed that the *Amblystoma* derived from the metamorphosis of *Siredon* was sterile. This belief ultimately proved erroneous. In the autumn of 1874 the animals in the menagerie of reptiles were transferred to new premises, where they were all placed in more healthy conditions. Immediately after this the *Amblystoma* deposited fertilized eggs, and the fact was reported by M. Blanchard to the Académie des Sciences (**4**), with the comment that the *Amblystoma* was thus shown to be similar to other cold-blooded animals which were capable of reproducing in both the young and the adult condition.

Although at first Duméril believed and stated that his specimens of axolotl belonged to the species which bears that name in Mexico, he afterwards, in his more detailed work on the subject (**2**), explained that the grounds for his first opinion had been insufficient. American zoologists, especially Baird and Cope, had distinguished several species of *Siredon*, and Baird had separated the Mexican species, which alone was originally called axolotl, as *Siredon mexicanus*. Duméril came to the conclusion that the axolotls in the Paris Museum were identical with *Siredon lichenoides*, Baird (described in Stansbury, *Exped. Gr. Salt Lake, Utah*). All the axolotls which were kept and studied and subjected to experiment by naturalists on the Continent after Duméril's discovery were descendants of the Paris specimens, so that the results obtained really did not necessarily prove anything with regard to the true Mexican axolotl, *Siredon mexicanus*, if that were really a distinct species. There is no evidence in literature to show whence the first axolotls in the Paris Museum were obtained. It was evident that *Siredon lichenoides* was capable of breeding in both the larval and the salamandroid condition, and that its metamorphosis in captivity in Europe was rare and to a certain extent controlled by definite external conditions. Prof. O. C. Marsh has recorded his experience of the metamorphosis of *S. lichenoides*. He obtained several specimens from alpine lakes 7000 feet above the sea in Wyoming Territory, and some of these metamorphosed into *Amblystoma mavortium*, Cope. Marsh does not say if the larvæ he obtained were sexually mature, nor did he ascertain if breeding of the species in the larval condition took place at all in the lakes he visited; he thinks it probable that the metamorphosis in that region was rare in the natural conditions.

The metamorphosis of the true axolotl, undoubtedly obtained from the Lake of Mexico, seems to have been observed only once—namely, by Tegetmeier in London. That naturalist had 5 specimens, and one of them underwent the metamorphosis. In 1871 Cope (**10**) stated that no one had seen the metamorphosis of the true siredon, *Siredon mexicanus*, Baird, and that no *Amblystomæ* had been obtained from Mexico south of the Tropic of Cancer, while the true axolotl is found south of that line. He was unaware of Tegetmeier's observation. He further declared that Prof. Baird was aware of the metamorphosis of all the North American species of *Siredon* so-called, excluding *S. mexicanus*, years before the observation of it by Duméril, though he had at first named one of them *Siredon lichenoides*, in the belief that it was adult. Cope considered the observation of Duméril important, as showing that siredons reproduced as such.

Finally, according to Boulenger (**7**), the *S. lichenoides* and *mexicanus* of Baird, are synonymous, the Paris axolotl is identical with the same species, and the perfect form into which it changed is identical with *A. tigrinum*, *mexicanum*, and *mavortium* of Cope, *obscurum* of Baird, while the form named *Siredon gracilis* by Baird is probably the larva of *Amblystoma tenebrosum*. Boulenger adopts the name *A. tigrinum* of the synonyms given above, and gives as the distribution United States and Mexico; the specific diagnosis is—series of palatine teeth extending to external fissure of choanæ; plicæ of tongue radiating from behind; costal grooves twelve; head large; brown or blackish, with yellow markings.

It is therefore very probable that the Paris specimens were really Mexican axolotls, and there is no doubt that these animals do in captivity undergo metamorphosis. So far as is known, they never do so in their natural conditions. But the animals are specifically identical with *A. tigrinum*, which is found in many parts of the United States, from New Jersey to California, and normally breeds in the salamandroid condition. It is not known at present whether the larva of *A. tigrinum* ever attains sexual maturity in other regions where the species occurs besides Mexico. It is not improbable that it does so. De Fillipi (**8**) found in a marsh on the shores of the Lago Maggiore 48 larvæ of *Triton alpestris* in the branchiate condition, which contained fully developed ova and spermatozoa, so that the occurrence of sexual maturity in the larvæ of *Amblystoma* is not unique. Prof. August Weissmann (**5**) has discussed at considerable length and with much thoughtfulness the true significance of the phenomena exhibited by the axolotl, and has concluded that its ancestors passed through the normal life-history of *Amblystoma*, the climate of the Mexican tableland having been at one time moist enough to permit of the existence of a terrestrial Salamandroid; that the climate has now become so dry and unfavorable to vegetation that no amphibian can live in it except in water; and that *Amblystoma* has become adapted to these conditions by ceasing to pass through its metamorphosis, and breeding entirely in the branchiate condition. Thus the metamorphosis which takes place occasionally in captivity is a case of what has been called since Darwin's epoch, atavism; its peculiarity consists in the fact that the evolution of the animal has resulted in the arrest of development at a larval stage, and the occasional reversion is the continuation of the development to the higher condition of the ancestor. Atavism is the occasional resemblance of one individual to some remote ancestors instead of to its immediate parents. Another possible way of explaining the axolotl is to suppose that it has remained in the perennibranchiate condition while other members of the same species elsewhere have developed into the salamandroid condition. This explanation cannot be the true one. It would necessitate the belief that a metamorphosis lasting a few days or weeks, and induced often by the gradual removal of the animal from water into air, could produce the same specific characters as a gradual development which has occupied a great number of generations. The axolotl is an example of one of the most curious and interesting modes by which animals may be adapted to their conditions, and two species formed out of one. At present the disappearance of the metamorphosis from the life-history of the axolotl has taken place so recently that not even specific differences exist, according to some observers, between the metamorphosed axolotl and the natural *Amblystoma tigrinum*. At some future time slight differences are almost sure to occur, and then there will be two species or the tendency to metamorphosis in the axolotl will be lost. In the latter case some slight differences will probably be developed between the axolotl and the branchiate larva of *A. tigrinum* in other parts of America; and then the axolotl and *A. tigrinum* will be two species. Finally, it may be pointed out that it is possible that the axolotl could have reached its present locality and conditions without any change in the climate of Mexico. The lakes in the arid district might somehow occasionally be visited by breeding

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[1] The generic characters of *Amblystoma*, Tschudi, are, according to Boulenger—tongue subcircular or oval, with radiating plicæ, lateral borders free, anterior border slightly free; two transverse series of palatine teeth in same straight line, not separated by a wide interspace in the middle; toes five; tail more or less compressed.

A. tigrinum, and of the larvæ so produced in them some might become sexually mature before metamorphosing, and so give rise to the present axolotls.

There is some reason to believe, according to the American zoologist Prof. Cope, that the perennibranchiate *Menobranchus lateralis*, Tschudi, of the Mississippi, which when full grown is over a foot in length, and has four branchial apertures, stands in the same relation to the genus *Batrachoseps*, Bonap., as *Siredon* to *Amblystoma*.

Literature.—(1) A. Duméril, *Comptes Rendus*, vol. lx., 1865, p. 765; (2) A. Duméril, *Nouv. Arch. Mus.*, ii., 1866; (3) A. Duméril, *Comptes Rendus*, vol. lxi. p. 775; (4) M. Blanchard, *ibid.*, vol. lxxxii., 1876, p. 716; (5) A. Weissmann, *Zeitschr. f. wiss. Zool.*, xxv. p. 297; (6) M. von Chauvin, *ibid.*, xxvii. p. 522; (7) G. A. Boulenger, *Brit. Mus. Cat.—Batrachia, gradientia*, etc., 1882; (8) De Filippi, *Archivio per la Zoologia*, 1861; (9) De Saussure, *Verhandl. d. Schweiz. naturforsch. Gesellsch. Einsiedeln*, 1868; (10) E. D. Cope, "Metamorphosis of Axolotl," *Amer. Journal*, 1871; (11) O. C. Marsh, *Amer. Jour.* [2], xlvi. p. 364; (12) Tegetmeier, *Proc. Zool. Soc.*, 1870. (J. T. C.)

SIREN. *Siren lacertina*, Lin. (*Cyst.*, *Nat.*, i., Addenda), is an animal belonging to the class Amphibia (*q.v.*). It forms the type of the family *Sirenidæ*, called by Prof. Huxley *Trachystomata*, among the group *Perennibranchiata*. The body is elongate and eel-like, only the anterior limbs being present; the posterior are entirely wanting. The anterior limbs are short and feeble, and each is furnished with four digits pointed at the ends. The head is small; the snout is short and broad, and the nostrils are placed at its extreme end. The tongue is free anteriorly. The jaws are destitute of teeth and covered with a horny sheath like a beak. There are numerous teeth on the vomer, arranged in two large patches converging anteriorly. The eyes are very small. On each side of the neck are three branched external gills attached to the first, second, and third branchial arches; and below the gills are three reduced branchial apertures. The tail is shorter than the body, much compressed, and provided with a median membranous fin; the tail terminates in a point. The skin is smooth, and black in color, sometimes sprinkled with white dots. *Siren* grows to a large size, some specimens measuring 3 feet in length; the largest example in the British Museum is 670 mm. or about 2 feet 3 inches. The animal inhabits the stagnant waters of marshes in South Carolina and Texas.

The only other member of the family *Sirenidæ* is *Pseudobranchus striatus* (Gray, *Brit. Mus. Cat.—Batrachia*, 1st ed.). This animal resembles *Siren* in most respects, but has only a single branchial aperture on each side, and only three digits to the anterior limb. Its color is dark-brown with a broad yellow band on each side and a narrower one inferiorly. It occurs in Georgia, but seems to be very rare; there are two specimens in the Paris Musée, none in the British Museum.

Figures of *Siren lacertina* are to be found in the following works: Cuvier in Humboldt's *Obs. Zool.*, i. pl. 11; Daudin, *Reptiles*, viii. pl. 49; Holbr., *N. Amer. Herp.*, pl. 34. *Pseudobranchus striatus* is figured in Duméril and Bibron, *Erpétologie Générale*, pl. 96; Holbr., *loc. cit.*, pl. 36; Leconte, *Ann. Lyc. N. Y.*, 1824, pl. 4 (under name *Siren striata*).

SIREN, or Syren. See Acoustics, vol. i. p. 102–3.

SIRENS, fabulous creatures of Greek mythology, that, like the Loreley of German legend, lured mariners to destruction by their sweet song. In the *Odyssey* Ulysses sails past their island; but, warned by Circe, he had stopped the ears of his crew with wax and caused himself to be bound to the mast. In Homer they are two in number, but in later writers they are generally three, and are located on the coast of Italy, near Sorrento and Capri, or on the straits of Messina. The tomb of one of them, Parthenope by name, was shown at Naples in Strabo's time. A sanctuary of the Sirens stood on a headland near Sorrento. According to Eratosthenes the Sirens were a three-headed rock separating the Bay of Naples from the Gulf of Salerno; but Strabo says they were three rocky islands on the southern side of the cape. The cape itself (now Cape Campanella), was sometimes called the Cape of the Sirens. When the Argonauts drew near the isle of the Sirens, Orpheus struck up and drowned their song. According to Hyginus the Sirens were daughters of the river Achelous and the muse Melpomene, and because they had not rescued Proserpine from Pluto they were turned by Ceres into winged creatures, who were to live only so long as no one passed by them as they sang. So, when Ulysses had eluded them, they flung themselves into the sea. According to another story, they were instigated by Hera to vie with the Muses in singing; the Muses were victorious, and plucked the feathers from the Sirens and made crowns for themselves out of them. In art they are usually represented with the bodies of women and the legs of birds, with or without wings. More rarely they appear as birds with only the heads of women. They seemed to have had a funereal significance, and were often represented on tombs. For representations of them see J. E. Harrison, *Myths of the Odyssey*.

SIRICIUS, pope from December, 384, till November, 398, was the successor of Damasus and was himself succeeded by Anastasius I. See Popedom, vol. xix. p. 505.

SIRMÚR, one of the sub-Himalayan or Simla hill states under the government of the Punjab, lying between 30° 24′ and 31° N. lat. and between 77° 5′ and 77° 50′ E. long. Its area is 1096 square miles, and it is bounded on the N. by the hill states of Balsan and Jubal, on the E. by the British district of Dehra Dun, from which it is separated by the rivers Tons and Jumna, on the S.W. by Ambala district, and on the N.W. by the states of Patiála and Keunthál. Except a very small tract about Nahan, the chief town and residence of the raja, on the southwestern extremity, where a few streams rise and flow southwestward to the Saraswatí and Ghaggar rivers, the whole of Sirmúr lies in the basin of the Jumna, which receives from this tract the Giri and its feeders the Jalál and the Palúr. The Tons, the great western arm of the stream called lower down the Jumna, flows along the eastern boundary of Sirmúr, and on the right side receives from it the two small streams Minus and Nairai. The surface generally declines in elevation from north to south; the chief elevations on the northern frontier (Chor peak and station) are about 12,000 feet above the sea. The valley of the Khiárda Dún, which forms the southern part of the state, is bounded on the S. by the Siwalik range, the hills of which are of recent formation and abound in fossil remains of large vertebrate animals. Though the rocks of Sirmúr consist of formations usually metalliferous, the yield of mineral wealth is at present but small. The forests are very dense, so much so that the sportsman finds difficulty in making his way through them in search of wild elephants, tigers, leopards, bears, and hyenas, with which they abound. The climate of Sirmúr varies with the elevation; the northern extremity has very little rain; but large and excellent crops are everywhere to be obtained by irrigation.

The population in 1881 was 112,371 (males 63,305, females 49,066), the great majority being Hindus. The only town of any importance is Nahan, with a population of 5253. The principal products of the state are opium, tobacco, and cereals, and its gross revenue is estimated at £21,000 [$102,060]. Sirmúr, which means "a crowned head," was the place of residence of the rajas who ruled over the state before the present dynasty entered the country. The reigning raja (Shamsher Prakásh, K.C.S.I.) holds his possessions by a grant made on the expulsion of the Gúrkhas by the British in 1815.

SIROHI, or Seerohe, a native state in the Rájputána agency under the Government of India, with an area of 3020 square miles, lying between 24° 20′ and 25° 20′ N. lat. and between 72° 10′ and 73° 10′ E. long., and bounded on the W. and N. by Márwár or Jodhpur, on the E. by Mewár or Udáipur, on the S. by Pálanpur and the Mahi Kántha states of Edar and Dánta. The country is much broken up by hills and rocky ranges; the Aravalli range divides it into two portions, running from northeast to southwest. The south and southeast part of the territory is very mountainous and rugged, containing the lofty Mount Abu, an isolated mass of granite rock, culminating in a cluster of hills, inclosing several valleys surrounded by rocky ridges, like great hollows. The highest peak rises to 5653 feet above sea-level, and is one of the great trigonometrical stations. On both sides of the Aravallis the country is intersected with numerous water channels, which run with considerable force and volume during the height of the rainy season, but are dry for the greater part of the year. The only river of any importance is the Western Banás. A large portion of the state is covered with dense jungle, in which wild animals, including the tiger, bear, and leopard, abound. Many splendid ruins bear witness to the former prosperity and civilization of the state. The climate is on the whole dry; in the south and east there is usually a fair amount of rain. On Abu the average annual rainfall is about 64 inches, whereas in Erinpura, less than 50 miles to the north, the average fall is only between 12 and 13 inches. The Western Rájputána Railway runs through the length of the state, passing just east of Mount Abu.

In 1881 the population numbered 142,903 (males 76,132, females 66,771), of whom 123,633 were Hindus, 2935 were Mohammedans, and 16,137 were Jains. The town of Sirohi, the capital of the state, is situated at the western base of the range of hills north of Mount Abu, and its population (1881) numbered 5699. Wheat and barley are the staple crops; pulses and cotton are also grown. The present ruling family of Sirohi are Deora Rajputs, a branch of the great Chauhán clan, and are said to be immediately descended from Deo Raj, a descendant of Pirthvi Raj, the Chauhán king of Delhi. During the early years of the present century Sirohi suffered much from wars with Jodhpur and the wild Miná hill tribes. The protection of the British was sought in 1817; the pretensions of Jodhpur to suzerainty over Sirohi were disallowed, and in 1823 a treaty was concluded with the British Government. For services rendered during the mutiny of 1857 the reigning "rao" received a remission of half his tribute.

SÍRSA, a British district in the lieutenant-governorship of the Punjab, lying between 29° 13′ and 30° 40′ N. lat. and between 73° 57′ and 75° 23′ E. long. It has an area of 3008 square miles, and is bounded on the N. by Firozpur district and the native state of Patiála, on the W. by the river Sutlej, on the S.W. by the native states of Baháwalpur and Bíkaner and on the E. by Hissar district. Lying as it does between the barren deserts of Bíkaner and the comparatively fertile though sandy plains of the Cis-Sutlej states, Sírsa district in soil as well as position forms an intermediate link between the two. It forms for the most part a bare and treeless plateau stretching from the valley of the little river Ghaggar on the east to the main stream of the Sutlej on its western border. In the immediate neighborhood of the Sutlej, however, is a fertile alluvial tract (*khádar*), intersected by numerous branches of the river and flooded by their outflow during the rainy season. Eastward of the khádar lies the sandy central tableland, which is chiefly employed for purposes of pasturage. East of this plateau is the valley of the Ghaggar, a formidable torrent in the rainy months, but so entirely dependent on the rainfall of the lower Himalayas that it is usually dry from October to July. The Ghaggar expands into three jhils or marshy lakes, the largest of which is 5 miles in length by 2 in breadth. South of the Ghaggar spreads a sandy tract beyond the reach of its fertilizing influence, and of small agricultural value. Formerly the district was covered by an excellent grazing grass, known as *dháman*, but with the increase of cultivation it is fast disappearing. The climate of Sírsa is extremely dry, the average annual rainfall reaching only 15 inches. The Rewari-Ferozepore Railway passes through the district from south to north.

The population of the district, according to the census of 1881, was 253,275 (males 138,691, females 114,584), of whom 130,582 were Hindus, 93,289 Mohammedans, and 28,303 Sikhs. The only town with a population exceeding 10,000 is Sírsa, the administrative headquarters of the district, with 12,292 inhabitants. The modern town of Sírsa was founded in 1837, and the ruins of old Sírsa lie near its southwest corner. It is a considerable entrepôt for the trade of the wheat-growing countries to the north and east with Bíkaner and Márwár. At the opening of the present century nearly the whole of Sírsa district was a barren almost uncultivated waste. Gradually, however, with more peaceful times cultivation has again extended. Of the total area 1353 square miles are now cultivated and 1548 square miles are cultivable. The staple product is bajra, which in 1882–83 occupied 546,905 acres; the other principal crops are joar, barley, and wheat. The district has little trade except in agricultural produce, which goes chiefly to Bíkaner; and the only manufacture of any importance is that of *sajji*, an impure carbonate of soda, used in washing and dyeing cloth. Sírsa was officially included in the territory conquered from the Mahrattas in 1803, when it was almost entirely uninhabited. It required reconquering from the Bhattis in 1818; but it did not come under British administration until 1837. During the mutiny of 1857 Sírsa was for a time wholly lost to British rule. On the restoration of order the district was administered by Punjab officials, and in the following year, with the remainder of the Delhi territory, it was formally annexed to that province.

SISKIN (Dan. *Sidsken*; Germ. *Zeisig* and *Zeising*), long known in England as a cage-bird, since, in 1544, Turner mentioned it in that character under this name,[1] and said that he had only once met with it at large—the *Fringilla spinus* of Linnæus, and *Carduelis* or *Chrysomitris spinus* of modern writers. In some of its structural characters it is most nearly allied to the GOLDFINCH (vol. x. p. 675), and both are often placed in the same genus by systematists; but in its style of coloration, and still more in its habits, it resembles the Redpolls (*cf.* LINNET, vol. xiv. p. 682), though without their slender figure, being indeed rather short and stout of build. Yet it hardly yields to them in activity or in the grace of its actions, as it seeks its food from the catkins of the alder or birch, regardless of the attitude it assumes while so doing. Of an olive-green above, deeply tinted in some parts with black and in others lightened by yellow, and beneath of a yellowish-white again marked with black, the male of this species has at least a becoming if not a brilliant garb, and possesses a song that is not unmelodious, though the resemblance of some of its notes to the running-down of a piece of clockwork is more remarkable than pleasing. The hen is still more soberly attired; but it is perhaps the Siskin's disposition to familiarity that makes it so favorite a captive, and, though as a cage-bird it is not ordinarily long-lived, it readily adapts itself to the loss of liberty. Moreover, if anything like the needful accommodation be afforded, it will build a nest and therein lay its eggs, but it rarely succeeds in bringing up its young in confinement. As a wild bird it breeds constantly, though locally, throughout the greater part of Scotland, and has frequently done so in England, but more rarely in Ireland. The greater portion, however, of the numerous bands which visit the British Islands in autumn and winter doubtless come from the Continent—perhaps even from far to the eastward, since its range stretches across Asia to Japan, in which country it is as favorite a cage-bird as with us. The nest of the Siskin is very like that of the Goldfinch, but seldom so neatly built; the eggs, except in their smaller size, much resemble those of the GREENFINCH (vol. xi. p. 148).

A larger and more brightly colored species, *C. spinoides* inhabits the Himalayas, but the Siskin has many other relatives belonging to the New World, and in them serious modifications of structure, especially in the form of the bill, occur. Some of these relatives lead almost insensibly to the GREENFINCH (*ut supra*) and its allies, others to the GOLDFINCH (*ut supra*), the Redpolls, and so on. Thus the Siskin perhaps may be regarded as one of the less modified descendants of a stock whence such forms as those just mentioned have sprung. Its striated plumage also favors this view, as an evidence of permanent immaturity or generalization of form, since striped feathers are so often the earliest clothing of many of these birds, which only get rid of them at their first moult. On this theory the Yellowbird or North-American "Goldfinch," *C. tristis*, would seem, with its immediate allies, to rank among the highest forms of the group, and the Pine-Goldfinch, *C. pinus*, of the same country, to be one of the lowest,—the cock of the former being generally of a bright jonquil hue, with black crown, tail, and wings—the last conspicuously barred with white, while neither hens nor young exhibit any striations. On the other hand, neither sex of the latter at any age puts off its striped garb—the mark, it may be pretty safely asserted, of an inferior stage of development. The remaining species of the group, mostly South-American, do not seem here to need particular notice. (A. N.)

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[1] It is also called by bird-fanciers "Abadavine" or "Aberdevine"—names of which the etymology is wholly unknown.*

* [May be from Ahmedabad of India, of which city the birds were called Aberdebad birds.—AM. ED.]

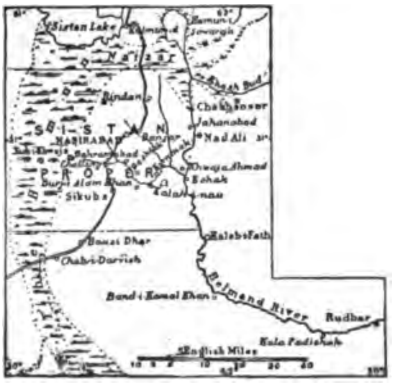
SISMONDI, JEAN CHARLES LEONARD DE (1773–1842), whose real name was SIMONDE, was born at Geneva on May 9, 1773. His father and all his ancestors seem to have borne the name Simonde, at least from the time when they migrated from Dauphiné to Switzerland at the revocation of the edict of Nantes. It was not till after Sismondi had become an author that, observing the identity of his family arms with those of the once flourishing Italian house of the Sismondi, and finding that some members of that house had migrated to France, he assumed the connection without further proof and called himself De Sismondi. The Simondes, however, were themselves citizens of Geneva of the upper class, and possessed both rank and property, though the father was also a village pastor. The future historian was well educated, but his family wished him to devote himself to commerce rather than literature, and he became a banker's clerk at Lyons. Then the Revolution broke out, and as it affected Geneva the Simonde family took refuge in England, where they stayed for eighteen months. Disliking, it is said, the climate, they returned to Geneva, but found the state of affairs still unfavorable; there is even a legend that the head of the family was reduced to sell milk himself in the town. The greater part of the family property was sold, and with the proceeds they emigrated to Italy, bought a small farm at Pescia near Lucca, and set to work to cultivate it themselves. Sismondi worked hard here, both with his hands and his mind, and his experiences gave him the material of his first book, *Tableau de l'Agriculture Toscane*, which, after returning to Geneva, he published there in 1801. Two years later he published his *Traité de la Richesse Commerciale*, his first work on the subject of political economy, which, with some differences of view, continued to interest him to the end of his life (for his position and work in this respect the reader is referred to the article POLITICAL ECONOMY, vol. xix. pp. 396–97). Meanwhile he began his great *History of the Italian Republics*, and was introduced to Madame de Stael. With her he became very intimate, and after being regularly enrolled in the society of Coppet he was invited or commanded (for Madame de Stael's invitations had something of command) to form one of the suite with which the future Corinne made the journey into Italy, resulting in *Corinne* itself during the years 1804–5. Sismondi was not altogether at his ease here, and he particularly disliked Schlegel, who was also of the company. But during this journey he made the acquaintance of the countess of Albany, Louisa of Stolberg, widow of Charles Edward, and all her life long gifted with a singular faculty of attracting the affection (Platonic and other) of men of letters. She was now an old woman, and Sismondi's relations with her were of the strictly friendly character, but they were close and lasted long, and they produced much valuable and interesting correspondence. In 1807 appeared the first volume of the above mentioned book on the Italian republics, which (though his essay in political economy had brought him some reputation and the offer of a Russian professorship) first made Sismondi prominent among European men of letters. The completion of this book, which extended to sixteen volumes, occupied him, though by no means entirely, for the next eleven years. He lived at first at Geneva, and delivered there some interesting lectures on the literature of the south of Europe, which were continued from time to time and finally published; and he held an official post,—that of secretary of the chamber of commerce for the then department of the Leman. In 1813 he visited Paris for the first time and abode there for some years, mixing much in literary society. Although a liberal and in his earlier days almost an Anglomaniac, he did not welcome the fall of the empire. During the Hundred Days he defended Napoleon's constitutional schemes or promises, and had an interview with the emperor himself which is one of the chief events of a not very eventful life. After the Restoration he left Paris. On completing his great book on the Italian republics he undertook a still greater, the *Histoire des Français*, which he planned on a vast scale, and of which during the remaining twenty-three years of his life he published twenty-nine volumes. His untiring industry enabled him to compile many other books, but it is on these two that his fame chiefly rests. The earlier displays his qualities in the most favorable light, and has been least injuriously affected by subsequent writings and investigations. The *Histoire des Français*, as a careful and accurate sketch on the great scale, has been entirely superseded by that of M. Henri Martin, while it is not to be mentioned, as a work of historical or literary genius, in the same category with that of Michelet. Sainte-Beuve has with benevolent sarcasm surnamed the author "the Rollin of French History," and the praise and the blame implied in the comparison are both perfectly well deserved. In April, 1819, Sismondi married an English lady, Miss Allen, whose sister was the wife of Sir James Mackintosh, and the marriage appears to have been a very happy one. His later years were chiefly spent at Geneva, in the politics of which city he took a great, though as time and changes went on a more and more chagrined, interest. Indeed, in his later days he became a kind of reactionary. He died at Geneva on June 25, 1842. Besides the works above mentioned he had executed many others, his custom for a long period of years being never to work less than eight hours a day. The chief of these are *Nouveaux Principes d'Économie Politique* (1819), an historical novel entitled *Julia Severa ou l'An* 492 (1822), *Histoire de la Renaissance de la Liberté en Italie* (1832), *Histoire de la Chute de l'Empire Romain* (1835), *Précis de l'Histoire des Français*, an abridgment of his own book (1839), with several others, chiefly political pamphlets.

Sismondi's literary character has been hinted at in the above remarks on his French history. He was exceedingly laborious, for the most part (though not entirely) free from prejudice, and never violent even when he was prejudiced. He had (with much "sensibility") plenty of common sense, though not perhaps any extraordinary amount of acuteness in estimating things uncommon, and he was a little deficient in historical grasp and in the power of taking large views of complicated series of events. His style corresponded to his thought, and (putting aside certain solecisms which French critics usually affect to discover in Swiss writers) lacks point, picturesqueness, and vigor. Of his moral character no one has ever spoken except in terms of praise, and it appears (which is not invariably the case) to have been as attractive as it was estimable. His chief weakness seems to have been a tendency, frequently observable in writers of very great industry, to rank his own productions somewhat too much on a level with those of writers who, if less industrious, were infinitely more gifted. Thus he has somewhere naively observed that "he should not object to signing" a certain proportion of a certain book of Chateaubriand's. But this overvaluation of self appears to have been merely *naïf*, and not in the least arrogant.

Sismondi's journals and his correspondence with Channing, with the countess of Albany, and others have been published chiefly by Mlle. Mongolfier (Paris, 1863) and M. de Saint-René Taillandier. The latter work serves as the chief text of two admirable *Lundis* of Sainte-Beuve (September, 1863), republished in the *Nouveaux Lundis*, vol. vi.

SISTÁN, or **SEISTAN** (**SEJISTÁN**), the ancient *Sacastane* (*Çakasthána*, "land of the Sacæ") and the *Nimrúz* or "meridies" of the *Vendidad*, is situated generally between 30° 0′ and 31° 35′ N. lat. and 61° 0′ and (including Rudbár) 62° 40′ E. long. Its extreme length is about 100 and its breadth varies from 70 to over 100 miles,—but the exact limits are vague, and the modern signification of the name practically comprehends the peninsula formed by the lower Helmand and its embouchure on the one side and the "Hámún" or "lake" on the other. When British arbitration was brought to bear upon the disputed claims of Persia over this country in 1872, it was found necessary to suppose two territories—one compact and concentrated, which was called "Sistán Proper," the other detached and irregular, called "Outer Sistán." Of each of these a brief description will be given.

1. Sistán Proper is bounded on the north by the "Náizár," or reed-bed which fringes the "Hámún" or expanse; west by the Hámún itself, of which the hill called "Kuh-i-Khwájah" marks the central point; south by a line shutting in Sikuha and all villages and lands watered by the main Sistán Canal; and east by the old bed of the Helmand, from a mile above the dam at Kohak to the mouth. Kal'ah-i-nau and Rindan are among the more northerly inhabited villages. The Kuh-i-Khwájah is a sufficient indication of the western side. Búrj-i-'Alam Khan should be included within the southern boundary as well as Sikuha. Khwájah Ahmad and Jahánabád, villages on the left bank, or west of the true bed of the Helmand, denote the eastern line. The whole area is estimated at 947 square miles. The fixed population may be roughly stated at 35,000,—some 20,000 Sistánis and 15,000 settlers,—the greater part of whom are Parsiwans, or rather, perhaps, a Persian-speaking people. To the above numbers may be added 10,000 Baluch nomads. Taking the aggregate at 45,000, and looking at the extent of country comprehended, we find nearly 48 persons to the square mile. These figures are eight times in excess of the proportional result found for the whole of Persia. It should be explained that the designation Sistán Proper is not arbitrarily given. The territory comprehended in it is spoken of as Sistán by the dwellers on the right bank of the Helmand, in contradistinction to their own lands. At the same time it could only be but a fractional part—as indeed the whole country under consideration could only be—of the Sistán of Persian history.



Map of Sistán.

Sistán Proper is an extensive tract of sand and clay alluvium, generally flat, but irregular in detail. It has heaps, but no hills; bushes, but no trees, unless indeed three or four tamarisks of aspiring height deserve the name; many old ruins and vestiges of comparative civilization, but few monuments or relics of antiquity. It is well watered by rivers and canals, and its soil is of proved fertility. Wheat or barley is perhaps the staple cultivation; but peas, beans, oil-seeds, and cotton are also grown. Among fruits, grapes and mulberries are rare, but melons and watermelons, especially the latter, are abundant. Grazing and fodder are not wanting, and besides the reeds peculiar to Sistán there are two grasses which merit notice,—that called *bannu*, with which the bed of the Hámún abounds on the south, and the taller and less salt *kirta* on the higher ground.

2. Outer Sistán, the country on the right bank of the Helmand, and east of its embouchure in the Hámún, extends more than 100 miles in length, or from a point between the Charboli and Khuspas rivers north to Rudbár south. In breadth the district of Chakhansúr, measuring from the old bed of the Helmand, inclusive of Nad Ali, to Kadah, may be estimated at some 30 miles. It produces wheat and barley, melons, and perhaps a few vegetables and oil-seeds. Beyond the Chakhansúr limits, southward or up to the Helmand, there is probably no cultivation save that obtained on the river bank, and ordinarily illustrated by patches of wheat and barley with melon beds. On the opposite side of the river, in addition to the cultivated portions of the bank, there is a large tract extending from above (*i.e.*, south of) Kohak, or the Sistán dam (*band*), to the gravelly soil below the mountain ranges which separate Sistán from Baluchistan and Narmashir. The distance from north to south of this plain may be computed at 40 miles, and from east to west at 80 or 90 miles. Lands north of the Náizár not belonging to the Afghan district of Lash Juwain may also be included in Outer Sistán; but it is unnecessary to make any distinction of the kind for the tract marked "Hámún" on the west, where it merges into the Persian frontier. Bellew states there are 1200 houses in Chakhansúr. This can hardly apply to the fort in which the sardar lives, and the comparatively few houses outside, bearing that name, and noticed by Major Lovett on his visit in 1872. Nor did there then appear to be any other centres of population in the district, excepting perhaps Kadah on the eastern limit. The inhabitants are Sistánis or Parsiwans, Baluch nomads, and Afghans. Between the Kohak *band* and Rudbár they are mainly Baluch. Most of the less nomad tribesmen are Sanjuráni and Toki, the sardars jealously claiming the former appellation.

The most remarkable geographical feature of Sistán generally, in the modern acceptation of the term, is the Hámún, or expanse, which stretches far and wide on the north, west, and south, but is for a great part of the year dry or a mere swamp. In the early spring, at which period the present writer was in the locality, the existence of a lake could only be certified by pools or hollows of water formed at the mouths of the principal feeders, such as the Khash Rúd on the northeast, the Farah Rud on the northwest, and the Helmand, where its old bed terminates at no great distance from the Khash Rúd. Bellew describes the aspect of that portion of Sistán limited to the actual basin of the Helmand as indicating the former existence of a lake which covered with its waters a considerable area. On the north this tract has been raised to a higher level than the remainder by the deposit at the mouths of rivers of the solid matter brought down. It is still, however, from 200 to 500 feet below the level of the desert cliffs that bound it, and which at some former period formed the shores of the lake; and it is from 50 or 60 to 200 feet above the level of the beds of the rivers now flowing into the existing Hámún. The tract thus raised by depositions in the bed of the former lake, writes the same authority, is now the inhabited district of Sistán, and contains the Hámún, a great sedge-grown swamp, the last relic of the lake itself. To the south of the Hámún and inhabited tract of Sistán is the Zarah hollow. It extends for about 100 miles to the Sarhad Mountains. Called by the natives God-i-Zarah, or the hollow of Zarah, it is described as a wide and circular depression sloping gently up to the bounding hills and desert cliffs. It receives the drainage of these in its central and deepest hollow, which, except in seasons of drought, is more or less marshy. It is connected along the western border of the area with the existing Hámún by the Sar-shila, a great drainage gully through which runs the superfluous flood of the Hámún.

The water-supply of Sistán is about as uncertain as that of Sind, though the general inclination to one bank, the left, is more marked in the Helmand than in the Indus. Therefore the boundary lines given must be received with slight reservation. It is easy to see that a good year of inundation extends the borders of the so-called lake to within the Náízár; and there are well-defined beds of dry canals intersecting the country, which prove the existence formerly of an extensive water-system no longer prevailing. The main canal of Sistán, confounded by some writers with the parent river, bears the waters of the Helmand westward into the heart of the country. They are diverted by means of a large *band* or dam, known indifferently as the "Amir's," the "Sistán," or the "Kohak" *band*. It is constructed of horizontally laid tamarisk branches, earth, and perpendicular stakes, and protected from damage by a fort on the left and a tower on the right bank of the river. Although this diversion of the stream may be an artificial development of a natural channel, and undoubtedly dates from a period long prior to recent Persian occupation, it appears that the later arrangements have been more maturely and better organized than those carried on by the predecessors of the amír of Káian. The towns of Deshtak, Chelling, Burj-i-'Alam Khan, Bahramabad, Kimmak, and others of less note are actually on the banks of this main canal. Moreover, it is the indirect means of supplying water to almost every town and village in Sistán Proper, feeding as it does a network of minor canals, by which a system of profuse irrigation is put in force, which, with an industrious and a contented population, should be productive of most extensive grain cultivation. To consider the main canal as the river itself is a theory which a brief inspection of the locality seems quite to disprove. On the one hand we have a comparatively narrow passage abruptly turning to the westward, on the other a broad and well-defined river-bed prolonged in the old direction, into which the waters would at all times flow unrestrained but for an artificial embankment. Whatever arguments, however, may be used on this head, the larger bed is assumed to be the original Helmand for purposes of territorial limitation.

Provisions in Sistán are, as a rule, sufficient, though sheep and oxen are somewhat poor. Bread is cheap and good, being procurable to natives at less than a halfpenny the pound. Vegetables are scarce, and rice is chiefly obtained from Herat. The inundated lands abound with water-fowl. Partridges and sand-grouse are occasionally seen. River fish are plentiful enough, but confined to one species, the barbel.

The inhabitants of Sistán are mainly composed of Kaiyánis, descendants of the ancient rulers of the land; Sarbandis and Shahrakis, tribes supposed to have consisted originally of immigrants from Western Persia; and Baluchis of the Nharui and Sanjurani (Toki) clans. Bellew separates the "Sistánis"; but it is a question whether this term is not in a large measure applied to fixed inhabitants of the country, whatever their descent and nationality. For instance, an old Shahraki guide to the Sistán Mission of 1872 persisted in being a "Sistáni"; and, if his definition be accepted, the outside element must be confined to Baluchis and modern settlers only.

History.—The ancient Drangiana (Zaraya, Darafika, "lake land") received the name of "land of the Sacæ" after this country was permanently occupied by the "Scythians" or Sacæ, who overran Iran in 128 B.C. (see PERSIA, vol. xviii. p. 605 *sq.*). It was inclnded in the Sásánian empire, and then in the empire of the caliphs. About 860 A.D., when it had undergone many changes of government under lieutenants of the Baghdad caliphs, or bold adventurers acting on their own account, Ya'kúb b. Láith made it the seat of his power. In 901 it fell under the power of the Sámánids, and a century later into that of the Ghaznavids. An invasion of Jaghatais and the irruption into its richer lands by Timúr are salient points in the history of Sistán prior to the Safawid conquest (1508). Under this dynasty for more than two centuries, or up to 1722, Sistán remained more or less a Persian dependency. At the time of the Afghan invasion of Mir Mahmúd (1722), Malik Muhammad Kaiyáni was the resident ruler in Sistán, and by league with the invader or other intrigue he secured for himself that particular principality and a great part of Khurasan also. He was slain by Nadir Kulí Khan, the general of Shah Tahmasp, who afterwards, as Nadir Shah, became possessor of Sistáu as part of his Persian dominions. Shortly after the death of Nadir (1751) Sistán passed, together with other provinces, into the hands of Ahmad Shah Abdali, the first sovereign in a united Afghanistan. On the death of Ahmad Shah in 1773 the country became a recognized bone of contention, not so much between Persians and Afghans as between Herat and Kandahar; but eventually the internal dissensions of Afghanistan gave Persia the desired opportunity; and by a steady course of intrigue and encroachment she managed to get within her grasp the better lands on the left bank of the lower Helmand and something on the right bank besides. When the British arbitrator appeared on the scene in the beginning of 1872, though compelled to admit the shah's possession of what has been called "Sistán Proper," he could in fairness insist on the evacuation of Nad Ali, Kala Fath, and all places occupied on the right bank by Persian troops; and furthermore he left to the Afghans both sides of the river Helmand from the dam of Kohak to its elbow west of Rudbár. For the precise boundary see PERSIA, vol. xviii. p. 665.

See *Eastern Persia*, vol. i.; Bellew's *Record of Sistán Mission*; *Journal of R. Geog. Society*, vol. xliii. (1873). (F. J. G.)

SISTOVA, a town of Bulgaria, at the head of a district of its own name (40,893 inhabitants in 1881), is situated on the right bank of the Danube, about 40 miles above Rustchuk, and has rather a picturesque appearance on the slopes of the Kadbair and the Chuka. On the latter hill there stood till the fire of 1810 a mediæval fortress, and previous to the 15th century it contained a Latin church of traditional celebrity. The lower town along the river consists of modern houses, mostly erected since 1870, and is the scene of busy commercial life, especially during the grain-export season. The principal church, completed in 1867, is a large and costly building with an imposing dome. Sistova was one of the first of the Bulgarian towns to introduce the national language into its schools (1833), some of which are now well-endowed and flourishing. More than half of the inhabitants, who numbered 11,560 in 1881, are Bulgarians, the rest being Turks, Walachians, and Gypsies.

Sistova is identified with the old Roman colony *Novæ* mentioned by Ptolemy and others. The exact site appears to have been Staklen, a cluster of vineyards with remains of ancient buildings to the west of the present town, which has gradually moved eastward since the 16th century, when it was reduced by the Turkish wars to a miserable village. It was at Sistova that the peace of 1790 was signed, by which the Austrian-Turkish boundary was determined. The town was burned in 1810 by the Russian general Saint Priest; but subsequent to 1820 it began to revive, and the introduction of steam traffic on the lower Danube (1835) restored its prosperity in spite of the effects of the Russian war of 1828-29, when the Walachian town of Alexandria was founded by fugitives from Sistova. In 1877 the Russians entered Bulgaria by passing the river just below Sistova.

SISTRUM, a kind of rattle used by the ancient Egyptians in religious ceremonies, especially in the worship of Isis. It consisted of a frame through which passed four rods; attached to the frame was a handle. When shaken the rods rattled and produced the sound. After the introduction of Egyptian worships into Italy the Romans became familiar with the sistrum. It is described by Apuleius (*Metam.*, xi. 4). An ancient sistrum formerly existed in the library of Ste. Geneviève at Paris. In paintings found at Portici a priest of Isis and a woman are represented rattling the sistrum. The instrument is said to be still in use in Nubia and Abyssinia.

SISYPHUS, a famous character of Greek mythology, was a son of Æolus and Enarete and brother of Cretheus, Athamas, and Salmoneus. He built Ephyra (Corinth), and married Merope, daughter of Atlas, by whom he had a son Glaucus. According to Pausanias (ii. 3, 11) Sisyphus succeeded Medea in the sovereignty of Corinth. Having found the body of the drowned Melicertes lying on the shore of the isthmus, Sisyphus buried him and instituted in his honor the Isthmian games. From Homer onwards Sisyphus was famed as the craftiest of men. His name (formed by reduplication from the same root as σοφός) means the Wise, Wise One. When Death came to fetch him, Sisyphus put him into fetters, so that no one died till Ares came and freed Death, and delivered Sisyphus into his custody. But Sisyphus was not yet at the end of his resources. For before he died he told his wife that when he was gone she was not to offer the usual sacrifice to the dead. So in the under world he complained that his wife was neglecting her duty, and he persuaded Hades to allow him to go back to the upper world and expostulate with her. But when he got back to Corinth he positively refused to return to Deadland; so he lived to a good old age, and even then Hermes had a tough job to carry him off. In the under world Sisyphus was compelled to roll a big stone up a steep hill; but before it reached the top of the hill the stone always rolled down, and Sisyphus had to begin all over again. The subject was a commonplace of ancient writers, and was depicted by the painter Polygnotus on the Lesche at Delphi.

The way in which Sisyphus cheated Death is a common incident in folk-tales. Thus in a Venetian story the ingenious Beppo ties up Death in a bag and keeps him there for eighteen months; there is general rejoicing; nobody dies, and the doctors are in high feather. In a Sicilian story an innkeeper corks up Death in a bottle; so nobody dies for years, and the long white beards are a sight to see. In another Sicilian story a monk keeps Death in his pouch for forty years. (See Crane, *Popular Italian Tales*, Nos. 63, 64, 65, 66, with the translator's notes.) The German parallel is Gambling Hansel, who kept Death up a tree for seven years, during which no one died (Grimm, *Household Tales*, No 82; in his notes Grimm cites a number of German parallels). The Norse parallel is the tale of the Master Smith (Asbjörnsen og Moe, *Norske Folke-Eventyr*, 21; Dasent, *Popular Tales from the Norse*, p. 106). For a Lithuanian parallel, see Schleicher, *Litauische Mährchen, Sprichwörte, Rätsel, und Lieder*, p. 108 *sq.*); for Slavonic parallels, Krauss, *Sagen und Mährchen der Südslaven*, ii., Nos. 125, 126.

SITÁPUR, a British district in Sitápur division or commissionership of Oudh, under the jurisdiction of the lieutenant-governorship of the North-Western Provinces of India. It lies between 27° 7′ and 27° 53′ N. lat. and between 80° 21′ and 81° 26′ E. long., and it is bounded on the N. by Kheri district, on the E. by that of Bahraich, from which it is separated by the Gogra river, and on the S. and W. by Bara Banki, Lucknow, and Hardoi districts, the Gumti river forming the boundary. Sitápur district is elliptical in shape; its greatest length from southeast to northwest is 70 miles, and its extreme breadth from northeast to southwest 55 miles; its area is 2251 square miles. Being without hills or valleys, and devoid of forests, Sitápur presents the appearance of a vast plain sloping imperceptibly from an elevation of 505 feet above sea-level in the northwest to 400 feet in the southeast. The country is, however, well wooded with numerous groves, and well cultivated, except in those parts where the soil is barren and cut up by ravines. It is intersected by numerous streams, and contains many shallow ponds and natural reservoirs, which overflow during the rains, but become dry in the hot season. Except in the eastern portion, which lies in the doabs or alluvial plains between the Kewáni and Chauka and the Gogra and Chauka rivers, the soil is as a rule dry, but even this moist tract is interspersed with patches of land covered with saline efflorescence called "reh." The principal rivers are the Gogra, which is navigable by boats of large tonnage throughout the year, and the Chauka. Nylghau, many varieties of deer, wild hog, wolf, jackal, and fox are common, but none of the larger wild animals are found within the district. The climate is considered healthy, and the cantonments of Sitápur are famous for the low mortality of the British troops stationed there. The average annual rainfall is about 33 inches. The district contains no railway, but it is well provided with good unmetalled roads.

In 1881 the population was returned at 958,251 (505,986 males and 452,265 females); Hindus numbered 818,738, Mohammedans 138,733, and Christians 443. Sitápur contains but two towns with more than 10,000 inhabitants,—namely, Khairabad, 14,217; and Laharpur, 10,437. The administrative headquarters of the district are at Sitápur town, which is prettily situated on the banks of the Saráyan river, with good groves in all directions, and with a population in 1881 of 6780. Of the total district area 1455 square miles are cultivated and 510 are cultivable. The principal staples are wheat, barley, joar, gram, bajra, and rice; besides these a considerable quantity of sugar-cane is raised, as also oil seeds, cotton, and tobacco. The only manufactures of any note are tobacco and tazias at Biswán, with a little cotton printing and weaving in most of the towns. The history of Sitápur is closely associated with that of the rest of Oudh. The district figured prominently in the mutiny of 1857, when the native troops quartered in the cantonments rose in mutiny and fired on their officers, many of whom were killed, as were also several military and civil officers, with their families, in attempting to escape. Order being restored in 1858, the Government offices were re-opened, and nothing has since occurred to disturb the peace of the district.

SITTINGBOURNE, an ancient town of Kent, is situated on a navigable creek of the Swale, and on the London, Chatham, and Dover Railway, at the junction for Sheerness, 7 miles south from the latter town and 45 east southeast of London. It consists principally of one long street and the northern suburb of Milton, formerly celebrated for its oysters, the fishery of which used to employ a large number of the inhabitants. Brickmaking is a very important industry, and there are large paper-mills. St. Michael's church, in the Early English and later styles, underwent extensive restoration in 1873 at a cost of nearly £3000 [$14,580]. The principal other public buildings are the old town-hall, the corn exchange (erected 1859), and the museum. Public gardens 10 acres in extent have recently been laid out. The local government board was instituted in 1878. The population of the urban sanitary district (area 1004 acres) in 1871 was 6148 and in 1881 it was 7856.

Sittingbourne, or Sedyngburne, received a grant of a market and two annual fairs by a charter of Queen Elizabeth. The style "guardian and free tenants," applied to the corporation in this charter, was subsequently changed to that of "mayor and jurats."

See W. A. Scott Robertson, *Sittingbourne and the Names of Lands and Houses in or near it*, Sittingbourne, 1879.

SIÚT, or Asyút (Asioot), more correctly Osyút, a town of Upper Egypt, and southern terminus of the railway on the left bank of the Nile, by which it is 229 miles from Búláḳ Dakrúr. The population is about 25,000. See Egypt, vol. vii. p. 672.

SIVA. See Brahmanism.

SÍVÁS, or Síwás, a pashalic and capital of a pashalic of great importance in Asia Minor. The town is situated on the right bank of the Kizil Irmak (Halys), in a plain of some 16 to 20 miles in length and 4 to 6 in breadth. From the south the approach is by a good road among the mountains, and the aspect from the heights is pleasing. Dotted here and there with trees, some in large extended clusters, the houses and citadel cover a considerable space and appear much scattered. On the north a military road has been constructed to facilitate communication with the coast. Sívás is 4670 feet above the level of the Black Sea, and should be a healthy residence for Europeans. The population, estimated on the spot in 1864 at 10,000 houses, more than a fifth being Armenians, is stated in Murray's *Handbook* of 1878 to consist of 5000 Turkish and 1200 Armenian families. There are some respectable residences but not many buildings or monuments of note; and the streets are narrow and ill-maintained. The bazaars are fairly stocked with goods, British as well as of other European nations.

Sívás is the ancient *Sebasteia* (not to be confounded with Sebaste or Cabira on the Lycus, the modern Niksar), the capital of Armenia II., and the seat of an archbishop. In 1021 it was ceded by the emperor Basil to the Armenian king, Senekharim. It again became Greek in 1080, but soon after fell to the Seljúks. In the 13th century Marco Polo speaks of Sevaste as the place "where the glorious Messer Saint Blaise suffered martyrdom." It was, when he wrote, in the possession of the Turkmáns of Karamania, living under the government of the Seljúk princes. In the 14th century we have the testimony of Ibn Batuta, who says (ii. 289): "It is one of the possessions of the king of Irak, and the largest town owned by him in the country. His chiefs and his collectors reside there. It is well-built, and has wide streets and crowded markets." Colonel Goldsmid visited Sívás in July, 1864, and was shown some fine monuments described as the mausolea of the Seljúks, the inscriptions on which he found to date no earlier than 670 of the Hijra, though the actual tombs might be traceable to a former period.

SIXTUS I. (Xystus) figures in the lists accepted by the Roman Church as having been bishop of Rome from about 119 to about 126. He is conjectured to have been a presbyter and a martyr.

SIXTUS II. followed Stephanus I. as bishop of Rome in 257, and suffered martyrdom under Valerian in the following year. He restored the relations with the African and Eastern Churches which had been broken off by his predecessor on the question of heretical baptism. Dionysius succeeded him.

SIXTUS III., bishop of Rome from July 31, 432, to August 18, 440, had Cœlestinus I. as his predecessor, and was succeeded by Leo I.

SIXTUS IV. (Francesco della Rovere), pope from 1471 to 1484, was born 21st July, 1414, near Savona. The statements respecting his parents' situation in life are very conflicting. In consequence of a vow made by his mother he entered the Franciscan order at an early age, and speedily acquired a great reputation for eloquence and learning. After filling several minor offices he became general of his order, and in 1467 was to his own surprise made cardinal by Paul II., at the recommendation, it is asserted, of Cardinal Bessarion. When, upon Paul's death in 1471, the rigor of Bessarion's principles prevented his profiting by the favorable sentiments of influential cardinals, who, nevertheless, expected to be recompensed for their suffrages, Rovere seems to have been found more accomodating. The liberality of his donations after his election, at all events, raised suspicion; but the friendship of Bessarion has also been enumerated among the causes of the sudden elevation of the most recent member of the Sacred College. He was elected on 9th August, 1471, and immediately proceeded to lavish Paul's treasures — partly in laudable preparations against the Turks; partly in embassies, receptions of foreign princes, public improvements, and other expenses possibly imprudent, but at least not indecorous; partly, without any excuse, upon his unworthy nephews, Count and Cardinal Riario. The prodigalities of the latter surpassed all measure, and he compromised his uncle much more seriously by his complicity in the conspiracy of the Pazzi, aiming at the assassination of the Medici family. Sixtus was cognizant of the plot, but had positively forbidden the shedding of blood, which he must nevertheless have known to be inevitable. He deserves still more censure for entering into a fruitless and inglorious war with Florence, which terminated in 1480, after having kept Italy for two years in confusion. Scarcely was it over when he allowed himself to be involved in yet more troublesome and discreditable contests,—first inciting the Venetians to attack Ferrara, and then, after having been delivered by their general Roberto Malatesta from a Neapolitan invasion, turning round upon them and eventually assailing them on their refusal to desist from the hostilities which he had himself instigated. He relied on the co-operation of Lodovico Sforza, who speedily forsook him; and the scandal was witnessed of the secular princes and cities of Italy agreeing to a peace which the Father of Christendom did his best to thwart, and vexation at which was believed to have hastened his death. He died, at all events, a few days afterwards, 13th August, 1484, leaving an unfortunate reputation as the first pope who brought nepotism into politics, and, not content with enriching his relatives by gifts and lucrative offices, made their aggrandizement the principal object of his policy as a secular prince. His private character was nevertheless estimable: he was pious, of blameless morals, hospitable and munificent to a fault, and so exempt from avarice, says his secretary Conti, that he could not endure the sight of money. His faults were those of a monk who had no natural outlet for strong affections except unworthy relatives, and who had been called from a cloister to fill the most conspicuous position in the world. His secular policy was capricious and spasmodic; he neither maintained the peace of Italy like his predecessor and successor nor carried out a consistent and well-considered scheme of conquest like Alexander VI. He was, notwithstanding, always firm in his resistance to the Turks, and showed magnanimity by aiding his enemy the king of Naples against the common foe of Christendom. The brilliant side of his administration was his munificence as a founder or restorer of useful institutions and a patron of letters and art. He established and richly endowed the first foundling hospital, built and repaired numerous churches, constructed the Sixtine Chapel and the Sixtine Bridge, commissioned paintings on the largest scale, pensioned and rewarded men of learning, and, above all, immortalized himself as the second founder of the Vatican library. It has been said that the stones alone inscribed with his name would serve to erect a considerable edifice. These great works, however, were not accomplished without grievous taxation and questionable methods of raising money; and Sixtus's successor expressed the general condemnation of his government when he declared that he for his part would imitate the example of Paul II. Sixtus was succeeded by Innocent VIII. (R. G.)

SIXTUS V. (Felice Peretti), pope from 1585 to 1590, was born 13th December, 1521, at Grottamarina, in the district of Fermo, of a family said to be of Dalmatian extraction. His parents were undoubtedly in humble circumstances, but the story of his having been a swineherd in his youth seems to be a mere legend. He entered the Franciscan order at an early age, and obtained great celebrity as a preacher. After having been successively professor at Rimini and at Siena, he became inquisitor-general in Venice (where his firmness in controversy with the Venetian Government exposed him to personal danger), theologian at the council of Trent, and ultimately vicar-general of his order. In 1565 he accompanied the papal legate to Spain, and in 1570 was created cardinal by Pius V., and intrusted with the publication of a correct edition of the works of St. Ambrose, which appeared in 1579–1585. Finding himself out of favor with Pius's successor, Gregory XIII., he withdrew to a villa which he had purchased, and lived in strict retirement, affecting, it is said, to be in a precarious state of health. According to the usual story, which is probably at least exaggerated, this dissimulation greatly contributed to his unexpected elevation to the papacy on the next vacancy, 24th April, 1585. If the electors had indeed anticipated a weak or ephemeral pontificate, they were grievously disappointed. Sixtus speedily proved himself one of the most vigorous popes, both in body and mind, that had ever occupied the chair of St. Peter. Within two years he issued seventy-two bulls for the reform of religious orders alone. Ardent, despotic, indefatigable, he did everything by himself, rarely invited advice and still more rarely followed it, and manifested in all his actions a capacious and highly original genius, in most respects eminently practical, but swayed in some things towards the visionary and fantastic by the inevitable effects of a monastic training. His first great aim was to purge the papal dominions of the robbers who had overrun them under the weak administration of his predecessor. This salutary undertaking was effectually accomplished, not without many instances of tyranny and cruelty which have left a stain upon his name; but security of life and property returned. Sixtus's financial management seemed on a superficial view equally brilliant; he had found the exchequer empty, and speedily accumulated an immense treasure. But this end was obtained partly by excessive taxation, partly by the sale of offices which had never before been venal; and the withdrawal of such an amount of specie from circulation impoverished the community. His intention was to amass a fund for use in special emergencies, such as a crusade or a hostile invasion, which never arose. Much, nevertheless, was expended by Sixtus in the encouragement of agriculture and commerce, and in public works, either of signal utility, like his supply of Rome with water, or such at least as impressed the popular imagination with his munificence, as the completion of the cupola of St. Peter's, the construction of six new streets, and the elevation of four Egyptian obelisks in various parts of Rome. Though a scholar, Sixtus was no humanist, and did much mischief to the monuments of antiquity, ruthlessly destroying some, and disfiguring those which he repaired by the addition of Christian attributes. In his ecclesiastical and foreign policy good sense contended with eccentricity but usually obtained the upper hand. He thought of attacking Turkey with the alliance of Poland and Russia, of subjugating Egypt by his own forces, of making a descent into Syria and carrying off the Holy Sepulchre. But he never attempted to realize these projects, and his conduct of the affairs which imperatively required his attention evinced more moderation than could have been expected. After having strongly sided with Spain and the League, he allowed himself to be convinced by the Venetian ambassador of the evil consequences of Spanish preponderance in Italy, and showed a manifest disposition to acknowledge Henry IV. as king of France, on condition of his abjuration. This led to violent altercations with the Spanish ambassador, and the death of the pope on 27th August, 1590, was attributed by many to poison, though without sufficient ground. He was succeeded by Urban VII. Sixtus V. left the reputation of a zealous and austere pope,—with the pernicious qualities inseparable from such a character in his age,—of a stern and terrible but just and magnanimous temporal magistrate, of a great sovereign in an age of great sovereigns, of a man always aiming at the highest things and whose great faults were but the exaggeration of great virtues.

The best view of his character and government is that given by Ranke. Leti's well-known biography is full of fables; Tempesti is too panegyrical; and Lorentz is little more than a compiler from the two. The most valuable part of Baron von Huebner's *Sixte Quint* (Paris, 1870) is the rich appendix of documents. Sixtus's note-books and drafts of letters in the Chigian library, frequently referred to by Tempesti and Ranke, were published by Cugnoni in 1882.

(R. G.)

SKATE. See RAY.

SKATING, as at present practiced, may be defined as a mode of progression (usually rapid) upon smooth ice, by the aid of steel blades attached to the soles of the feet. It probably originated in the far north of Europe, in Scandinavia and Germany, where it is still in common use. In Russia it has never been a national pastime, as no smooth ice is formed in the rapidly running rivers. Even in St. Petersburg it is mainly engaged in by English and Germans. The earliest skates appear to have been certain bones of large animals, but wood was also used from an early period.

In modern skating there are two totally distinct styles, which require different skates differently attached to the feet, and different extents and qualities of ice. The first, the "running" or "fen" style, simply consists in going straight ahead at the highest possible speed. Its home is on the fiords of Scandinavia, the fens of Lincolnshire, and the large rivers and lakes of North America. In Holland, Denmark and North America it is the medium for carrying a large winter market traffic. It first became common in England in 1662 after the return of the Stuarts. The wooden part or stock of a running skate is from 8 to 12 inches long, according to the length of the foot. The blade is made of the best steel, with an average width of $\frac{5}{32}$ inch. The heel is at right angles to the surface of the ice. The prow begins to rise off the ice at the fore end of the stock, at a gradually increasing angle, and projects 4 inches. The entire skate is attached to the foot by an iron screw in the heel of the stock which enters the skater's boot heel and two long straps which pass through slots in the stock and fasten round the ankle and toes of the skater. The length of the heel strap varies from 22 to 32 inches, and that of the toe strap from 15 to 23 inches. Formerly the bottoms of the blades were fluted. A concavity is now effected by grinding; and, when in motion, the blade is rarely flat on the ice. The curve should be slight, and the depth no greater than will insure a curve being made without touching the ice. The feet are placed at right angles to each other with the toes turned out and the body bent slightly forward. Each foot is then raised alternately and set down slightly on the inside edge. It immediately acquires a forward motion, which is increased by pushing with the other foot, that being at right angles and having no sliding motion. The feet must be kept perfectly level when raised and set down, and the skate carried in the same manner an inch above the ice when going forward. The forward stroke is made on the outer edge, and the pressure applied to the inner edge of the other foot. The arms are swung across the chest from side to side, and opposite to the direction of the striking leg in order to balance the weight. The quickest method of stopping is to place the feet parallel, dig the heels into the ice and arch the back. A longer but more graceful method is to turn the toes inwards, thus spreading the outside edges athwart the line of going. The feet should never be looked at, as the balance of the body is thereby disturbed. The eye should always be on a line with the horizon.

The fastest skating times recorded, from a standing start, and with no rear wind, have all been made in the United States, at New York, as follows: 100 yards, 10⅗ s.; 200, 21⅗ s.; 300, 31⅖ s.; ¼ mile, 44⅕ s.; ½, 1 m. 41⅘ s.; ¾, 2 m. 34⅖ s.; 1, 3 m. 26⅖ s.; 2, 6 m. 56⅕ s.; 3, 10 m., 33⅗ s.; 4, 14 m. 10½ s.; 5, 17 m. 45 s.; 6, 21 m. 38 s.; 7, 25 m. 17⅗ s.; 8, 29 m. 9⅘ s.; 9, 32 m. 54⅕ s.; 10, 36 m. 37⅕ s.,; 20, 1 h. 14 m. 7⅕ s.; 30, 2 h. 31 m. 12 s.; 40, 3 h. 21 m. 22 s.; 50, 4 h. 13 m. 36 s. The best running high jump on skates recorded is 3 ft. 1¾ in., and running long jump 15 ft. 2 in.

The second style, termed "figure skating," is quite modern and purely English in its origin. This may be practiced on any small pond, provided the ice is clear of snow and perfectly smooth. The more numerous opportunities thus afforded make it the more popular style in Great Britain, where the large streams seldom freeze. Figure skating consists in cutting arcs, circles, figures, lettters, serpentines and spirals—either forwards or backwards, slowly or rapidly, on one or both feet, singly or in combination. The style can ultimately be analyzed into four kinds of strokes, all made on the edges of the blade—the inside forward, the outside forward, the inside backward, and the outside backward. The variety of evolutions which can be developed from these four movements is endless. The figure skate is made entirely of metal, is strapless and fixed to the boots by clamps or like devices. Unlike the running skate, it can be instantly put on or taken off. Many kinds have been invented, but the "Acme," first produced in Canada, is generally acknowledged the best. The blade projects the merest trifle beyond the length of the foot, and is rounded off in an upward direction from the ice at both toe and heel. The bottom is ⅛ inch wide, and the best curve for grinding it is to that of a seven-foot radius, equal throughout and not increased at either end. In stopping the end of one skate is placed at right angles to the other.

Summer skating has been occasionally provided in "glaciariums" by means of artificially produced ice.

The London Skating Club, founded in 1830, is the leading skating society of Great Britain. Comprising but 170 members, including 20 ladies, and practicing on exclusively private water in Regent's Park, it countenances figure skating only, and gives no encouragement whatever to the spread or teaching of a national pastime. The National Skating Association was formed in the year 1879, and on December 8, held the first race for the running championship at Thorney, Cambridgeshire. The objects of the Association are as follows:

> To promote, ascertain and reward speed in skating—by the establishment and management of amateur and open skating championships of England; by stimulating and supplementing local action in holding of skating matches; by establishing an order of merit for speed skaters, and awarding badges for the same; by assisting in providing facilities for skating by the shallow flooding of land in each locality where local branches exist; and by collecting through corresponding members information of the existence of ice on which skating is practicable, and the supplying of such information to its members; and to promote and encourage figure skating, by the establishment of standards at which figure skaters may aim, by bestowing badges of merit on those who attain these standards, and by promoting and assisting in the formation of skating clubs; to provide rules and regulations for the game of hockey on the ice; also to promote the establishment of international skating contests in various countries under the direction of an international council.

In the United States and Canada large and shallow artificial ponds under cover, termed "rinks," are in winter frozen by filling them with water. Each night the surface is covered with a layer of water, which gives a fresh sheet of ice by morning. The covers protect the rinks from snow, another great advantage.

As regards a substitute for ice and ice skating on wooden or asphalt floors, the only invention that has ever been found even partially successful is that of James L. Plimpton, of New York, in 1869. The implements may be described as skates with two parallel wheels at the toe and heel, so hung that the wheel axles are moved out of parallel by the transverse rocking of the skater's foot, the wheels setting squarely on the surface whether the skater be upright or canted. The fatigue caused by these "roller skates" is quadruple that of ordinary ice skating.

See *The Field*, December 23, 1882, January 6 and February 3, 1883; N. & G. A. Goodman, *Handbook of Fen Skating*, 1882; G. Anderson, *Art of Skating*, 4th ed., 1880; H. C. Vendervell and T. M. Witham, *Figure Skating*, 3d ed., 1880; and M. F. M. & S. F. M. Williams's *Combined Figure Skating*, 1883.

SKELETON.

THE word "skeleton," meaning in Greek a mummy, is popularly taken to denote that assemblage of bones and cartilages which forms the internal support of the body of man and of the animals more or less nearly resembling him. A slight acquaintance with the structure of these animals, however, seems to make it evident that a wider signification must be given to the term, since parts which in man and many of his animal allies are bony or cartilaginous may be only membranous in other such animals; and conversely, parts sometimes quite external, which are merely membranous in man and many animals, may in others assume the structure of horn or bone, or may contain bones or cartilages. The word skeleton may indeed be taken to denote both a more or less firm and complete *external* protection to a living body, and also a more or less firm and complete *internal* support to such body.

In this very wide sense even many vegetal structures may be said to possess a skeleton. For all plants which can sustain themselves in an upgrowth from the ground obviously both require and possess solid structures—various groups and varieties of woody fibres—to support such an upgrowth. Organs also, such as leaves, which need to be maintained in the form of a thin, flat expanse, require and possess bundles of fibres (vulgarly called veins), which are even popularly said to constitute the skeleton of the leaf. Many plants form such skeletal structures largely of silex, as do the grasses and the horsetails (*Equisetum*), and others invest themselves to a greater or less degree with carbonate of lime, as do some *Algæ*, such as *Corallina* and *Melobesia*, while the *Diatomaceæ* clothe themselves with a horny coat. Ordinarily, however, the word skeleton is only used to denote certain animal structures, and mainly such structures as form the skeleton of man and of creatures so nearly allied to him as to constitute, together with him, that primary division of animals known as backboned animals or *Vertebrata.*

It is to a concise description of the skeleton as it exists in Vertebrates generally that this article is devoted. For the details of the human skeleton the reader is referred to the article ANATOMY. In order, however, that its condition in Vertebrate animals may be better understood, it will be well briefly to point out some of the more important varieties of condition presented by the protecting or supporting parts of the body of the lower, or Invertebrate, animals.

THE SKELETON OF INVERTEBRATA.

A great and fundamental distinction exists, however, between those lowly organisms known as *Protozoa* or *Hypozoa*—which are generally reckoned as animals—on the one hand, and all the higher forms, both Vertebrate and Invertebrate, on the other. It is a distinction which renders it difficult to regard any skeletal structures of the *Hypozoa* as anwering to, in the sense of being the homologues[1] of, any of the skeletal structures of higher animals. This great fundamental distinction consists in the fact that the bodies of all the higher animals are made up of distinct "tissues," which are derived from three different layers of cells, of which the embryos of all[2] of them are for a time composed, whereas the bodies of the *Hypozoa* either consist of but a single cell or else of a smaller or larger number of cells more or less loosely aggregated and not forming any distinct tissue. It follows of course that their reproduction does not take place by means of embryos formed of cellular layers.

Nevertheless, the *Hypozoa* or *Protozoa* may exhibit very distinct protective structures. Thus the outermost layer of the substance of an *Amœba*, called its ectosarc, is of a firmer consistency than its interior, and it may in allied forms take on a chitinous character, or become quite hard through the deposition within it of calcareous salts (as in the sometimes singularly complex shells of the *Foraminifera*), or form symmetrical cases of silica.

In the *Radiolaria*, the skeleton of the *Protozoa* attains its maximum of beauty and complexity. It consists of spicules which are generally siliceous, but may consist of a peculiar firm organic substance termed "acanthin." The spicules arrange themselves in an extraordinarily symmetrical manner, generally radiating from the central portion of the organism, and being connected with one or more series of encircling spicules which may constitute a series of concentric spheres.

Among the *Infusoria* we also find examples of a hardening of the external cuticle, as in *Tintinus lagenula*, and in some other forms.

When we pass to that vast group of animals—the *Metazoa*—which includes all but the *Protozoa* (and all those, therefore, the bodies of which are formed of tissues derived from the three primitive layers), a distinction again requires to be drawn between the Sponges (*Porifera*), which constitute its lowest group, and all higher forms. The three primitive or germinal layers of the *Metazoa* are termed respectively—(1) the epiblast, (2) the mesoblast, and (3) the hypoblast.

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[1] "Homologous parts," or "homologues," are parts of an organism which correspond in relative position, that is, in their relation to surrounding structures, whether or not they serve the same ends. They thus differ from "analogous parts," which are parts performing similar functions whether or not they agree as to their relations of position to surrounding structures. Thus, *e.g.*, the nail of a man's middle toe and the hind hoof of a horse are "homologous parts," but the hoof, as the support of the body and agent in locomotion, is analogous to the whole foot of a man.

[2] Certain Cœlenterate animals consist but of two layers.

Of these three layers the epiblast and the hypoblast are to be regarded as primary.[1] The epiblast is essentially the primitive integument, and its cells give rise to the epidermis and cuticle and to the organs of sense. The hypoblast is essentially the digestive layer, and gives rise to the epithelium lining the alimentary canal. The mesoblast seems to originate from one or both of the two preceding layers, and gives rise to the general substance of the body—including that part of the skin which is beneath the epidermis, the muscles, and the bloodvessels. It may divide into two layers, whereof the more external is distinguished as "somatic," while the more internal is called "splanchnic," Such is the general condition of the three germinal layers in the *Metazoa*. In the Sponges, however, it seems probable[2] that the germinal layers have a different nature—the epiblast and mesoblast being respectively the digestive and sensory layers.

The skeletal structures of the Sponges have the form of spicules, which may vary greatly in different genera as to their form, while they may be siliceous, calcareous, or horny. Sometimes they constitute structures of singular beauty. They appear to be formed in or on the cells of the mesoblast, and it does not seem that any skeletal structures arise in the epiblast or hypoblast of the *Porifera*. Should such, however, be hereafter found, then it must be borne in mind that their homologies with analogous skeletal structures of other organisms must depend on the final decision of the question of the exact relations which may exist between such germinal layers in Sponges and the epiblast and hypoblast of higher *Metazoa*.

In the great group of the *Cœlentera*, the skeleton may be either epiblastic or mesoblastic in nature. Thus in the *Hydrozoa*—where it mostly has the form of a horny investment, but may be (as in the Millepores) calcareous—it is epiblastic. In the *Actinozoa*—which includes the true coral animals—it is generally mesoblastic, although it is formed from the epiblast in the *Gorgoniæ*, *Isidinæ*, and *Pennatulidæ*. In *Isis*, the skeleton curiously consists of a series of segments which are alternately horny and calcareous.

In the *Echinodermata* we generally have, notably in the Sea Urchin (*Echinus*), a wonderfully complex skeleton, which is so near the outer surface that at the first glance it seems necessarily a most external form of skeleton. Nevertheless, the plates which compose it are mesoblastic in nature, and are independent of the epidermis.

The two valves forming the shell of the Lamp-shells (*Branchionopoda*), and the very different two valves which constitute the shells of creatures of the Oyster class (*Lamellibranchiata*), as well as the single shells of the Snail and Whelk class (*Gasteropoda*), are all epiblastic in nature, and are calcifications of the outer part of the epidermis. The same is the origin of the apparently internal shell of the Slug, which is at first external in the embryo and subsequently becomes enclosed.

Similar is the nature of both the internal and external shells of the Squids, Cuttle-fishes, and Nautili, *i.e.*, of the class *Cephalopoda*. In the last-named class, as in some Gasteropods, there is a cartilaginous structure inside the head, which structure supports and partly protects the brain. It is unlike any skeletal part yet mentioned save in its mode of origin, which, like the skeleton of some of the *Actinozoa*, is mesoblastic.

Lastly may be mentioned the hard protecting external coat of insects and animals of the Crab and Lobster class—in short, the external skeleton of that primary division of animals which is called *Arthropoda*. This is again epiblastic, and a hardening of a cuticle on the outer surface of the epidermis—a hardening effected generally by chitinization (the deposition in it of a substance termed "chitin"), or, as in many *Crustacea* and some *Myriapoda*, by calcification.

GENERAL SKELETAL CONDITIONS.

Having thus briefly glanced at the leading skeletal structures of a number of groups of lower organisms, we may make the following generalization, which will be of use to us in helping us to understand how the skeletal parts of backboned animals stand related to the skeletal parts of animals lower in the scale:

(1) Skeletal structures may conceivably arise in parts which are epiblastic, or mesoblastic, or hypoblastic.

(2) Skeletal structures belonging to any one of those three categories may be further divisible into two subordinate categories, according as they belong to a superficial or a deep part of the layer to which they appertain.

(3) Skeletal structures may be siliceous, chitinous, calcareous, cartilaginous, or horny.

(4) In certain animals, the mesoblast subdivides into two layers, one *somatic* and the other *splanchnic*. Obviously, then, there may be skeletal parts corresponding to either of these last-named layers, and conceivably to a deeper or more superficial portion of either of them.

THE SKELETON OF VERTEBRATA.

The skeleton of the *Vertebrata*—that is, of the five classes of animals named *Pisces*, *Amphibia*, *Reptilia*, *Aves*, and *Mammalia*—may in the first place be most conveniently considered as consisting of two parts—a dermal skeleton, or *exoskeleton*, and an internal framework, or *endoskeleton*. The latter, which is generally much the more considerable, is mesoblastic, and the muscles are external to it.

External Skeleton of Vertebrata.

This division of the skeleton is itself again made up of two parts. The more external of these is the epidermis, and is of epiblastic origin, and dense epidermal structures may arise towards its inner or its outer surface. The more internal constituent of the exoskeleton is the dermis and dense structures formed in it, and these are from the outer portion of the mesoblast.

Epidermal hard structures formed towards either surface of the epidermis may become intimately united with subjacent dermal hard structures, and then again, as we shall see, with parts of the true endoskeleton.

Any hard structures formed in the walls of the alimentary canal—the lining of which is continuous at either end with the external skin—are to be reckoned as fundamentally exoskeletal. In the process of development the epiblast becomes inflected more or less into either extremity of the alimentary tube, but the intermediate portion, together of course with any hard structures developed in it, is of hypoblastic origin.

In the great majority of Vertebrate animals the two layers of the skin, the epidermis and the dermis, are, as in man, soft, though locally provided with certain denser appendages, such as epidermal and dermal scales, hairs, nails, scutes, and teeth.

The soft, general exoskeleton or skin invests the body of Man pretty closely, though slightly projecting folds of it extend between the roots of the fingers and toes. In some abnormal cases these folds extend so far and bind the digits together so much that the thus malformed person is said to be "web-fingered" or "web-toed." Such a condition is found normally in many animals, as notably in Ducks and Geese, and such parts form a large portion of the "wing" of the Bat.

Other extensions of the skin of the body are noteworthy. Thus in the "Flying" Squirrels and Opossums, and the curious Rodent named *Anomalurus*, the skin of the sides, between the arms and the legs, is much expanded, serving for a parachute.[3] There may be a skin parachute supported by long free movable ribs, such as we shall see exist in the little Lizards called "Flying Dragons." There may be a very remarkable extensive skin round the neck, as in the Frilled Lizard, and folds of skin may hang freely, as in the "dewlap" of Cattle, or may be formed here and there as in the Rhinoceros, the skin of which animal is so thick as to necessitate the existence of such folds to allow free movements to the body and limbs. Long filamentary processes may be formed along the back, as in the Iguana and various other Lizards.

In the Seals a fold of skin connects together the hind legs and the tail, and also in our common Bats, which have in addition their very elongated webbed fingers connected with the sides of the body and legs by another great fold of skin which, with those between the fingers, forms the entire bat's "wing."

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[1] See F. Balfour's *Comparative Embryology*, vol. i. p. 103.

[2] *Op. cit.*, vol. i. p. 122, and vol. ii. p. 286.

[3] [See also Galeopithecidæ, Vol. XV., p. 405.—Am. Ed.]

The integument may be very distensible, as in those Fishes (*e.g.*, *Diodon*) which distend themselves with air and then float belly upwards.

The epidermis of many Vertebrates, and of Man, is shed in minute fragments, constantly removed by friction and ablution, and constantly replaced; only under abnormal conditions and after certain diseases does it come away in large and continuous patches. In some other Vertebrates, as notably in Snakes, the entire epidermal investment of the body, even that of the eyes, is cast off entire as one whole.

The epidermis never has its superficial layer connected with bone, but it often becomes thickened and horny, as we see in the sole of the foot, or the laborer's hand, and in those abnormal thickenings called "corns." Certain local thickenings which are not abnormal may exist in animals; such are the callosities on the inner side of the legs of the Horse, on the breast of the Camel, and on the nates of the lower Old-World Apes.

Of the appendages of the epidermis the most simple are scales, such as we find on the legs of Birds and the bodies of Serpents and Reptiles generally.

A *scale*—a true scale, such as those of Snakes and Lizards—consists of papillæ of the dermis invested by the epidermis, the whole being covered by a cornification of the external part of the epidermis. Scales may be very diverse in shape, prominence, and relative size, and may form very large plates. The so-called scales of Fishes are of deeper origin and are a form of scutes.

A *hair* differs from a scale in that, instead of being an epidermic investment of a dermal projection outwards, it originates by an epidermal projection inwards into the subjacent dermis. A small papilla of the dermis, however, soon projects upwards, in turn, into the descending epidermal process, and then cornification sets in (at first in the immediate vicinity of the dermal papilla) in the cells around the axis of the epidermal descending projection, and this hardened portion soon projects beyond the surface of the body, while the part of the epidermis about its deepest part becomes modified into its so-called "root."

A *nail* or *claw* arises as a cornification of the epidermis (but not of its deepest layer) lying upon numerous very vascular ridges (or transversely elongated papillæ) of the dermis, forming the primitive bed of the nail, and enclosed in a deep fold of the integument. One end of the structure becomes free and projecting superficially, while the opposite region grows by epidermal additions from beneath and at its attached extremity.

A *feather* is more nearly related to a scale than it is to a hair. It consists at first of an upwardly-projecting dermal papilla invested with epidermis, and it is only at a later stage that its base sinks into a sack or "feather follicle." The outermost layer of epidermis becomes converted into a horny sheath, which is thrown off when the feather is completed. The *quill* is formed by cornification of the deepest and more superficial layer of epidermis investing the base of the dermal and vascular papilla, and is open at both ends. The vascular papilla it encloses shrinks up when the feather is fully formed. The *vane* of the feather is formed from the more apical portion of the papilla, and its central part, or *shaft*, is continuous with the quill, while ridge-like thickenings of epidermis diverging from either side of this central part constitute the barbs of the vane, from each of which yet smaller processes or barbules proceed.

A *scute* is a hardening of the outermost portion of the dermis, with an investment from the deepest layer of the epidermis. Such are the so-called scales of ordinary Fishes, which may be represented by the bony plates and processes called placoid scales—so common in the groups of Sharks and Rays. In these latter structures dermal papillæ appear and calcify, forming a dense structure without corpuscles, called dentine, beneath which may be a corpusculated structure of true bone. The calcifying papillæ receive an investment of still denser calcareous tissue, called enamel, from the deepest layer of the epidermis. These placoid structures often come to project outwards on the surface of the body as long spines or as shorter tooth-like processes, or they may protect the surface of the body as flat plates. Often the dentine more or less entirely atrophies, so that the structure comes to be formed almost entirely of true bone or of that peculiar calcified tissue of which the scales of ordinary Fishes (such, *e.g.*, as the Perch and Carp) are composed.

A *tooth* is a structure closely related to a scute. It differs from the latter just as a hair differs from a scale—namely, by owing its origin to an ingrowth of the epidermis instead of merely to a primitive outgrowth of the dermis.

The so-called teeth of the Lamprey are not true teeth, but are merely horny epidermal structures essentially similar to scales.

In the origin of a true tooth a process of the epiblastic layer of the mouth—the buccal epithelium—grows into the subjacent dermis, and, assuming a cup-like form (with the concavity of the cup turned away from the epithelial surface of the mouth), a dermal papilla rises into the cup. The apex of this papilla then superficially calcifies into dentine, and becomes invested with a layer of enamel formed from the immediately adjacent surface of the epidermic cup or "enamel organ." An investment of connective tissue called the dental capsule becomes formed round the whole. The dentine then increases, a remnant of the papilla remaining as the "pulp." The young tooth gradually approaches the buccal surface, and the base of the papilla becomes formed into the root or fang of the tooth. The enamel organ does not descend so far, but only invests the crown of the tooth. The inner layer of the capsule, however, investing the fang gives rise to a third dental tissue known as the cement. A bud may or may not be given off from the developing tooth to serve as its future successor.

Thus teeth are normally both epiblastic and mesoblastic structures, but in certain Fishes they line parts of the throat (the branchial arches), the superficial membrane of which is derived from the hypoblast, and such may of course be considered as hypoblastic skeletal elements, and, thus considered, must be reckoned as constituting a separate category of teeth.

Such being the various kinds of dense structures which enter into the composition of the Vertebrate exoskeleton, each kind may be developed to a greater or less extent in different groups of Vertebrate animals.

Exemplifications of Epidermal Skeletal Parts.

Scales entirely clothe the bodies of most Lizards and Snakes and the legs of Birds. In Tortoises and Turtles they take the form of large plates, which in one species are known as tortoise-shell. The shape and size of scales are made great use of as distinctive characters for classification. See REPTILES. The scales of a Serpent are held together by their epidermic investment in such a way that it and they are cast off as one whole each time the animal effects that process known as changing its skin. In the Rattlesnakes curiously modified thickenings of epidermis surrounding the end of the tail are not cast off but continue partially adherent; as growth proceeds and successive castings of the skin take place, these ring-like thickenings become numerous, and so knock one against the other, when the end of the tail is vibrated, as to produce a singular sound—the so-called rattling of the system of rings or "rattle."

Hairs form the characteristic clothing of the class *Mammalia*, though certain Mammals, such as Whales and Porpoises in their adult condition, are naked. Man is quite exceptional in having the ventral surface of the body more hairy than its dorsum. Long hair on the head, and whiskers and beard, are variable human characters, also possessed by some Apes; and many animals—as the Lion, the Horse, the Aardvark, etc.—have long hair in one or other region of the body. Some hairs may be especially thickened and serve as feelers, as in the "vibrissæ" or "whiskers" of the Cat tribe. But the maximum of development is shown in such creatures as the Hedgehog and the Porcupine, where hairs become dense and solid spines.

Nails do not exist in the class of Fishes and rarely in that of Batrachians. They first make their appearance in the most simple form—that is, in the form of slight thickenings of the epidermis—at the ends of the digits in certain Toads and of one kind of Eft. A nail is at its maximum of development when it quite surrounds and encloses the last or end bone of the digit which bears it. Such nails exist in Horses, Oxen, etc., and are called hoofs. A nail when produced into a sharp point is called a claw,—as in the familiar case of the Cat, and also in Birds. Nails may, however, be much reduced in size and not nearly extend to the end of the digits which support them, as in the Sea Bears. They may be altogether wanting, even in Mammals, as in the Porpoise, or attain a prodigious relative size, so that the body can be suspended by them in progression, as in the Sloth.

Nail-like structures may be developed from the side of the hand, as in certain Birds (*e.g.*, *Palamedea*), which are said to be "spurwinged," and in a Mammal (*Ornithorhynchus*) a hollow horny spur grows upon each ankle.

In the Rhinoceros we meet with a horn, or two horns, which grow up from the dorsum of the muzzle like a great blunt nail, long dermal papillæ extending into it and answering to the dermal ridges beneath a true nail. In Owen's Chameleon no less than three long horns are developed—one from the nose and a symmetrical pair from the front of the head.

Other horns which do possess bony cores are developed from the head in pairs on the so-called hollow-horned Ruminants, *i.e.*, the Oxen, Antelopes, Goats, and Sheep; and only in one anomalous form, the Prongbuck (*Antilocapra*), are these horny structures shed at intervals; in the rest they persist throughout life. Normally there is never more than one pair amidst existing Ruminants, with the exception of the Four-horned Antelope, which has two pairs. Such horns may be straight or curved or spirally twisted, but they are never branched, with the single exception of the Prongbuck.

Sharp-edged, overlapping, horny plates (each of which is comparable with a nail) may be developed beneath the proximal part of the tail, as in the curious Rodent *Anomalurus*. Such plates may clothe the entire body, head, limbs, and tail, as in the scaly Manis or Pangolin.

The epidermis and epithelium which respectively line the outside and inside of the jaws may both be converted into horn, forming a small beak which may be composed of a number of close-set processes and may be temporary, as in the Tadpole, or permanent, as in the Siren. Larger and denser structures of a similar kind form the beak of Birds and of the Turtle and of that most exceptional Mammal, the Ornithorhynchus.

The epithelium within the mouth may be locally cornified, forming horny teeth which have, as before mentioned, rather the nature of scales—as in the suctorial mouth of the Lamprey.

In certain Beasts, as the Cow and the Sheep, the front edentulous part of the upper jaw is invested by a horny epithelial pad against which the teeth of the front of the lower jaw bite. A much more developed structure is met with in the Dugong. The front of both jaws is furnished with a dense horny plate formed like the horn of the Rhinoceros, though of course widely different in shape. But the maximum development of this kind of structure is found in the Whalebone Whales. The upper jaw in these is furnished with very numerous horny plates, termed *baleen*, which hang down from the palate along each side of the mouth. They thus form two longitudinal series, each plate of which is placed transversely to the long axis of the body, and all are very close together. The outer edge of each plate is entire, but its inner edge gives forth numerous hair-like processes. These are some of the constituent fibres of the horny plates which thus, as it were, fray out and line the sides of the buccal cavity with a network of countless fibres formed by the inner edges of the two series of plates. This network acts as a sort of sieve, allowing water to escape between the plates but retaining in the mouth the small creatures on which the whale feeds.

Cornifications of the tongue may exist. Thus in some Birds, as in Woodpeckers, the structure of its apical portion becomes so dense that it serves as a dart or spear. Its surface may be more or less cornified in Beasts. Thus it may be furnished all round with backwardly-pointing spines, as in the Lesser Anteater (*Tamandua*). There may be a large horny papilla on each side of it, as in the Manatee or Ornithorhynchus, or there may be horny plates on the tongue, as in the Java Porcupine.

Horny structures also exist which cannot be considered as either epiblastic or mesoblastic, but must be hypoblastic in origin. Such are the horny linings of the stomachs or gizzards of Birds, and the similar lining of the stomach of the Great Anteater, *Myrmecophaga jubata*.

Feathers are the universal and peculiar cutaneous appendages of Birds, and generally differ much in size in different parts of the body, long and strong feathers constituting the most conspicuous part of the wings and so-called "tails" of Birds. Feathers are implanted on the body neither in an irregular nor in a uniform manner, but are aggregated together in different modes in different groups of Birds—each definite patch of implanted feathers being called a feather tract. The arrangement of these tracts in a bird is called its "pterylosis," and serves amongst other characters to distinguish different groups of Birds one from another.

Exemplifications of Dermal Skeletal Parts.

Scutes.—True dermal ossifications are met with in some kinds of Mammals. Thus the Armadillos possess a very complete external *dermal* skeleton formed of small many-sided bony scutes, the margins of which are adjusted together, and which are differently aggregated—into transverse bands or into larger inflexible masses—in different species. In the extinct *Glyptodon*, the body was invested, from the neck to the root of the tail, with one such solid case.

In the Armadillos a horny *epidermal* skeleton is so adjusted to the bony case that the former is divisible into small scales corresponding with the several scutes. Amongst Reptiles, we find in the Tortoises and Turtles (*e.g.*, *Emys*, *Testudo*) a solid exoskeleton, the dorsal part of which is called the "carapace," while the ventral portion is named the "plastron." The former consists of a median series of scutes, to each side of which is annexed a series of lateral scutes which are more elongated transversely to the long axis of the animal's body, and these three series are intimately united with subjacent portions of the internal skeleton. The carapace is completed by a series of smaller scutes, which surround it and are therefore called "marginal" scutes. The plastron consists of eight pairs of scutes and one azygous scute. In the Box-Tortoises one end of this plastron is movable, and (the head and limbs of the animal being drawn in within the shell) can be applied to the ends of the carapace, so that all the soft parts can be completely enclosed within the dense exoskeleton. As in the Armadillos, the bony scutes are covered by epidermal scales, some of which have been already referred to as constituting "tortoise shell." Unlike the Armadillos, however, the segments of the epidermal and dermal skeletons do not correspond. The dorsal scales are much larger and less numerous than are the scutes, but, while the scutes of the plastron are but nine in number, it has twelve horny plates or large scales.

Amongst the *Amphibia* certain Frogs (*e.g.*, *Ephippifer* and *Ceratophrys*) develop dorsal osseous scutes, and these, as in the Tortoises, are more or less united with parts of the subjacent internal skeleton.

A solid skeleton of juxtaposed osseous scutes may exist in Fishes, as in the Bony Pike *Lepidosteus*, where the scutes are enamelled and united by a peg-and-socket articulation. *Polypterus* also has an investment of bony scutes, and in the extinct fish *Pterichthys* they were developed into large plates on both the dorsal and ventral surfaces of the body. The Sharks and Rays may have their scutes thickly distributed over the surface of the body, but quite small. A skin so furnished is called "shagreen." They may also be larger and fewer, and placed far apart, with elegant patterns on their exposed surfaces; or they may take the form of strong defensive spines. In the Sturgeon the scutes are arranged in rows along the body, separated from each other by softer portions of integument.

In the ordinary bony Fishes, or *Teleostei*, the scutes (commonly but erroneously called "scales") are differently calcified from the scutes of Sharks, and may have their free projecting margin smooth, when they are described as *cycloid*, or in toothed-like processes, when they are termed *ctenoid*; or they may be intermediate between these two types of form. The Teleostean scutes are generally separate, but they may coalesce to form a connected solid investment, as in *Ostracion* and the Seahorses (*Lophobranchii*), or develop strong projecting spines, as in *Diodon*.

Fishes have two other very important exoskeletal structures, which may be bony or cartilaginous. One set of these structures consists of filamentary processes, which may be either horny or calcareous, and which support the skin of the fins, whether those of the back, belly, and tail, or those of the limbs; such structures are termed "fin-rays." The other set consists of bony or cartilaginous hard parts, which serve to support the fin-rays, which therefore lie more deeply, or at least are less projecting, and are commonly termed "interspinous bones or cartilages," but which may be conveniently distinguished as *radials*; they are very important elements of the fins of Elasmobranchs.

Certain Siluroid fishes exhibit in the adjustment of portions of their dermal exoskeleton an altogether peculiar mode of articulation, called a shackle joint. This is in the form of a dermal scute articulated with a superposed spine. The scute has an osseous ring on its dorsal surface, and through this passes another osseous ring which forms part of the base of the superimposed spine.

In connection with dermal scutes and spines may be mentioned those familiar yet exceptional structures, the bony horns of Ungulates. In the Oxen, Goats, and their allies horns exist on the head as bony cores, persisting throughout life, and supporting those "hollow horns" before noticed amongst the epidermal or epiblastic parts of the exoskeleton. As is the case with the scutes of Chelonians, these bony parts are intimately united with subjacent parts of the true endoskeleton. In the Giraffe there are three such bony prominences, which arise as distinct ossifications, and only later anchylose with the skull. These are the Giraffe's pair of short horns, together with the median prominence in front of them. In the Deer we find bony antlers, which are shed annually and are destitute of any horny covering. Antlers may exist in both sexes, as in the Reindeer, but generally they are present in the males only. They arise as soft highly vascular prominences, and when fully grown become hardened by calcareous deposit. In some months the investing skin dries up and is got rid of; and the horn itself falls off after the breeding season, leaving a stump whence a new antler shoots forth again in the following year. Antlers, as a rule, are branched—more so as the individual becomes older, till maturity is attained. Some Deer have enormous antlers, weighing as much as 70 ℔, and formed at the rate of 1 ℔ a day.

Teeth.—The differences in structure, number, form, and development of the dental organs are so great that they cannot here be treated of. See vol. vii. pp. 84–6, 202–7; also vol. xv. pp. 351 *sq.*

Internal Skeleton of Vertebrata.

The most essential part of the Vertebrate internal skeleton is the spinal column, the foundation of which is laid by a temporary or permanent structure called the notochord or *chorda dorsalis*. At the anterior end of the spinal column there is almost always a solid structure known as the cranium or skull, to which mandibular, hyoidean, and branchial arches may or may not be attached. The spinal column may be divisible into cervical, thoracic, lumbar, sacral, and caudal portions, and may have processes projecting from it upwards, downwards, or laterally, with arches of varying extent, as neural arches, chevron bones, and ribs, together with a median ventral portion—the sternum. The whole of these parts taken together constitute the axial skeleton. This may exist alone if the body is limbless, but otherwise additional hard structures are found which together constitute the appendicular skeleton.

Vertebrate animals never have more than two pairs of limbs, and each pair is attached to the body by the help of certain skeleton elements termed a limb-girdle, diverging from which are the hard parts which constitute the skeleton of either "appendage" or "limb." In addition to these we find in Fishes certain azygous structures—the unpaired fins,—the osseous or cartilaginous supports of which must be reckoned as a part of the appendicular skeleton. With the occasional (or possibly constant) exception of the notochord, the whole Vertebrate internal skeleton is a mesoblastic structure. In the great majority of the *Vertebrata* the skeleton is more or less bony, but it always in part consists of cartilaginous and fibrous structures.

The number and nature of the solid parts vary with age in the same species. When, in the earlier stages of existence, the process of ossification has once begun, it goes on more or less rapidly till maturity is attained, and is continued, to a certain extent, throughout the whole of life.

The points at which bone formation begins and whence it radiates are termed "centres of ossification," and there may be one, two, or several of these in what is ultimately to become a single bone. Sometimes these "centres" have an important morphological significance, and in other instances they would seem to be determined by the size of the future structure.[1] Bones are classed as "cartilage bones" or "membrane bones" according as they are formed either through the previous formation of a cartilage which subsequently ossifies or directly from membrane without the intervention of cartilage. These two classes can generally be easily distinguished, but there are instances in which it would seem that what is really the same corresponding bone differs as to its mode of origin in different animals. Moreover, a compound bone, formed of a membrane bone and a cartilage bone intimately united, may come to lose either its cartilaginous or its membranous elements, and thus further difficulties of interpretation may arise. There are also cases (as in the carapace of Chelonians) in which exoskeletal dermal bones coalesce with subjacent bones of the endoskeleton. Such bones may become deeper in position as development advances, and there is reason to think that not a few bones ordinarily reckoned as parts of the endoskeleton are of dermal origin, and first appeared in ancestral forms as placoid scutes or dermal spines.

As the development of the skeleton proceeds, ossification tends to fuse together more and more bones which at their first appearance were separate and distinct. This is notably the case in warm-blooded animals, and is most noteworthy in the warmest-blooded class—that of Birds.

Besides the coalescence of distinct bones, another fusion of bony structures occurs. This is due to the fact that the ends, or projecting portions, of what are essentially and ultimately one bone may for a time persist as distinct bony parts, termed "epiphyses." Thus, in the case of Man, the ends of the long bones of the limbs are at first separate from the main part (or shaft) of each long bone, and do not become continuous with the latter till the human frame has nearly attained maturity.

The hard parts of the internal skeleton, being those which as a framework support the body, form points of attachment for the muscles which move the body,—such hard parts being used as either levers or fulcra, as the case may be. The great majority of the bones are thus intended to move one upon another. The contiguous surfaces of bones form "joints," which may be immovable, mixed, or movable. The bones of the skull are united by immovable joints, called "sutures." Joints are said to be mixed when the motion allowed is exceedingly slight, as when two bones are allowed to be slightly separated from each other by the intervention of a softer substance which is attached to both. We have examples of movable joints in the human neck, the two uppermost bones of which are articulated on the principle of a pivot; in the elbow, which forms a hinge; and in the shoulder, where the upper arm joins the shoulder-blade in a ball and socket joint.

If one convex articulating surface be globular, it is termed a head; if it be elongated, it is called a condyle. If either of these is borne upon a narrow portion of bone, this latter is called a neck; if a pulley-like surface is formed by such a juxtaposition of two condyles as to leave a depression between them, such an articular surface is named a trochlea.

The curious and exceptional arrangement termed a shackle joint has been already noticed under the head of "Scutes."

AXIAL SKELETON.

The whole axial skeleton—including both the cranium and the spinal skeleton—apart from the notochord, is formed from the mesoblastic tissue bordering the medullary groove of the embryo. As the essential part of the axial skeleton is the spinal column, so the essential foundation of this column itself is what is known as the "notochord." This is an elongated cylindrical rod of soft tissue running along the antero-posterior axis of the body immediately subjacent to the central portion of the nervous system. Its mode of origin from the germ-layers of the embryo has yet to be finally determined. It is said by Balfour[2] to be developed, in most if not all cases, as an axial differentiation of the hypoblast. The cells of the notochord form a tissue resembling cartilage, and it becomes surrounded by a more or less dense fibrous sheath. Such an organ is found to exist, temporarily or permanently, in certain lower creatures—Ascidians—which in most other respects widely differ from Vertebrate animals. Some few of these animals are furnished with a tail throughout the whole of life, while others are furnished with such an organ only in their larval or immature condition. It is alone in such permanent or temporary tail, and not in the body of Ascidians, that a structure of this kind is met with.

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[1] Balfour's *Comparative Embryology*, vol. ii. p. 448.

[2] *Comparative Embryology*, vol. ii. p. 449.

In every Vertebrate animal the notochord is the first part of the skeleton to appear, and it extends throughout the whole length of the body, as well as of the tail. In every such animal, except the Lancelet (*Amphioxus*), it becomes arrested anteriorly in the midst of that secondarily formed skeletal region which becomes the skull. In *Amphioxus*, however, in which no skull is ever formed, the notochord extends to quite the anterior end of the body. It is inclosed in a strong sheath, within which its substance is segmented so as to resemble a longitudinal series of coins[1] or counters. The only other representatives of the internal skeleton in this animal are: (1) longitudinal ligaments (strengthening the sheath of the notochord above and below); (2) fibrous septa which pass out laterally from it between the muscles of the body, to the fibres of which they give attachment; (3) a longitudinal membranous sheath of the central part of the nervous system, forming an elongated antero-posteriorly directed cylinder above the notochord; (4) two vertical septa,—one dorsal, ascending medianly from such neural sheath, and one ventral, descending medianly from the sheath of the notochord in the region of the tail; (5) two jointed cartilaginous filaments which lie one on each side of the longitudinal slit which serves the lancelet for a mouth; and (6) certain cartilaginous filaments which strengthen the sides of the branchial cavity between the intervening vertical fissures of the walls of that cavity.

In all other Vertebrate animals the axial skeleton is divisible into that of the head, or the cranial skeleton, and that of the axial skeleton behind the head, or the spinal skeleton.

Spinal Skeleton.

In all Vertebrate animals except the Lancelet, the axial skeleton is complicated by a longitudinal series of additional hard parts—cartilaginous or osseous—which serve to protect the spinal cord, or marrow, above it, or the great bloodvessels beneath it, and which hard parts support, encroach upon, or replace the notochord itself. Nevertheless, the notochord persists throughout the whole of life in certain Fishes both of the lowest and highest types of piscine organization, but it does not persist in its entirety in any adult Vertebrate which is not a Fish.

In the Lamprey the notochord persists, but a longitudinal series of small, similarly shaped cartilages strengthen the sides of the more anterior part of the membranous dorsal canal which incloses the spinal marrow. In the Chimæra these are more developed, while numerous circular calcifications appear in the notochordal sheath. In the most anterior part of the trunk the cartilaginous elements unite to form a continuous investment of the notochord. Amongst the Ganoid Fishes, the notochord persists unconstricted and cylindrical in the Sturgeon and the Lepidosiren, but cartilaginous or bony parts appear about it and form a longitudinal series of arches above and below it for the protection respectively of the spinal marrow and sub-vertebral bloodvessels. In different kinds of Sharks further complications arise, and the notochord becomes encroached upon, in different modes, by chondrification and calcification, till it becomes segmented by the intervention of a series of thus formed hard parts called "bodies" or "centra," between which relics of the notochord still remain. By this process of segmentation there come to be formed what are called vertebræ, the presence of which in the overwhelming majority of Fishes, as well as in all the higher classes of animals, has led to the whole group being called *Vertebrata.*

In the vertebræ of most Vertebrates we have a solid body or centrum, from the dorsum of which there arises on each of its two sides a neural plate, which then bends inwards to meet its fellow of the opposite side, thus forming an arch (the neural arch) for the protection of the spinal cord, or marrow, which passes through it. From the dorsal side of such neural arch a process called the neural spine very commonly ascends. From the sides of the centrum or neural arch, or of both, a single process, or two superimposed processes, may jut outwards, which are known as the transverse process or processes, to which the ribs are generally articulated when ribs are present. Inferiorly directed processes, single or double, may descend from beneath the centrum, or may be developed in the intervals between adjacent centra, and are generally related to the protection of large bloodvessels, though they may only serve for muscular attachment.

Adjacent vertebræ are commonly connected together by special modifications of the neural arches or the centra, or of both. Mostly the opposed margins of the neural arches develop special processes for attachment called articular processes or zygapophyses, and there may be additional interarticulations. There may be as few as ten or as many as four hundred vertebræ.

Vertebræ may be divisible, as in the highest animals, into five categories: (1) cervical, or those of the neck; (2) dorsal, or those of the back; (3) lumbar, or those of the loins; (4) sacral, or those with which the pelvic limbs are connected; and (5) caudal, or those which are posterior to the sacral vertebræ, or which support the tail when such an organ is present. There may be only two categories (dorsal and caudal), as in Fishes.

In most Fishes and some exceptional Reptiles the body or centrum of each vertebra is so imperfectly ossified as to remain biconcave or amphicœlous,—that is to say, it presents a deeply concave cup-like form both in front and behind. The space thus inclosed by the adjoining cups of each pair of successive vertebra is filled up by a soft, spheroidal remnant of the notochord, which thus serves as an intermediate connecting substance. The cups may become filled up by ossification, as in Man and Beasts, the flattened surfaces being connected by what are called intervertebral disks. Each such disk is made of fibrous lamellæ which surround a soft elastic central portion which is a last remnant of the notochord. Often the vertebra may have the centrum very convex at one end and very concave at the other, and so give rise to a ball-and-socket joint at each junction between the successive centra. Such vertebræ may be procœlous (*i.e.*, have the cup in front and the ball behind), as in existing Crocodiles, or opisthocœlous (*i.e.*, with the cup behind and the ball in front), as in the Bony Pike Fish (*Lepidosteus*), the Land Salamander, and the cervical vertebræ of Ruminants; sometimes a vertebra may be biconvex (*i.e.*, have a ball at each end of its centrum), as in the first caudal vertebra of the Crocodile; or, very rarely, there may be two prominences, or the cups may exist side by side on one surface of a centrum, as in some cervical vertebræ of Chelonians. Instead of intervertebral disks, with spheroidal remnants of the notochord, adjacent vertebræ are often (as in Snakes) united by what are called synovial sacs, or membranous closed bags containing an albuminous fluid called "synovia" and commonly known as "joint-oil."

The various parts of a vertebra may be all united to form one single bone, as is generally the case in the higher animals, but such is by no means universally the case. In the Ichthyosaurus we find the neural arch permanently distinct from the centrum; and in the Carp the transverse processes are separate. The neural arch itself may be made up of two separate pieces on each side, as in some Elasmobranch Fishes, *e.g.*, *Raia* and *Spinax.*

Sometimes the neural arch, instead of reposing upon its own centrum only, appears, as it were, shifted so as to be connected with two adjacent centra, as is the case, *e.g.*, with the dorsal vertebræ of Tortoises.

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[1] Owen's *Anatomy of Vertebrates*, vol. i. p. 31.

Generally the nerves which pass outwards from the spinal marrow which lies in the neural canal pass out in the intervals between adjacent neural arches. Instead of this, however, they sometimes perforate the neural arch.

Neural spines, though generally single, may be double or altogether absent, and sometimes, as in Tortoises, they may intimately coalesce with superimposed dermal plates.

Cervical Vertebræ.—As has been already indicated, no vertebræ can be distinguished as cervical in the class of Fishes. Nevertheless the first three or four vertebræ next the head may, in some of these animals, present a marked difference from the succeeding vertebræ, being much elongated and united to each other by suture, as in *Fistularia* and *Bagrus*, and they may, as in the latter Fish, develop a continuous inferior vascular canal. The second and third vertebræ may form a hollow bladder-like case of bone, as in *Cobitis*, or send outwards or downwards special processes, as in the Carp.

In Amphibians only a single vertebra can be called cervical, but in Sauropsidans the number may be very large. Thus in the Swan it amounts to twenty-five, while in some of the Plesiosaurians it exceeded forty. Birds, being animals which have to perform with the beak functions which in most animals are performed by limbs, require to have a very movable neck; and consequently a considerable number of joints (and therefore of vertebræ) are required in the neck, which is the only part of the spinal column that is very flexible. In Serpents, which have the whole spinal column very flexible, no really satisfactory line can be drawn between cervical and dorsal vertebræ. In Lizards there are usually from seven to nine, but in the whole class of Mammals (whether the neck be very long, as in the Giraffe, or, like that of the Porpoise, extremely short) there are constantly but seven cervical vertebræ, except in the Sloths, which may have from nine to six, the Manatee, which has but six, and the Manis, which may have eight. All the cervical vertebræ may become anchylosed together into a single mass, as usually in the true Whales. Ordinarily in Mammals the transverse process is said to be perforated, *i.e.*, there are two such on each side, which are short and connected at their distal ends by a bony bridge which represents what, in the thorax, is known as a rib, as is shown by their condition in other classes of Vertebrates. Indeed in the lowest Mammals (*Echidna* and *Ornithorhynchus*) these osseous bridges have the form of distinct, more or less Y-shaped bones, as also in the Crocodile, where they are much prolonged. In many Lizards and Birds the posterior cervical vertebræ bear long ribs and are only counted as cervical because such ribs do not reach the breast bone, while more posteriorly placed ribs do attain it. The two superimposed transverse processes, with the rib joining them attached to succeeding vertebræ, form on each side of the neck a sort of bony canal, in which runs the vertebral artery. Sometimes, however, as in the Camels and Llamas, this canal is replaced by one excavated in the neural arches. In some cetaceans the external bar (or rudimentary rib) is wanting, so that there come to be two elongated transverse processes on each side.

Successive cervical vertebræ may differ strikingly one from another. Thus in the common European Terrapin we find the fourth cervical vertebra with its centrum convex in front and concave behind. The centrum of the fifth is biconvex. That of the sixth is concave in front with a double convexity behind. The seventh is doubly convex both in front and behind. The eighth is doubly concave at each end. The ninth is doubly convex in front and singly so behind.

The first cervical vertebra is known as the atlas, and joins the skull, which in Man it supports. It may be fused in one solid mass with the skull, as in the Sturgeon, or with a certain number of vertebræ, as in the Rays. It may be united by suture, as in *Bagrus*. The vertebral part of the atlas may be unossified, as in the Wombat, or remain a distinct bone, as in the Thylacine. The neural spine may be detached from the neural arch, as in the Crocodile and Tunny. Its ventral part may send out a pointed process towards the head, as in *Amphiuma*. It may develop two concave surfaces to articulate with the skull, as in Amphibians and Mammals, or only a single cup, as in Sauropsidans generally.

The second cervical vertebra is known as the axis, and is distinguishable in all vertebrates above the *Ichthyopsida*. Its centrum develops anteriorly a special peg-like or toothlike prominence known as the odontoid process, round which the head and atlas vertebra turn as on a pivot. This process may (as in many Reptiles and in the *Ornithorynchus* amongst Mammals) remain a distinct bone, and is regarded as the true centrum of the atlas, which thus generally coalesces into the axis vertebra instead of with the other portions of its own vertebra. The odontoid process may be absent in certain Mammals, as amongst Cetaceans.

Dorso-Lumbar Vertebræ.—The vertebræ which come between the cervical vertebræ and those (sacral) which support the pelvic limbs, or, when these latter are absent, the vertebræ between the cervical and the caudal vertebræ, form the vertebræ of the trunk. These are subdivisible into dorsal and lumbar when some of them (always the more anterior) bear ribs and others do not but have transverse processes only.

The number of trunk (or dorso-lumbar) vertebræ varies greatly, being very few in Frogs and Tortoises and very numerous in Serpents. In Mammals it ranges from about seventeen, in some Primates, to twenty-seven, in *Hyrax*. A definite number of trunk vertebræ is characteristic of certain groups of Mammals, though this number may be made up by different numbers of dorsal and lumbar vertebræ.

Dorsal Vertebræ.—Rib-bearing vertebræ are structures constantly found in all Vertebrate animals save certain Fishes and Amphibians. Dorsal vertebræ must be considered as including the whole number of trunk vertebræ in Serpents, since in those animals the whole series of the latter support ribs.

An ordinary Mammalian dorsal vertebra consists of a body and neural arch with articular processes or zygapophyses and with a more or less elongated neural spine, and a transverse process which juts out and bears an articular surface at its end. This process answers to the more dorsal of each pair of transverse processes on each side of a cervical vertebra. Another articular surface placed at about the junction of the neural arch and centrum answers to the more ventral of each pair of transverse processes on each side of a cervical vertebra.

The rib which on each side of the vertebra articulates with these two surfaces has generally itself such a surface at its proximal end (or head) and another on a more or less marked prominence called the tubercle of the rib. These are respectively designated the capitulum and tuberculum, and therefore the processes or articular surfaces of the vertebra to which the capitulum and tuberculum are respectively attached are called the capitular and tubercular processes or surfaces, as the case may be.

Sometimes each vertebra carries but one such articular surface (that for the capitulum of the ribs), as in the Dolphin. The two articular surfaces may coexist at different levels on one single process, as in the dorsal vertebræ of the Crocodile, or they may be in close apposition, and, as it were, fused together, as in Serpents. They may, however, be supported by two quite distinct processes—one dorsal, the other ventral—as in *Ichthyosaurus* and *Menobranchus*.

Man has twelve dorsal vertebræ. This is a little below the average of his class, where there may be twenty-four, as in the Two-toed Sloth. There are more than twelve in most Reptiles, while in Birds there are mostly but seven to nine, or, very rarely, eleven, while there may, as in *Ciconia alba*, be but three reckoned as dorsal on account of the great extent of ossification in the sacrum, or part connected with the legs.

The most remarkable modification of dorsal vertebræ is that in Tortoises and Turtles, where the neural spines expand at their summits into wide plates which articulate by suture with each other and with similarly expanded ribs, to form the carapace.

In Serpents and Iguanas we have a special mode of vertebral interarticulation, over and above that formed by the zygapophyses. The neural arch develops a median anterior prominence with two articular surfaces called the zygosphene, and this fits into a corresponding median posterior recess called the zygantrum.

The maximum of complication as regards the interarticulation of dorsal vertebræ is found in the last dorsal of the Great Anteater. There each posterior zygapophysis develops two additional articular surfaces, one on each side of a notch which receives a process from the anterior side of the neural arch of the succeeding vertebra, which process is furnished with two corresponding surfaces. More or less distinct traces of certain additional processes, called metapophyses and anapophyses, are sometimes present, but these it will be better to notice when describing the lumbar vertebræ, wherein they are more developed.

We find in some Serpents peculiar processes which project downwards and forwards from the base of the inner side of the transverse processes. We may also find present a long median inferior process extending vertically from the ventral surface of the centrum and as long as, or longer than, the neural spine of the same vertebra. Such processes are present in many Serpents—especially the poisonous ones—and in such Birds as the Penguin and Cormorant.

Lumbar Vertebræ.—These are vertebræ interposed between the dorsal vertebræ and the sacrum; they are generally the largest vertebræ of each vertebral column, but sometimes (as in Bats and Pterodactyles) the cervical vertebræ are yet larger. Lumbar vertebræ are generally to be distinguished in Mammals, in Crocodiles, and in certain Lizards, but not in any Ichthyopsidan.

In Birds lumbar vertebræ are present, but are disguised and hidden by the extent to which the sacral ossification extends forwards.

There are five lumbar vertebræ in Man, but the number in him is below the average of his class, though some Apes have but four. The Slow Lemur may have nine, the Two-toed Sloth has but three, and the Monotremes but two. These vertebræ are very numerous in the *Cetacea*, but the hinder limit of the lumbar region is more or less difficult to determine in these animals. The transverse processes are generally much longer than those of the dorsal vertebræ, and do not bear either capitular or tubercular articular surfaces.

The processes already spoken of as metapophyses and anapophyses are generally much more developed in the lumbar than in the dorsal vertebræ. The former project forwards from the vicinity of the anterior zygapophyses, and the latter project backwards at a lower level. Both processes are to be detected in the last dorsal and first lumbar vertebræ of Man, but are at their maximum in the Armadillos. In addition, also, to the complexity of articulation before described as existing on the last dorsal vertebra of the Great Anteater, we find in that animal's lumbar region an additional articular surface on each side of each transverse process.

The lumbar vertebræ may be anchylosed together and to other parts of the skeleton, as is the case in Birds.

Sacral Vertebræ.—These are distinguished from others, not only by their connection with the skeleton of the pelvic limbs, but also by their coalescence and a certain degradation in their structure as compared with the trunk and cervical vertebræ. In Man five vertebræ thus coalesce to form the more or less triangular single bone known as the sacrum, but which always shows plain traces of its composite nature. Such coalescence and degradation generally exist in Vertebrates above the *Ichthyopsida*, which possess fully developed limbs. The coalescence of vertebræ is generally less extensive than in Man, though sometimes—as in Birds, some Edentates, and some Reptiles—it is much greater. The sacrum may be composed of as many as ten vertebræ (as in some Armadillos) or of twenty (as in the Ostrich), and the lumbar or caudal vertebræ or both contribute to its formation.

In most if not all Mammals the sacral vertebræ—or the more anterior of them—have what are at first distinctly ossified elements in their transverse processes, which elements (like parts before noticed in the cervical vertebræ) are costal in their nature, *i.e.*, represent rudimentary ribs, and in Crocodiles and Tailed Amphibians the sacral vertebræ have a distinct rudimentary rib attached to each transverse process. In Birds, however, the vertebræ of the sacrum, which have expanded transverse processes, do not develop these from distinct ossifications.

As regards the extent of connection between the sacrum and the hip bones, union is more extensive in Man than in most Beasts, or in animals below Birds. Often in Mammals and almost always in Tailed Batrachians it may be confined to a single vertebra; but ten vertebræ may be involved in this union in Mammals and twenty in Birds.

That the development of the sacrum is not always in proportion to that of the pelvic limbs is proved by the little Lizard *Seps*, in which, in spite of the rudimentary condition of the limbs, there are true sacral vertebræ.

No Fishes have a true sacrum, though, very rarely, as in the Turbot, we meet with a kind of false sacrum, formed by the anchylosis of the bodies and ventral spines of the first two caudal vertebræ.

Caudal Vertebræ.—The vertebræ of the tail may be as many as 270, as in some Sharks. Amongst Mammals 48 (*Microgale longicaudata*) is the highest number. Man has usually rudimentary caudal vertebræ, completely or partially united so as to form a small conical bone called the coccyx. Its proximal end articulates with the sacrum by its centrum and two small zygapophyses. It has besides two rudimentary transverse processes and two processes representing piers of the absent neural arch. The other vertebræ are destitute of processes and consist but of smaller and smaller vertebral centra. Thus the last vertebra is the very opposite of the first (or atlas), being all centrum, while the atlas has no centrum at all. The coccyx usually becomes anchylosed to the sacrum about or after the middle of life. The caudal region is still more reduced in some Bats, where there may be but two such vertebræ.

In animals provided with numerous coccygeal vertebræ, such vertebræ may be provided with processes and articulations as complex as those of other spinal regions. Transverse processes may be largely developed at the tail root, but almost always thence backwards diminish in extent; sometimes, however, as in the Armadillo (*Chlamydophorus*), they may increase in size backwards from the tail root. Rarely (as, *e.g.*, in *Menobranchus*), caudal vertebræ may be furnished with two ribs supported by both tubercular and capitular processes. Inferior arches may exist in the form of detached "chevron bows" placed beneath the intervals of successive caudal vertebræ, especially towards the tail root. They may be represented by processes or by continuously ossified inferior arches, which may, as in the Flat Fishes, be very prolonged, extending downwards from each centrum as much as the neural arch and spine extend upwards from it.

Birds have generally six or eight, but may have ten, caudal vertebræ, at the end of which is a so-called "ploughshare-bone," consisting of two or more vertebræ anchylosed together.

The caudal region of the Frog is formed in a very peculiar way. It never consists of distinct vertebræ at any time of life, but is formed by the ossification of the membrane which surrounds the notochord, to which two small neural arches become attached. This structure is called the urostyle.

In Fishes (as in the Perch and Stickleback) there may be a urostyle continuous with the centrum of the last vertebra. Such a urostyle, unlike that of the Frog, is very sharply bent upwards. It is very small and inconspicuous. In other Fishes the hinder part of the notochord may (as in the Salmon) remain unossified and only protected by lateral bony plates, but it is still sharply bent upwards. In a few Fishes (as, *e.g.*, *Polypterus*) the hinder end of the spinal column is not bent upwards. In other Fishes again (as in the Sturgeon and many Sharks) the hinder end of the vertebral column gradually tapers and gradually (not suddenly as in the Perch and Salmon) inclines upwards. In the forms in which the hinder end of the vertebral column bends upwards—whether gradually or suddenly—the arches and processes beneath its hinder end exceed in size those on the dorsal side of it, as also do the fin-rays attached to them. Thus it happens that the part of the caudal fin which is on the ventral side of the gradually or suddenly bent-up part of the spinal column more or less greatly exceeds in size the part on the dorsal side. In those Sea Fishes (*e.g.*, the Sturgeon and many Sharks) in which the upward flexion is gradual and manifest, the ventral part of the caudal fin is evidently the larger, and such a tail is called *heterocercal*. In Fishes in which the hinder end of the spinal column is suddenly bent up and of minute size, so that its real condition is disguised, the caudal fin appears symmetrical and as if the parts dorsal and ventral to the end of the spinal column were equal. Such a condition has been named *homocercal*. Those Fishes in which the spinal column ends without turning upwards, and in which the parts of the caudal fin dorsal and ventral to it are really and not only apparently symmetrical, are said to be *diphycercal*.

Sternum.—The breastbone or sternum extends more or less along the middle line of the ventral region of the anterior part of the trunk in all Vertebrates above Fishes, except Serpents and a few other Reptiles.

Almost always it is connected with the more anterior ribs. Its anterior end is distinguished as the manubrium or presternum, and its hinder is called the xiphoid process or xiphisternum—the middle part being the "body" or mesosternum. A sternum may exist without ribs, or without forming any cartilaginous or osseous connection with ribs, as in the *Amphibia*. The plastron of Chelonians might well be supposed to be a great sternum, more especially as the plate-like ribs are connected with it. It appears, however, that this great complex plate does not really include a sternum.

The before-mentioned three-fold division of the sternum is normal in Mammals, and also exists, though more obscurely, in Birds and Reptiles. Even in Mammals it is not universal; the manubrium only may be present, as in the Greenland Whale, or the manubrium and xiphisternum without any mesosternum, as in the Dugong.

In Tailed Amphibians and the Slow-Worm (*Anguis*) we have a single sternum, which may be mesosternum only, while in many Frogs and Toads we have only the latter and the xiphisternum. The manubrium may develop a median keel, as in Bats, the Mole, and Armadillos; or the mesosternum, as in the Tamandua; or the mesosternum and xiphisternum, as in most Birds.

The xiphisternum may assume various forms, but attains its maximum development in Birds, where it forms the part of the sternum posterior to the attachment of the ribs, and may consist of a median and four lateral processes, as in the Fowl. It bears the greater part of the keel.

In the Monotremes there is a median ossicle in front of the manubrium, which is often called the episternum. It is really a part of the appendicular skeleton.

Ribs.—Mammals possess a greater or less number of ribs, which are mostly long, slender, curved bones, extending downwards from the transverse processes or bodies of the vertebræ, the more anterior of them forming a junction with the sternum. The part of the skeleton formed by the rib-bearing vertebræ, the ribs and the sternum, is called the thorax. In Man (see ANATOMY) there are twelve ribs (on each side of the body), whereof the first seven join the sternum by the intervention of cartilages, and are called "true ribs." The other five, which do not join the sternum are called "false ribs." Each rib (except the last two on each side) has a double attachment to the spinal column. At its proximal end it has a rounded "head" or "capitulum," which articulates with the capitular surface of a dorsal vertebræ. At a little distance from the capitulum is another rounded articular prominence called the "tubercle" or "tuberculum," which joins a vertebral tubercular surface. The part of the rib between the head and the tubercle is called the "neck." At its distal end each rib has attached to it an elongated cartilage called "costal." Those costal cartilages which do not join the sternum either end freely or blend with the costal cartilage next in advance.

Frogs and Toads have no ribs, nor can they be said to exist in some Fishes (*e.g.*, the Chimæra, the Seahorse, the Lamprey and its allies); but in the immense majority of Vertebrates there are cartilaginous or osseous ribs, attached by their proximal ends to the vertebral column, and tending to surround the trunk.

All rib-bearing animals have both "true" and "false" ribs, save Serpents, Fishes, and Chelonians, which can have no true ribs since they have no sternum, and Tailed Amphibians, in which, though there is a sternum, no ribs join it. There may, however, be but a single pair of true ribs—as in the Whalebone Whales. The ribs are exceptionally broad in the Two-toed Anteater, where they overlap one another. The number of ribs has already been indicated under the head of "dorsal vertebræ," though in Birds we may have short ribs attached to the cervical vertebræ, and others coming from vertebræ which are generally counted as "sacral." There may be as few as five or six pairs, as in *Amphiuma;* or the numbers may reach 320, as in some Pythons. In many Reptiles, as in the Crocodiles, there may be cervical ribs; and there may even be caudal ribs, as in *Menobranchus*.

The function of aiding respiration is one which the ribs possess in the higher *Vertebrata*, but quite other purposes may be subserved by them in addition to, or instead of, respiratory action—namely, locomotion, change of form, or bodily protection as armor. Thus the ribs may form a solid case for the safe keeping of the parts within, co-operating in this office with other skeletal structures so as to form the "carapace" of Tortoises already noticed. Ribs may be the main agents in locomotion, as in Snakes, which glide along by the successive application to the ground of the edges of their ventral scales, which is brought about by the motions of the ribs, the ends of which are connected with the inner surface of such scales. In the little flying Lizard *Draco* certain much elongated ribs serve to support a parachute-like flying membrane, and in the Cobra it is certain ribs which sustain its "hood" when distended.

The presence of a distinct "head" and "tubercle" is a general but not constant character, and the head of the ribs may be connected with two vertebræ or only with one vertebra. The ribs may bifurcate proximally into two equal diverging branches, one representing the "head" and the other the "tubercle." A small backwardly-projecting structure termed an "uncinate process" may be given off from the ribs and may ossify as a distinct bone, as in most birds and in the Crocodile.

Sometimes (as in Monotremes and many Lizards) a third segment may be intercalated between a rib and its sternal cartilage, and sternal cartilages may be represented by bones, as in Birds and Armadillos. In some Lizards the sternal cartilages of opposite ribs are continuous in the mid ventral line. There may be no representative of a sternal rib, as in Fishes and Batrachians.

Rarely, as in the Crocodile, there may be ventral rib-like structures in the wall of the abdomen, which meet and are attached ventrally, but are "free" at their dorsal ends. These cannot, however, be counted as true ribs. Fishes have often two series of ribs on each side of the body, and in *Polypterus* some vertebræ may have four ribs on either side. In Fishes the ribs may also be in part attached to the neural spines above or to the hæmal spines below the vertebræ.

Cranial Skeleton.

By the cranial skeleton we mean the skull, or that part of the axial skeleton which serves to shelter the brain (or anterior expanded end of the central part of the nervous system), together with solid structures continuous or more or less directly connected therewith. Such a structure exists in every Vertebrate animal, except the *Amphioxus*, which has no brain. Nothing of the kind is known to exist in any Ascidian or in any Invertebrate animal,—unless that cartilage of Cuttlefishes which serves as an investment of the nerve centres and a support for the optic and auditory organs may be deemed a true cranial skeleton, since its portions just enumerated make it, as we shall shortly see, very analogous to a true skull.

The cranial skeleton is, of course, at first composed entirely of soft mesoblastic tissue, parts of which always become cartilaginous and generally also osseous, while more or less of its structure may remain in the condition of mere membrane. The bones which generally, as just said, enter into its framework may arise directly in the membrane or may be preceded by cartilage which ossifies, a circumstance which divides the cranial bones into two categories—"membrane bones" and "cartilage bones."

The cranial skeleton of Vertebrates is made up of three sets of parts: (1) parts devoted to enclosing and protecting the brain; this is the cranium proper; (2) parts sheltering the organs of sense situated in the head—namely, the optic, auditory, and olfactory capsules; these skeletal parts consist of the bones, cartilages, and membranes of the orbit, the internal ear, and the nose respectively, or the perioptic, periotic, and perirhinal bones and cartilages; (3) parts continuous or more or less directly connected with the cranium, and applied to aid nutrition in the form of deglutition or respiration; such skeletal parts are the jaws and arches (or parts of such) behind the jaws known as the hyoidean and branchial arches.

1. *The Cartilaginous Cranial Skeleton.*—This is formed "by a differentiation within the membranous cranium,"[1] and consists of two plates (parachordals) placed one on each side of the anterior part of the notochord, and forming with the latter the floor of the

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[1] Balfour, ii. p. 466.

hinder part of the cranium, which part is known as the basilar plate. The cartilaginous auditory capsules are closely united to the outer sides of the basilar plate. From the anterior margin of that plate two bars, called the "trabeculæ," diverge forwards from the anterior end of the notochord, and then approximate, so as to enclose what is known as the pituitary space, and also the floor of the anterior part of the cranium. Thence they advance (generally united) into the nasal or ethmoidal region of the skull, forming a median nasal septum, having a cartilaginous olfactory capsule on each side of it, and developing lateral processes in front of and behind those capsules. Only in the *Cyclostomata* is there a single olfactory capsule instead of a pair. The nature of the parachordals and trabeculæ is disputed, but opinion inclines to regard them as corresponding to the neural arches of the spinal skeleton,—except the part around the notochord, which corresponds with centra in an unsegmented condition.

Upgrowths arise on the outer side of each parachordal, and these meet above and thus form a complete dorsal arch in the hinder or occipital region of the skull. The posterior aperture of this arch is called the occipital foramen, and through it the spinal cord enters the cranium, there to expand and become the brain. Lateral plates arise on each side farther forwards, in the anterior or sphenoidal region of the cranium. But these do not generally ascend enough to unite together dorsally, at least they almost always form but an imperfect roof to the cranial cavity. This cranial aperture may be related to a median, dorsally placed eye, which probably once existed in all Vertebrates, and still exists in a rudimentary condition in many Lizards.[1] The lateral plates grow together medianly in front, and more or less completely separate the cranial cavity from the ethmoidal region in front of it. Openings are left here and there in the cartilages of the cranial walls for the passage outwards of nerves from the central part of the nervous system; but these openings or foramina will be noticed in describing the osseous cranial skeleton. On each side of the sphenoidal region are the optic cartilaginous capsules, which, however, never become united (as do the others) with the cranium, and therefore are not generally reckoned as parts of the skull. A special median cartilaginous vertical upgrowth from the trabeculæ between these capsules may (as in Teleostean Fishes, Lizards, and Birds) form an interorbital plate beneath the most anterior part of the cranial cavity.

The third category of cranial skeletal parts is generally represented by a series of descending cartilaginous bars (or visceral arcs) on each side of the alimentary canal, running forwards beneath the cranium to terminate at the mouth.

As this lateral region of the head corresponds with the body wall behind it, and shows transitory indications of division (like the body wall behind it) into an inner part or splanchnopleure and an outer part or somatopleure, it is obvious that skeletal structures formed in its inner or outer part may be taken as belonging to different categories. In the *Cyclostomata*, as in the Lamprey, we find cartilaginous bars placed in the somatic divisions exclusively,—bars which support and externally protect the series of gill-pouches on each side; and parts probably homologous with these somatic bars of the Lamprey are found also in some Sharks.

The Cyclostomes also possess complex labial cartilages which support the lips of their suctorial mouths. Representatives of these cartilages are also to be found about the mouths of many Fishes, as well as in the temporary suctorial mouth of the Tadpole; and they still persist in connection with the olfactory capsules, though in a reduced form, in higher animals.[2] The most important members of the third category of cranial skeletal parts are—(1) the series of cartilaginous arches lying in the splanchnic or inner region of the lateral wall of the head, which arches support the gill-pouches on their inner sides and are known as the branchial arches, and (2) the arches seemingly in series with them, which are more anteriorly placed, and which are known as the hyoidean arches and the jaws.

One or other, or both, of these two sets of arches are well developed in all craniate Vertebrates, except the Cyclostomes, in which there are no true branchial arches, but only a hyoidean and a rudimentary jaw arch. There may be as many as seven branchial arches (*e.g.*, in *Notidanus*), but five are usually present in water-breathing Vertebrates. The hyoidean arch becomes segmented into two noteworthy portions, the upper of which is known as the hyomandibular portion.

The most anterior, or mandibular arch, also becomes segmented into an upper or metapterygoid portion, an inferior or Meckelian portion, and a median or pterygoquadrate portion, which grows forwards in front of the metapterygoid portion, and forms the foundation of the upper jaw against which the lower jaw (formed from the Meckelian portion) bites.

The thus formed upper and lower jaws may come to be suspended from the cranium in one of three ways. (1) They may depend from the cranium directly, that is, without the intervention of the hyoidean arch; this arrangement is known as autostylic,[3] and exists in all Vertebrates above Fishes, as well as in certain of the latter (*Chimæra* and the *Dipnoi*). (2) They may be suspended by the co-operation of the hyomandibular portion of the hyoidean arch with their own metapterygoid portion; this arrangement is known as amphistylic, and is found in *Notidanus*, *Hexanchus*, and *Ostracion*.[4] (3) They may be suspended exclusively by the hyomandibular portion of the hyoidean arch (to the exclusion of their more proximal portion), as in most Fishes and the Skates—an arrangement known as hyostylic.

2. *The Osseous Cranium.*—The bony skull is formed partly by ossifications of the cartilage of the cartilaginous skull and partly by ossifications of the membranes investing or completing it. The cartilaginous cranium may, as in Elasmobranchs, be covered by a thin calcified layer without becoming ossified. It may, as in the Selachian Ganoids, remain itself quite unossified, and yet become enveloped by membrane bones. In most cases, however, the investment of the cartilaginous cranium by membrane bones is accompanied by a more or less complete ossification of the cartilage itself. In the *Amphibia* the cartilaginous cranium is to a not inconsiderable extent ossified, but the membrane bones which invest it are nevertheless easily separable from it. The most constant ossifications of the cartilaginous cranium are in the occipital region. In the Lepidosiren these are the only ones, a bone being thus formed on each side of the occipital foramen, which bones are known as the exoccipitals.

Many disputes have taken place as to what cranial bones (both cartilage and membrane bones) of one group of animals correspond with those of other groups. Such disputes still exist in certain cases, and it would be unwise to positively assert more than the existence of a general correspondence between the cranial bones of widely different Vertebrates—such, for example, as between Teleostean Fishes and Reptiles or Mammals.

Beneath the occipital foramen the basioccipital bone arises, and it may, as in Birds and Reptiles, develop a posterior prominence which joins with contiguous prominences of the exoccipitals to form a single "condyle" for articulation with the spine. On the other hand, there may be, as in Mammals and Amphibians, two lateral exoccipital condyles unsecompanied by any median basioccipital prominence. In most Fishes we find only a concave articular surface behind the basioccipital, which thus resembles in form the vertebral centra, the anterior posterior surfaces of which are concave. A fourth bone, the supraoccipital, generally bounds the occipital foramen above.

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[1] See *Nature* of May 13, 1886, p. 33.

[2] Balfour, *loc. cit.*, p. 490.

[3] These terms were proposed by Professor Huxley.

[4] Balfour, *loc. cit.*, p. 475.

In front of this occipital segment the auditory capsule, on each side, generally ossifies from three centres of ossification, which form the prootic, opisthotic, and epiotic bones respectively. Of these the first is the most constant, and is the only one which ossifies in the Frog. When all three are present, the prootic is anterior in position, the opisthotic inferior and posterior, and the epiotic posterior and superior. Sometimes, as in Fishes, two other superoexternal bones may be formed in the auditory capsule, the more anterior of which is the sphenotic and the more posterior the pterotic.

The base of the cranium, in front of the basioccipital, generally ossifies as the basisphenoid, and a depression on its upper surface is known as the sella turcica or pituitary fossa. In front of the basisphenoid there may be, as in Mammals, another azygous bone, the presphenoid. The skull's lateral walls (in front of the auditory capsule) ossify as the alisphenoid and orbitosphenoid on each side, the latter forming the antero-lateral wall of the cranium. The optic capsule or sclerotic may be merely membranous, as in Mammals, or may ossify, as in Birds, but it never forms any solid connection with the cranial walls.

The olfactory region very often ossifies as a median vertical bone (the mesethmoid) and two lateral ones (the lateral ethmoids or prefrontals). These ethmoidal ossifications may close the cranial cavity anteriorly, or may be altogether anterior to it. The olfactory and presphenoidal region may ossify very exceptionally as one bone. Such a condition we find in the Frog and its allies. These bones vary greatly in different classes of Vertebrates as to the degrees in which they anchylose together or remain distinct, and also as to the order in which those unite which ultimately coalesce. Similar differences occur with respect to the remaining skull bones. Speaking generally, we find the greatest amount of distinctness in the Osseous Fishes, and the greatest amount of coalescence in the class of Birds.

The membrane bones of the cranium are most conspicuous and constant on its roof. In Fishes we find every grade of transition between simple dermal scutes and true subdermal bones of the internal skeleton. Well-developed dermal cranial scutes are to be found in the Sturgeon and some Siluroids. Where the membrane bones still retain the character of dermal plates, those on the dorsal surface of the cranium are usually arranged in a series of longitudinal rows, continuing in the region of the head the rows of dermal scutes of the trunk. The dorsal cranial dermal bones differ in different Fishes as regards arrangement and number as well as size. Owing, however, to their linear arrangements, they usually receive corresponding names, though it is very doubtful whether they can be considered as truly homologous.[1] In most Bony Fishes, as in higher animals, we may generally distinguish in the cranial roof one or two parietals, with an interparietal or upper (or upper part of a) supraoccipital behind the parietals, and a frontal or pair of frontals in front of them. A bone called the squamosal may also form part of the cranial roof, as in Mammals, and may send forwards and outwards a process which unites with another form, a preorbital bone, to form a zygomatic arch. In front, above, behind, and beneath the orbit (in which lies the sclerotic) bones may arise termed malars and lachrymals, supraorbitals, and post-frontals respectively, and the zygomatic process of the squamosal may unite with a corresponding process from the malar or the post-frontal. The malar bone, or (as it is often called) the jugal, rather belongs, however, to the third category of cranial skeletal parts. The olfactory or ethmoidal region becomes roofed over in part by the frontals, in part by the lateral bones (belonging to the third category of cranial parts to be presently noticed) called the maxillæ, but it is mainly roofed over by two bones (sometimes one bone) called nasals, which bound the posterior surface of the external nasal opening on each side of the skull. In Bony Fishes, Amphibians, and Serpents almost the whole cranium is invested below by a large membrane bone called the parasphenoid.

The nervous centres within the cranial cavity send forth nerves through certain definite small apertures or foramina, which show much constancy of position. As a rule, and in the highest class of Vertebrates, the olfactory nerves pass out medianly in front to the ethmoids, between the orbitosphenoids or the membranous parts which may represent them. The optic nerves perforate the orbitosphenoids, but may pass out behind them. In Lizards (*e.g.*, *Hatteria*, *Anguis*, and many others) an aperture is left in the roof of the skull which is called the "parietal foramen." It serves for the reception of a third and rudimentary eye, the existence of which in Lizards was before referred to in noticing the cartilaginous cranium. It is a structure of great morphological interest. The nerves of the muscles of the eye, as well as the first of the three divisions of the fifth nerve, pass out in the interval between the orbito- and ali-sphenoids. The two other divisions of the fifth, as a rule, perforate the alisphenoid, the third the more constantly, the aperture for it being known as the foramen ovale, the less constant aperture for the second branch being called the foramen rotundum. The auditory nerve enters the auditory capsule (whether ossified or not) on its inner side, and does not pass out from it, but the facial nerve both perforates and traverses it. The glossopharyngeal, pneumogastric, and spinal accessory nerves pass out between the auditory capsule and the exoccipital, which latter bone is perforated and traversed by the hypoglossal nerve.

Thus the osseous cranium (apart from the sense-capsules) consists of three arched segments; of these the hindmost is formed by the basi-, ex-, and supra-occipitals, the median by the basisphenoid, alisphenoids, and parietals, and the anterior by the presphenoid, the orbitosphenoid, and the frontals. These have been called "cranial vertebræ," and certainly if the essence of vertebræ consists in their being a series of solid rings, fitted together and inclosing a tract of the nervous centres, then it must be admitted that the cranium—of the highest class of animals at least—is made up of three such vertebræ. Their development, however, is altogether different from that of true vertebræ, and no such resemblance to vertebræ is to be detected in the constituent parts of the cartilaginous cranium. Nevertheless it is undeniable that there is a singular secondary and induced resemblance to vertebræ in these ossified skeletal parts.

The osseous condition of the third category of cranial skeletal parts varies extremely in different classes of Vertebrates. The limits of this article are altogether insufficient for more than a brief indication of the main varieties of the cranial structures of any of the three categories, and the reader must refer for details to the descriptions given in the various articles of this work which are devoted to different groups of animals.

The most anterior lateral descending bar or visceral arc is known as the mandibular arch. That part of it which extends forwards and forms the upper jaw presents us with the following ossifications arranged in two rows—one external, the other internal. The external row, proceeding from before backwards, consists of premaxilla, maxilla, jugal (or malar), and very often of a quadrato-jugal, which latter, when present, is generally in the form of a bar of bone (with an interval between it and the skull), forming, or helping to form, an inferior lateral external arch analogous to the superior lateral arch already noticed as the "zygoma." There may be a pair of premaxillæ, or they may be represented by an azygous bone. The premaxilla, maxilla, and jugal often unite with the anterior outer margins of the nasal, frontal, and lachrymal to form a continuous bony external wall to the anterior part of the skull. The internal row of bones, proceeding again from before backwards, consists of the vomer, palatine, and pterygoid, which, with their fellows of the opposite side (and sometimes with the aid of the parasphenoid), form the bony roof to the mouth, which roof may (as in Mammals and Crocodiles) be a continuous bony partition, or may be but a sort of open bony framework. Besides the pterygoid proper other ossifications, adjoining it, have been distinguished as the entopterygoid and the ectopterygoid.

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[1] Balfour, *loc. cit.*, p. 486.

The lower part of the most anterior lateral visceral arc forms all or part of the lower jaw. In the *Mammalia* it forms the whole of that jaw, and is invested by but a single bone—the dentary. In other Vertebrates it forms but the distal, though greater part of that jaw, and may be invested not only by a dentary, but also by bones called angular, subangular, coronoid, and splenial. The jaw is further continued, proximally, by two bones—the articular and the quadrate—which are ossifications of the cartilaginous arc itself. This may, as in Birds and Reptiles, be directly articulated to the cranial wall, or it may be (as in Fishes) suspended therefrom by bones, the highest of which is termed the hyomandibular, which articulates with the ossified auditory capsule. The hyomandibular joins below two other bones, the anterior of which is called the metapterygoid and the posterior the symplectic, to both of which the quadrate is attached. Thus these four bones act as a "suspensorium" for the lower jaw, the joint between which jaw and the suspensorium is placed at the junction of the quadrate and the articular. In Mammals parts answering to the suspensorium, the quadrate and the articular form no part of the jaw, but are of relatively minute size, and are known as certain parts (the auditory ossicles, etc.) of the internal ear,[1] and are protected externally by an ossification called the tympanic bone.

The second lateral descending bar or visceral arc, known as the hyoidean arch, may have its upper part ossified, in union with the preceding arch, as in the bony suspensorium of Fishes just described. On the other hand, its upper part may, as in Mammals, be represented only by minute parts of the internal ear—except the very summit of the arch, which forms the tympanohyal, and is anchylosed to the ossified auditory capsule of the internal ear. In Bony Fishes the hyoidean arch begins to free itself from the suspensorium, as a bone called the stylohyal, which is attached to the preceding or mandibular arch, between the hyomandibular and the symplectic. The arc then continues downwards as the epihyal and ceratohyal, ending below in the basihyal, from which a glossohyal may project forwards and a urohyal backwards. In Fishes certain styliform ossicles termed branchiostegal rays may project backwards from the hyoidean arch; and above them certain membrane bones called opercular bones—the operculum, preoperculum, suboperculum, and interoperculum—are attached above to the hyomandibular, and lie outside the mandibular and hyoidean arches.

In the air-breathing Vertebrates the hyoidean arch may be well developed or very imperfectly so, and concurs with parts belonging to the more posteriorly situated lateral arches to form a complex bone—the os hyoides—as will be further described.

These more posterior lateral arches—the branchial arches—attain their most complex osseous condition in Bony Fishes, which have commonly five of them, not solidly united to the skull above, but connected one with another inferiorly and with the inferior part of the hyoid arch. From below upwards these arches consist generally of a basibranchial, a hypobranchial, a ceratobranchial, an epibranchial, and a pharyngobranchial, but the hindmost arch is less fully and complexly formed.

In air-breathing Vertebrates the already-mentioned os hyoides consists of a central part or "body," to which are attached two pairs of single or jointed processes termed cornua. The anterior pair of cornua (known in human anatomy as the lesser cornua) represent the hyoidean arch, and may contain all its bones, including the "tympanohyal." The posterior pair of cornua (the greater cornua of human anatomy and the thyrohyals of Mammals generally) answer to or represent part of the branchial arches, and may be longer or shorter than the anterior pair of cornua. That they really have this homology is proved by the process of metamorphosis of the Tadpole, which in its early stage has distinct cartilaginous branchial arches that become the posterior cornua of the os hyoides of the adult Frog.

The osseous skull may, its bones remaining distinct, form a very solid whole, and the brain case may be complete, as in Mammals, or it may be very loosely constructed and largely membranous, as, *e.g.*, in most lizards. Teeth may be connected with various bones—most constantly with the dentary, maxillæ, and premaxillæ—but the palatines, pterygoids, parasphenoid (in *Plethodon*), pharyngobranchials, and even the basioccipital (Carp and Tench), may be dentigerous.

The structure of the skull is so exceedingly complex and varied that it is impossible within the limits of the present article to do more than give the above general indications. For further particulars the reader is referred to the anatomical details which will be found in the several articles of this work which are devoted to the description of different single groups of Vertebrate animals, and especially to the description of the skull of Man in the article ANATOMY.

APPENDICULAR SKELETON.

This part of the internal skeleton of Vertebrate animals normally supports two pairs of limbs only, but in one class—that of Fishes—there are azygous structures—the unpaired fins—which, as before said, must be reckoned as belonging to this category. These latter will be more conveniently treated of later. The whole appendicular skeleton may, however, be wanting, as in the Lamprey and in most Serpents.

The Skeleton of the Paired Limbs.—The paired-limb skeleton normally consists of that of an anterior, pectoral, or thoracic pair of limbs and that of a posterior or pelvic pair. In certain species there may be but a single pair of limbs, which may either be the pectoral pair, as, *e.g.*, in the Amphibian genus *Siren*, or the pelvic pair, as in the Reptilian genera *Bipes*, *Lialis*, and *Ophiodes*.

Normally each pair consists of diverging appendages—the limb skeleton proper—attached to a solid structure embracing parts of the trunk, *i.e.*, a limb-root or limb-girdle. A thoracic limb-girdle may exist in a well-developed condition without any limbs attached to it—as in the Slow-Worm (*Anguis*), but there is never a well-developed pelvic girdle without a rudiment of a pelvic limb.

In all Vertebrates above Fishes the limbs are divisible into a main part of the limb—arm or leg,—with a distal part or extremity—"manus" (hand) or "pes" (foot). We sometimes find (as in *Lialis*, *Python*, and *Balæna*) a rudimentary development of the skeleton of the leg without any rudiment of a pes; but we never find any rudimentary development of an arm without any rudiments of a manus. In the paired limb, as we have seen, a limb-girdle may be present without any part of the limb, but no part of the limb-skeleton is ever developed without any limb-girdle.

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[1] The exact and precise homologies of these parts seem still to be *sub judice*.

Normally the two limb-girdles are attached in a solid manner to the axial skeleton, in different modes.

Normally the pectoral girdle is only thus connected with the axial skeleton by its ventral part, or with the ventral part of that skeleton, *i.e.*, with the sternum, while it ends freely above, being dorsally connected with the axial skeleton only by soft structures. In Fishes, however, it may abut by its dorsal extremities on each side against the neural region of the spinal column, as in *Raia clavata*, or be connected with the head by skeletal structures, as in Bony Fishes, *e.g.*, Perch, Cod, etc.,—having all the time no connection with the spine by its ventral part.

The pelvic girdle, on the contrary, is normally connected by its dorsal part solidly with the axial skeleton, though, as in Fishes, it may not be at all so connected. It never, however, abuts ventrally against the axial skeleton as does the thoracic girdle.

Appendicular Skeleton of Vertebrates above Fishes.

The paired limbs of all animals above Fishes are formed on one type, and differ greatly from those of the last-mentioned class. It will be convenient to describe first the general condition of the limbs in Mammals, Birds, Reptiles, and Amphibians.

Both the thoracic and pelvic limbs of these animals are divided, as before said, into main parts (arm and leg) and extremity (manus and pes). Each main part is further subdivided into a proximal segment (upper arm and thigh) and a distal segment (fore-arm and lower part of the leg). Each extremity is subdivided into a root portion ("carpus" and "tarsus"), a middle portion ("metacarpus" and "metatarsus"), and a terminal portion known as the digits. Thus the skeleton, *e.g.*, of the hand of Man, is composed of—(1) the root part of the hand or the "carpus" (made up of eight small bones); (2) the middle part of the hand or "metacarpus" (made up of five long bones enclosed in the flesh of the palm); and (3) that of the digits, *i e.*, of the thumb (or "pollex") and of the four fingers, while the great toe (or "hallux") and the four other toes are the "digits" of the pes.

The joints between the proximal and distal segments of the main part of each limb are the elbow and the knee, and these are turned mostly (as in ourselves) in opposite directions. Primitively, however, in all animals and permanently in some (*e.g.*, Tortoises), both these joints are so conditioned as to open inwards—the elbow and knee being both directed outwards—while the palm of the manus and the sole of the pes are also both inwards in the embryo, and in the adult are applied to the ground, the digits of each extremity being directed outwards. This is the position in which the correspondence in structure between the thoracic and pelvic limbs is most obvious, and in it the whole surface of the limbs, which (on account of the muscles there placed) is known as the "extensor" surface, is turned outwards, whereas that known as the "flexor" surface is turned inwards, while the pollex of the manus and the hallux of the pes are both in front of their respective extremities. This primitive condition is altered during the process of development of Man and most air-breathing Vertebrates, the knee becoming bent forwards and the elbow backwards, while the fore-arm is twisted by a movement called "pronation," so as to enable the flexor or palmar surface of the manus to be applied in a direction parallel to that of the flexor or plantar surface of the pes.

In Bats the thigh is turned backwards so that the knee bends backwards like an elbow. Were it necessary in these animals to apply the sole of the pes to the ground with the digits forwards (as in most animals), then a pronation of the lower leg would be needed in them, similar to the pronation of the fore-arm, which, as above said, takes place in the majority of animals here referred to—air-breathing Vertebrates.

The Thoracic or Pectoral Limb-Girdle.—The shoulder-girdle normally consists of the following bones or cartilages: (1) a superior portion, generally a more or less broad plate of bone, called the scapula, the upper part of which may remain cartilaginous and more or less distinguishable as a suprascapula; (2) a posterior inferior portion, named the coracoid, which may or may not be continuous with the scapula, and may have additional parts or subdivisions distinguished as the coracoid proper, precoracoid, and epicoracoid; at the junction of the scapula and coracoid there is a concave articular surface—the glenoid cavity, into which the pectoral limb is articulated; (3) an anterior inferior portion, called the clavicle, which may abut against an azygous median structure known as an interclavicle, the two being distinguished from the other elements of the girdle by being more or less entirely membrane bones.

These structures are found well developed in many Lizards and quite exceptionally in Monotremes amongst Mammals. In them and in birds, the coracoids are largely developed, while they remain mere processes of the scapula in non-Monotrematous Mammals, and sometimes are quite rudimentary. In such Mammals the pectoral arch is only completed inferiorly by the clavicles which abut against the sternum, but sometimes (as, *e.g.*, in Ungulates) are altogether absent. The "merrythought" of Birds is a clavicular structure. In Amphibians the two halves of the shoulder-girdle are each formed of a continuous plate. Some anatomists reckon part of this as representing a clavicle, but this determination is very doubtful.

The Pelvic Girdle.—This girdle, like the former one, normally consists of three parts—one dorsal, the ilium, and two ventral, whereof the more anterior is the pubis and the posterior the ischium, and all these are cartilage bones. The pubis generally meets ventrally its fellow of the opposite side, but not always so. The ischia meet ventrally more rarely. In Birds and certain extinct Reptiles a third element, the post-pubis, intervenes between the ischium (more or less parallel to the latter) and a pubis which may be fully or only rudimentarily developed. At the junction of the ilium and the ventral pelvic elements there is a concave articular surface for the pelvic limb, the acetabulum. An interval between the pubis and ischium of each side is known as the obturator foramen. We find amongst Amphibians there is a peculiar cartilage in the ventral median line in front of the pubis, which has been called the prepubic cartilage.[1] In Marsupials and Monotremes a bone extends forwards in front of each pubis, and these bones are known as the marsupial bones.

The Limbs.—The general condition of these organs and the bones supporting them in Vertebrates above Fishes having already been indicated, it remains but to fill in a few details as to their normal structure and its principal varieties.

A. *Pectoral.*—The bone of the upper arm is called the *humerus*, and is more or less cylindrical in shape, with an expansion at each end. It may, however, be almost as broad as long, as in the Mole and some Cetacea. The lower arm is generally furnished with two bones, the radius and the ulna, placed side by side. The ulna may be more or less abortive, as in Ruminants and Bats, but it may be the larger of the two fore-arm bones, as is the case amongst Birds.

The *carpus* may have its parts more or less permanently cartilaginous, as in some Urodeles and Cetaceans.

Taking the carpus of Man as a type of the ossified carpus (for further details, see ANATOMY), it consists of the eight following short bones arranged in two transverse rows. The proximal row (that next the arms) includes the scaphoides, lunare, cuneiforme, and pisiforme, while the distal row (that next the fingers) comprises the trapezium, trapezoides, magnum, and unciforme—starting, in each enumeration, from the thumb side of the manus. The pisiforme stands out from the rest, and is reckoned as a sesamoid bone or ossification of a tendon, rather than a true carpal ossicle. There may be an analogous sesamoid ossicle on the other side of the wrist (on the side of the scaphoid) even in Apes, and this obtains its maximum in the Mole, where it strengthens and broadens the manus for digging. The true carpal bones may be more numerous or less numerous than in Man. Thus there may be an ossicle—called intermedium or centrale—placed in the mid line between the two rows of carpals, and this may be double, as in *Cryptobranchus* and some Siberian Urodeles. The unciforme may also be represented by two bones, as amongst Chelonians; the pisiforme is often absent, and also the trapezium. The bones of the distal row are less constant in number and development, and they may coalesce with the metacarpals, as in the Chameleon. Their development is related to that of the digits with which they articulate. All the true proximal carpal ossicles may unite into one bone, as in *Pteropus*, and the whole carpus may be reduced to two distinct bones, as amongst Birds.

The *metacarpus*, when fully developed, consists of five rather long metacarpal bones, as in Man. There may, however, be but two, and these united into what is called a "canon bone" (as in Sheep, Deer, etc.); or there may be but a single one, as in the Horse,—answering to Man's third metacarpal. They vary in relative size and proportion in different animals, but are most remarkable for their length and slenderness in the Bats, while they are much elongated in the Horse and most Ruminants.

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[1] Balfour, *loc. cit.*, p. 499.

As to the *digits*, there may be but a single one, as in the Horse, or two, as in Ruminants and the Marsupial known as *Chœropus*. There may be three, as in the Rhinoceros, the Proteus, and in *Seps*; or there may be four. The digits are never certainly more than five (except by monstrosity), although in the Ichthyosaurus extra marginal bones along the manus give at least the appearance of more.

When a digit is wanting it is generally the pollex (thumb), as in Spider Monkeys, but it may be the fifth, as in Pterodactyles, or both fourth and fifth may be wanting, as in Birds. The pollex may be more or less opposable to the others, as in Lemurs, most Monkeys, and in Man, or two digits may be opposed to the other three, as in the Chameleon.

The second digit may be greatly reduced, as in the Potto, or the third may be disproportionally slender, as in the Aye-Aye, or thick, as in the Great Armadillo. The digits may be enormously elongated, as in the Bats, or short, as in the Mole and the Land Tortoises. They may be very imperfectly developed, as in Birds. They may be so united by dense tissue as to be quite incapable of separate motion, as in the Cetaceans. The bones of the fingers are called phalanges, and there are always three of them to each digit except the pollex, which has but two in all Mammals with the exception of certain Cetaceans, which have more. There may be as many as fourteen phalanges in one digit in *Globiocephalus*. The proximal row of these bones may become anchylosed to the metacarpals, as in the Three-toed Sloth. In Reptiles the numbers of the phalanges often increase from two in the pollex to five in the fourth digit, as in the Monitor. The abortive manus of Birds has at its best but three digits, with two phalanges to the pollex, three to the index, and one or two to the third digit. The phalanges are very numerous in the Ichthyosaurus and Plesiosaurus.

B. *Pelvic*.—The bone of the thigh is called the *femur*, and is a long bone which varies less in its form and proportion in different animals than does the humerus. It is, however, relatively very short in the Seals, and still shorter in the Ichthyosaurus.

In front of the knee-joint there is generally present a large sesamoid bone known as the knee-pan or patella. This, however, may even in Mammals be very small, as in Bats and Seals, or wanting altogether, as in the Wombat.

The leg below the knee is supported by two long bones, the *tibia* and the *fibula*, placed side by side, whereof the former is the more internally situated, the larger generally, and the more constant. The two bones may anchylose together at each end, as in the Armadillos, or they may do so only below or only above; the two bones may be completely fused together, as in the Frog. The tibia may be the only long bone, through the small development of the fibula, as in Ruminants and the Horse. The fibula may be quite styliform, as in Birds, or it may be developed inferiorly but be atrophied at its upper end, as in Bats. It may be represented only by a small ossification outside the lower end of the tibia, as in the Ox, and with this there may exist a styliform rudiment of its upper part, as in the Elk.

The joint by which the foot moves on the leg is situated between the lower end of the leg bones and the tarsus in Mammals and Amphibians. In Birds and Reptiles, however, this joint is placed in the tarsus, the proximal part of which is firmly connected with the leg, while its distal part is firmly connected with the metatarsus.

The *tarsus* of Man consists of seven irregularly shaped, more or less short bones. Of these the astragalus joins the tibia and has the os calcis beneath it and the naviculare in front of it, while the metatarsals are supported (from the great toe outwards) by the internal, middle, and external cuneiform bones and by the cuboides, which is connected with the fourth and fifth metatarsals.

The tarsus may have its parts more or less permanently cartilaginous, as in some Urodeles. The number of its bones, or cartilages, may be as many as nine, as in the Salamander, or be reduced to three, as in *Proteus*, or perhaps to two, as in *Ophiodes*. Two tarsal bones (the os calcis and naviculare) may take the form of long bones, as in *Galago* and especially in *Tarsius*. These two bones and the astragalus may be represented by a single bone, as in many Lizards, or may early unite with the tibia, as in almost all Birds. The astragalus may be represented by two bones, as in Urodeles. It may have an extra ossicle annexed to it, as in the male *Ornithorhynchus* and *Echidna*. Two extra ossicles may be attached to the tibial side of the foot, as in the true Porcupine (*Cercolabes*). The naviculare may anchylose with one of the distal tarsal bones, as in the Ox and Deer, where it unites with the cuboid. The distal bones are less constant than the others, and they may anchylose with the metatarsals, as in Birds, the Chameleon, and the Three-toed Sloth. The cuboid may be represented by two bones, as in certain Urodeles. The internal cuneiforme may be wanting, as in the Ox, or coalesce with the middle one, as in the Horse.

The *metatarsus* when fully developed consists of five rather long metatarsal bones, as in Man, and never of more. There may be but a single developed metatarsal, as in the Horse (the third) and *Chœropus* (the fourth), or two fused together, as in the Sheep, Deer, etc., or three fused together, as in the Jerboa, or four so fused, as in many Birds. There may be but two metatarsals well developed, as in the Hog, or three, as in the Rhinoceros, or four, as in the Dog. They are never enormously elongated like the metacarpals of Bats, but they may all be extremely short, as in Land Tortoises and the Ichthyosaurus.

The *digits* vary in number, as has just been indicated with respect to the metatarsal bones sustaining them.

When one digit is wanting it may be the fifth, as in Birds, or the hallux (first or great toe), as in the Hare. The third and fourth digits may be only functional ones, as in the Ostrich; but the third may abort, leaving only the fourth, as in *Chœropus*, or the fourth, leaving only the third, as in the Horse. The fourth and fifth may be the only functional ones, as in the Kangaroo. The hallux may be opposable to the other digits, as in Monkeys, Lemurs, Opossums, and Phalangers; or the first and fourth digits may be opposed to the second and third, as in Parrots; or the first and second to the third, fourth, and fifth, as in the Chameleon.

The phalanges of the digits are in Man's whole class always three to each digit except the hallux, which (like the pollex) has but two—save in the Orang, where it may have but one phalanx. They may be much more numerous than in Mammals, as in the pes of the Ichthyosaurus and Plesiosaurus. The numbers of the phalanges as we proceed from the first to the fifth digit may be 2, 3, 4, 5, 4, as in Lizards generally, or 1, 2, 3, 3, 2, as in the Salamander, or 2, 2, 3, 4, 3, as in the Frog. In Birds (where the fifth digit is more developed) the numbers of the phalanges, proceeding from the hallux, are mostly 2, 3, 4, 5; but they may be 2, 3, 3, 3, as in the Swifts, or 2, 3, 4, 3, as in the Goatsuckers.

Appendicular Skeleton of Fishes.

The Paired Limbs.—Most Fishes possess two pairs of limbs, known as the pectoral and ventral fins, which respectively correspond to the pectoral and pelvic limbs of higher vertebrates. These limbs are attached to corresponding limb-girdles, whereof the pelvic girdle is always inferior in development and never attains the large relative proportions and fixed position of the pelvic girdle of non-Piscine Vertebrates.

Very often, however, the ventral fins are entirely wanting, and the pectoral fins are sometimes wanting also. In the latter case there is usually present more or less of a pectoral limb-girdle, though it may be, as in *Murænophis*, little more than a filament. In all non-Piscine Vertebrates the right and left limbs are symmetrically and equally developed, but in the Flat Fishes (*Pleuronectidæ*) one pectoral fin may be larger than the other, or one may disappear, as in *Monochirus*.

The situation of the paired limbs is, in Elasmobranchs, Ganoids, and a good many Teleosteans, similar to that they hold in higher Vertebrates, but in some other Teleosteans (such as the Fishes on that account called "thoracic") the ventral fins are placed far forwards so as to come immediately behind the pectoral fins, while in yet other Teleosteans (known on that account as "jugular" Fishes) they are placed even in front of the pectoral fins.

The *pectoral girdle* may consist of a simple cartilaginous arch, as in Elasmobranchs, or it may be composed, as amongst Teleosteans, of two bones meeting ventrally, each being commonly regarded as a clavicle which is continued up dorsally to the skull by the intervention of a supra-clavicle and a post-temporal. Besides these there is a cartilaginous element on each side which usually ossifies in two pieces, the upper one of which is reckoned as representing a scapula and the lower one a coracoid. These parts are annexed to the inner side of the clavicle, where also there is sometimes found a styliform bone, more dorsally placed, called the post-clavicle.

The *pelvic girdle* is represented in Elasmobranchs by a transverse cartilaginous structure formed of two separated or two medianly-united pieces, each of which sometimes, as in *Chimæra* and *Callorhynchus*, shows much resemblance to the innominate bone of higher Vertebrates in that it sends up a process simulating (and probably representing) the iliac element and possesses a sort of obturator foramen. In Osseous Fishes the pelvic girdle is normally represented by two innominate bones medianly joined, each of which may, by rare exception, as in *Lophius*, send up a tall ilium-like process. In no Fish, however, does the pelvis become solidly united with the spinal column. In the cartilaginous Ganoids it is very rudimentary, and each lateral portion (which has a slightly-developed pubic and iliac process) is separated from its fellow on the opposite side, while in *Lepidosiren* there is only a single simple median cartilage with no iliac process.

The skeleton of the *pectoral limb*, or *fin*, of most Elasmobranchs consists of three considerable basal cartilages, placed side by side, articulating with the pectoral arch, and named the propterygium, the mesopterygium, and the metapterygium. Of these the propterygium is proximal or anterior in position. To the distal ends of these are articulated a number of slender elongated more or less segmented radial cartilages, and to the distal portions of these are annexed the horny fin-rays which form the solid supports of the distal portion of the fin.

Sometimes there may be but two and rarely only one basal cartilage, which one must then be considered as representing the whole three condifferentiated. In *Ceratodus* there is a single basal cartilage followed by a series of small cartilages—secondary radial cartilages diverging from both sides of that series and having fin-rays annexed to them. In *Lepidosiren* the limb skeleton is still more simplified, consisting only of a single series of short, slender cartilages with small fin-rays attached to one side alone, without the intervention of any radial cartilages.

In some Bony Fishes (*e.g., Polypterus*) the basal cartilages are more or less ossified, as are also most of the radials next them, while to these small cartilaginous radials are annexed, which support ossified fin-rays. In some other Ganoids certain of the radial cartilages articulate directly with the pectoral arch. In the *Teleostei* a few, not above five, more or less ossified cartilages lie side by side and articulate with the pectoral arch, and one or more rows of small cartilages succeed to them. These two elements represent the basal and radial cartilages of Elasmobranchs, and to them are articulated the relatively large fin-rays which make up the far greater part of the Teleostean pectoral limbs.

The skeleton of the *ventral fin* or *pelvic limb* is almost always more simple than that of the pectoral one. Only very rarely as in *Ceratodus, Lepidosiren*, and *Callorhynchus antarcticus* (see *Trans. Zool. Soc.*, vol. x. p. 455, and plate lxxix. Figs. 3 and 4), have they a close, or pretty close, resemblance. Generally the Elasmobranch ventral limb is supported by an elongated cartilage, the basipterygium, which articulates with the pelvic cartilages and bears on its ventral border a series of cartilaginous radialia with which the fin-rays are connected. In *Polyodon folium* there are only radials which support fin-rays but are not themselves supported by any basipterygium, nor is there any pelvic cartilage. In the *Teleostei* the fin-rays are directly attached to the osseous pelvic elements.

The Unpaired Appendicular Elements.—Besides the two pairs of limbs there are, as has been mentioned, certain azygous structures commonly known as the unpaired or azygous fins or limbs. They are only found in Fishes, and consist of the dorsal, caudal, and anal fins. These may all run one into the other and form a continuous fin fringe to the body from the head round the tail and forward again to the vent, as in Eels and many Gadoid and Blennioid Fishes. In most cases, however, there are one or two distinct dorsal fins, and an anal fin also distinct from the caudal one.

The structure of the *dorsal fin* in Elasmobranchs is singularly like that of their paired fins, inasmuch as it is supported by an elongated or segmented basal cartilage or cartilages, from the dorsal margin of which radial cartilages (generally elongated, slender, and segmented) proceed, having the fin-rays connected with them distally. The basal cartilages may or may not be directly connected or become confluent with the subjacent spinal skeleton. There may be (as in the second dorsal of *Callorhynchus antarcticus*) but a single longitudinal series of more or less elongated cartilages side by side, like radial cartilages devoid of any subjacent basal cartilages. In the *Teleostei* the fin-rays may be osseous and in the form of more or less strong spines, or soft and of a horn-like consistency, and segmented both vertically and horizontally; and fin-rays generally consist of two (right and left) halves, which, although closely applied together for the greater part of their length, diverge proximally to embrace the skeletal element to which they are annexed. These latter elements in the *Teleostei* are small ossicles or chondrifications, termed "inter-spinous bones or cartilages." They extend upwards between the neural spines of the axial skeleton and the dorsal surface of the body.

Anal fins are essentially similar in composition to dorsal fins.

The *caudal fin* is modified according to the condition of the posterior termination of the axial skeleton, the different condition of which in Fishes has already been noticed (p. 120). Much-modified axial elements generally form the support of the fin-rays, but the numerous complex and varied conditions which these parts may present in different forms is a matter of ichthyology, which can hardly find a place in a general description of the Vertebrate skeleton.

Nature and Origin of Appendicular Skeletal Parts.—From the researches of the late Prof. Balfour it appears that the paired limbs arise as differentiations of continuous lateral folds or projections from the surface of the body, and the azygous fins arise as differentiated projections from its dorsal and ventral surfaces. Thus all these appendicular parts may be viewed as different species of one fundamental set of parts (pterygia), for the sum total of which the term "sympterygium" has been proposed (see *Trans. Zool. Soc*,, vol. x. pp. 481, 482). The paired limbs and azygous fins are of similar origin and nature. Separate narrow solid supports, in longitudinal series, and with their long axes directed more or less at right angles with the long axis of the body, were developed in varying extent in all these four folds or projections. These supports have, it would appear, very often united to form basal cartilages, the original single and united condition persisting in such forms as the ventral fin of *Polyodon* and the second dorsal of *Callorhynchus*, both already noticed.

The paired limbs are thus, in all probability, essentially peripheral structures which have become more or less closely connected with the axial skeleton. Their proximal parts uniting and growing inwards have often become directly connected with parts of the axial skeleton. Thus the limb-girdles seem to have arisen,—namely, as ingrowths from the basal cartilages of the limbs; and, therefore, the whole appendicular skeleton belongs to a different skeletal category from that of the head and spinal column or axial endoskeleton.

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SKELTON, JOHN, an eccentric English scholar and poet of the 15th century. Mr. Dyce, the editor of his works, fixes his birth about 1460. His first essay in verse was a poem after the manner of Lydgate on the death of Edward IV. (1483). He lived to pay compliments to Catherine, wife of Henry VIII., to jeer at the Scotch over the battle of Flodden, and to make fierce attacks on Wolsey, and is supposed to have died in 1529. In general intellectual force, fierceness of invective, wildness of buffoonery, and coarseness of language Skelton bears some likeness to Swift. But he stands by himself as one of the most eccentric and paradoxical characters in English literature. He began life apparently as the protegé of a pious, learned, and literary lady, the mother of Henry VII., who founded St. John's College and Christ College, Cambridge, and translated devotional works from the French. He was himself one of the most notable scholars of his time, was appointed tutor to Henry VIII., was hailed by Erasmus (whether *ex officio* or *propter merita* is left to conjecture) as "unum literarum Britanniarum lumen et decus," was proclaimed *poeta laureatus* by both universities, and frequently applied this title as well as that of *orator regius* to himself without challenge. At about the age of forty he took orders, and was appointed rector of Diss in Norfolk, where he seems to have spent the last twenty-five years of his life. Yet this eminent scholar and churchman is the author of the oldest and the best drinking song in the English language—the drinking song in *Gammer Gurton's Needle*, and one of the coarsest poems in any language—*The Tunning of Elinor Rumming*. He is the author of a satire against the clergy of his time—*Colin Clout*,—unsurpassed in pre-Reformation literature for direct and merciless ridicule, and of a satire against the great cardinal when at the height of his greatness—*Why come ye not to Court?*—boiling over with ferocious invective and insolent contempt. At the same time he had such a repute for rough wit and irregularity of life that he became the hero of a book of "merry tales." These mythical tales were probably in the mind of the historian who has described Skelton as a "ribald buffoon," "a profligate and ill-living wretch." Whether the real Skelton deserved such epithets is doubtful; his verse undoubtedly contains much that may fairly be described as ribaldry and buffoonery. It has not a trace of the chivalrous spirit of Chaucer, and his most characteristic form, known as Skeltonical verse, is wayward and unconventional—adopted as if in mad defiance of regular metre. Still, as Skelton himself claimed for it, "it has in it some pith."

> "Though my ryme be ragged,
> Tattered, and jagged,
> Rudely rain-beaten,
> Rusty and moth-eaten,
> If ye take well therewith
> It hath in it some pith."

Colin Clout, *Why come ye not to Court?* and *The Book of Philip Sparrow*—which Coleridge pronounced "an exquisite and original poem"—are written in this metre. *The Bowge* (ship) *of Court*, a satirical vision of personified abstractions, is more conventional in form, and was probably one of his earlier works. Both it and his interlude *Magnificence* show great power in the vivid description of character.

SKIMMER, the English name bestowed by Pennant[1] in 1781 on a North American bird which had already been figured and described by Catesby (*B. Carolina*, i. pl. 90) as the "Cut-water,"—as it appears still to be called on some parts of the coast,[2]—remarkable for the unique formation of its bill, in which the maxilla, or so-called upper mandible, is capable of much vertical movement, while the lower mandible, which is considerably the longer of the two, is laterally compressed so as to be as thin as a knife-blade. This bird is the *Rhynchops nigra* of Linnæus, who, however, united with it what proves to be an allied species from India that, having been indicated many years before by Petiver (*Gazoph. Naturæ*, tab. 76, Fig. 2), on the authority of Buckley, was only technically named and described in 1838 by Swainson (*Anim. Menageries*, p. 360) as *R. albicollis*. A third species, *R. flavirostris*, inhabits Africa; and examples from South America, though by many writers regarded as identical with *R. nigra*, are considered by Mr. Saunders (*Proc. Zool. Society*, 1882, p. 522) to form a fourth, the *R. melanura* of Swainson (*ut supra*), p. 340). All these resemble one another very closely, and, apart from their singularly-formed bill, have the structure and appearance of TERNS (*q.v.*). Some authors make a family of the genus *Rhynchops*, but it seems needless to remove it from the *Laridæ* (GULL, vol. xi. p. 243). In breeding habits the Skimmers thoroughly agree with the Terns, the largest species of which group they nearly equal in size, and indeed only seem to differ from them in the mode of taking their food, which of course is correlated with the extraordinary formation of their bill. (A. N.)

SKIN DISEASES. These form a large and important class. In number they are very extensive, owing to the varied forms of morbid change which the skin texture may undergo, no less than to the different portions of the structure and its appendages which may be specially affected. Further, the modifications of the typical forms of these diseases which are to be observed have led to arrangements and classifications of very complex character and multiplied greatly their nomenclature. Skin diseases are regarded by the physician as of great importance, not only from the fact that morbid action in this texture must have a powerful influence on the general health and may bring in its train other maladies, but also because they are not unfrequently themselves the expression of constitutional conditions, inherited or acquired, the recognition of which is essential to their effectual treatment. In order to clearness of description it is necessary to make use of some method of classification. Various arrangements have been adopted by writers on the subject, but the following appears sufficient for the present purpose :[3]

I. Disorders of the secreting apparatus (of the sebaceous and sweat glands);
II. Disorders specially relating to nutrition (hypertrophies; atrophies; new formations; pigmentary changes);
III. Inflammatory affections (erythematous; papular; vesicular; pustular; squamous or scaly);
IV. Neuroses (nervous disorders);
V. Parasitic affections (animal; vegetable).

I. DISORDERS OF THE SECRETING APPARATUS.—(1) *Of the Sweat Glands.*—The chief morbid conditions are excessive sweating (*hyperidrosis*) and fetid sweating (*bromidrosis*). Excessive sweating is a symptom observed in various diseases, such as phthisis and rheumatic fever, but it may exist apart from such conditions, and either be general, affecting the whole body, or confined to a part, such as the axillæ, head, hands, feet, or, as in some rare instances, the one half of the body. Some persons habitually perspire, often to a great extent, on making any effort, yet never appear to suffer in health, although the discomfort is considerable. Excessive perspiration may often be prevented by the habitual use of the cold bath, and by tonics, such as iron, quinine, strychnia, etc. Locally, the use of astringent lotions of vinegar or a weak solution of lead will also be of service. Bromidrosis or fetid sweating is often associated with the former condition, and it too may be general or local. It most frequently affects the feet, especially in those who have much fatigue, and is a source of much personal discomfort as well as of annoyance to others. It is apparently due to rapid decomposition in the perspiration which has saturated the stockings, and for its treatment it is essential that these should be frequently changed and the feet washed several times a day, dried carefully, and dusted with some antiseptic powder, such as boracic or salicylic acid mixed with starch or French chalk. Hebra recommends the application to the feet of a composition of equal parts of olive oil and litharge plaster spread upon linen and used twice a day.

(2) *Of the Sebaceous Glands.*—*Seborrhœa* is a term applied to describe an accumulation on the skin of th

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[1] "I call it *Skimmer*, from the manner of its collecting its food with the lower mandible, as it flies along the surface of the water." (*Gen. of Birds*, p. 52.)

[2] Other English names applied to it in America are "Razorbill," "Scissorbill," and "Shearwater."

[3] For the structure of the skin see ANATOMY, vol. i. p. 757-59.

normal sebaceous secretion mixed up with dirt and forming scales or a distinct incrustation. On the head, where it is commonly seen, it may interfere with the nutrition of the hair and cause partial baldness. A form of this disease occurs in young infants. The main treatment is local, consisting in thorough cleansing of the parts. The crusts may be softened with oil and the affected skin regularly washed with soft soap and rectified spirit. The sebum frequently accumulates in the sebaceous ducts, giving rise to the minute black points so often noticed on the face, back, and chest in young adults, to which the term *comedones* is applied. A form of this disorder, but of larger size and white appearance, is termed *milium*. These affections may to a large extent be prevented by strict attention to ablution and brisk friction of the skin, which will also often remove them when they begin to appear. The retained secretion may be squeezed out or evacuated by incision and the skin treated with some simple sulphur application.

Acne is an eruption produced by inflammation of the sebaceous glands and hair follicles. It may occur in connection with the preceding or independently, and shows itself in the form of red pimples or papules which may become pustular and be attended with considerable surrounding irritation of the skin. This affection is likewise most common in early adult life, and occurs on the chest and back as well as on the face, where it may, when of much extent, produce considerable disfigurement. It is apt to persist for months or even years, but usually in time disappears entirely, although slight traces may remain in the form of scars or stains upon the skin. Eruptions of this kind are sometimes produced by the continued internal use of certain drugs, such as the iodide or bromide of potassium. The treatment is similar to that for the previous affection, viz., brisk friction of the skin, short of producing irritation, and the application of a sulphur lotion or ointment. Attention to the general health by suitable diet, tonics, exercise, etc., is a necessary adjuvant. A variety of this malady, to which the name *acne rosacea* is given, is a more severe and troublesome disorder than that already mentioned. It is characterized by great redness of the nose and cheeks, accompanied with nodular enlargements on the surface of the skin, which produce marked disfigurement. Although often seen in persons who live too freely, it is by no means confined to such, but may arise in connection with disturbances of the general health, especially of the function of digestion, and in females with menstrual disorders. It is apt to be exceedingly intractable to treatment, which is here too, as in the preceding form, partly local and partly constitutional. Of internal remedies preparations of iodine and of arsenic are sometimes found of service.

Molluscum contagiosum belongs to this class of skin diseases. It consists of an enlargement of the sebaceous glands and occlusion of the ducts, and is seen most commonly on the face, body, or hands in children, or on the breasts in women. It is said to be contagious, but it is a rare form of skin disease.

II. DISORDERS AFFECTING NUTRITION.—(1) *Hypertrophies.*—A *corn* (*clavus*) is a local thickening of the skin, generally occurring on the toes. There is hypertrophy of the epidermis, and in the centre of the corn there is usually a still denser mass, which, pressing down upon the subjacent sensitive true skin, causes pain and may give rise to inflammation and suppuration in the part. When situated between the toes the corn is softer than when on the free surface of the foot. The treatment consists in maceration of the hardened skin and the use of the knife or strong caustics. Salicylic acid combined with ether and collodion, painted over the part, is said to be useful in the case of soft corns.

A *wart* (*verruca*) is an excrescence from the surface of the skin due to hypertrophy of the papillary layer of the cutis and of the epidermis. This form of growth may also occur on mucous membranes. Warts occasionally disappear spontaneously, or they may be excised, or carefully touched with some strong caustic acid or alkali.

Ichthyosis or *xeroderma* consists of a general thickening of the whole skin and marked accumulation of the epidermic elements, with atrophy of the sebaceous glands, giving rise to a hard, dry, scaly condition. It generally first appears in infancy, and is probably congenital. It differs in intensity and in distribution in different cases, and is generally little amenable to any but palliative remedies, such as the regular application of oily substances, although it is not a fatal malady.

For *elephantiasis Arabum*, see vol. viii. p. 119.

(2) *Atrophies.*—The chief of these relate to the hair. *Canities* or whitening of the hair consists in the nonformation of the pigmentary matter which is normally present in the substance of the hair, and occurs generally as a slow senile change. It may, however, take place prematurely, in which case it is often hereditary; or it may be associated with degenerative changes taking place in the system. It is occasionally seen to occur temporarily in very young persons in connection with some defective condition of the general health. Its development suddenly has not unfrequently been observed as the result of some strong mental emotion.

Alopecia, or baldness, is the loss of hair, which is most commonly a senile change and irremediable, or on the other hand may be premature, occurring either hereditarily or in connection with some previous constitutional morbid state (*e.g.*, after fevers or other blood poisons), in which latter case it may be only, although not always, temporary. It appears to depend upon atrophic changes affecting the hair follicle, including obliteration of the capillary vessels,—the result of which is that strong hairs cease to be produced, and only feeble, short, and thin hair (*lanugo*) is formed, which soon falls off and is not reproduced. Usually the whole skin of the hairy scalp undergoes thinning and other atrophic changes as well as the hair follicle. Sometimes the loss of hair occurs in distinct circular patches (*alopecia areata*), which tend to spread until the whole scalp is denuded. The treatment of temporary or premature baldness bears reference especially to any known conditions affecting the general health; and tonics, baths, and other means to promote a vigorous skin function are useful. Stimulating liniments containing spirits and cantharides, the regular cleansing and moderate brushing of the parts, the application to the scalp of the constant current of electricity, and various other remedies appear to be of service in promoting the growth of hair.

(3) *New Formations.*—(*a*) *Lupus* is a disease characterized by the formation in the skin of tubercles or nodules consisting of new cell growth which has no tendency to further development, but to retrograde change, leading to ulceration and destruction of the skin and other tissues in which it exists, and the subsequent formation of permanent white scars. *Lupus vulgaris* is most commonly seen in early life, and occurs chiefly on the face, about the nose, cheeks, ears, etc., but it may also affect the skin of the body or limbs. It first shows itself in the form of small, slightly prominent nodules covered with thin crusts or scabs. These may be absorbed and removed at one point, but they tend to spread at another. Their disappearance is followed by a white permanent cicatrix. The disease may be superficial, in which case both the ulceration and resulting scar are slight (*lupus nonexedens*); or, on the other hand, the ulcerative process may be deep and extensive, destroying a large portion of the tissues of the nose or cheeks, and leaving deep marks with much disfigurement (*lupus exedens*). Another form of this disease, termed *lupus erythematosus*, is of comparatively mild character, and occurs on the nose and adjacent portions of the cheeks in the form of red patches covered with thin scales, under-

neath which are seen the widened openings of the sebaceous ducts,—this variety of the disease affecting specially that portion of the skin texture. It is very slow in disappearing, but does not leave any marked scar. Lupus is generally more frequently seen in women than in men, and it is held to be connected with a scrofulous constitution. Its treatment bears reference especially to this condition (see SCROFULA). In the superficial variety the application of soothing ointments when there is much redness, and Squire's method of slight linear incisions to destroy the increased blood supply, are often serviceable. In the ordinary form the great principle of local treatment is to remove the new tissue growth. This is most readily done either by solid points of caustic, of which the nitrate of silver is perhaps the best, thrust into the tubercles to break them up, or by means of a scoop (Volkmann's spoon) to scrape away the diseased masses. Only by such means can the ulceration be arrested and healing brought about.

(*b*) *Leprosy* (*elephantiasis Græcorum*) may be regarded as belonging to this class of skin diseases, inasmuch as it consists in a new growth of cell material, like lupus, but with less tendency to disintegration and with a wider distribution affecting the skin, mucous membranes, nerves, etc., all over the body. For its history and pathology see vol. xiv. p. 469 *sq.* Leprosy is not amenable to treatment, beyond attempts at palliation of the symptoms and by general hygiene.

(4) *Pigmentary Changes.*—*Chloasma* is an abnormal pigmentation, in the form of brown patches, either generally diffused or confined to one part, such as the forehead and face, and occasionally seen in women suffering from uterine ailments. *Addison's disease* is connected with a morbid condition of the suprarenal capsules (see PATHOLOGY), and is accompanied with general bronzing of the skin, together with anæmia and great and increasing prostration. *Leucoderma* is a change in the pigmentation of the skin, whereby it becomes white in patches, with a tendency to spread and affect almost the whole surface, until a few dark areas alone remain to represent the original appearance of the skin. It is sometimes called white leprosy, but has no relation to that disease, nor is it of any special significance as regards the health. *Albinism* is an entire absence of pigment from the hair, skin, eyes, etc. The hair is usually white, and the skin exceedingly pale; and the eye has a pinkish appearance. This condition is congenital. It occasionally exists to a partial extent in any of the textures named.

III. INFLAMMATORY SKIN AFFECTIONS.—These embrace the following chief varieties: (1) diffuse (erythema); (2) papular (lichen); (3) catarrhal (eczema); (4) vesicular (herpes, pemphigus); (5) pustular (impetigo); and (6) scaly (psoriasis, pityriasis).

(1) *Diffuse.*—This variety includes *erythema* (see ERYSIPELAS) and its forms, particularly *erythema nodosum*, which consists of spots and patches of dark red color and slightly elevated, appearing on the front of the legs and back of the arms in young persons, mostly females. The patches continue for a number of days and then become fainter. It is supposed to be connected with rheumatism, joint pains not unfrequently accompanying it. *Urticaria* or *nettle-rash* is a diffuse redness of the skin, accompanied with wheals of raised and paler appearance, not unlike the effect produced by the sting of nettles or of insects, and attended with great irritation and itching. Certain kinds of food, such as fruit and fish, produce this eruption in some persons, as also some drugs, such as opium. It is best treated by some soothing application, such as a solution of sal volatile, to which a little chloral has been added, and by attention to the state of the alimentary canal. *Roseola*, which consists in the appearance of rose-colored spots upon the body, is frequently seen in children, and is apt to be mistaken for measles, but has none of the accompanying febrile or catarrhal symptoms of that disorder, and is of brief duration.

(2) *Papular.*—*Lichen*, an eruption consisting of small, thickly-set and slightly-elevated red points, more or less widely distributed over the body, and in the young somewhat resembling scarlet fever, but with only slight febrile symptoms and no sore throat, usually results from digestive derangements, but apparently may also arise from exposure to the sun, and it lasts but a short time. Some forms, however (*e.g.*, *lichen ruber*), are of chronic character and difficult of treatment. The ordinary form requires little beyond attention to the digestive organs and the application of a soothing lotion or powder. The chronic forms are best treated by the administration of arsenic. *Strophulus*, or tooth-rash, or, as it is popularly termed, "red gum," an affection very common in young infants, belongs to this class of skin disorders.

(3) *Catarrhal.*—*Eczema*, one of the most common and important of all skin diseases, consists of an inflammation of the true skin, of catarrhal character, together with the formation of papules, vesicles, or pustules, attended with more or less discharge, and with itching and other symptoms of irritation. It may be either acute or chronic, and presents itself in a variety of forms. As regards causation, it appears impossible to assign any one condition as giving rise to this disease. It occurs frequently in persons to all appearance in perfect health, and it may in such cases be a permanent or recurring affection during a whole lifetime. Again it is undoubtedly found in persons who possess a morbid constitution, such as the gouty or scrofulous; but apart from any such evident associations it seems in some instances itself distinctly hereditary. Sometimes it is set up as the result of local or general irritation of the skin in certain occupations, and it may exist in connection with the presence of some other skin disease. It is much more common in men than in women. Numerous varieties of eczema are described, according to its site and duration; only the more important of these can be alluded to. *Acute eczema* shows itself by redness and swelling of the skin, with the formation of minute vesicles, and attended with severe heat and irritation. Should the vesicles rupture, a raw moist surface is formed, from which a colorless discharge oozes, which when it accumulates forms thin crusts. The attack may be general over the greater portion of the body, or it may be entirely localized to a limb or other part. It usually lasts for a few weeks and then passes off, leaving, however, a liability to recurrence. Such attacks may occur as a result of digestive derangements, or in persons of rheumatic or gouty habit, and they tend to appear at certain seasons, such as springtime. They are usually best treated by attention to the general health, and by a simple and carefully-regulated diet, while locally some soothing application, such as a weak lead lotion or a dusting powder of zinc, starch, or boracic acid, will be found of benefit. *Chronic eczema* shows itself in various forms, of which we note the most common. In *eczema rubrum* the disease affects a part, very often a limb, as a severe form of inflammation, with great redness and weeping or oozing of serous matter from the raw surface. It gives rise to great irritation and pain, and may cause considerable disturbance of the general health. It may last for years, with intervals of partial recovery, but easily recurring. The skin of the limb becomes in time thickened and the limb itself much swollen. In *dry eczema* the skin, though irritable, remains dry and scaly. In *pustular eczema* or *eczema impetiginodes*, in addition to the cutaneous inflammation there occur pustules which break and the purulent matter forms yellow crusts upon the skin. This form is very common on the heads of young children during the period of dentition. The treatment of chronic eczema depends in great measure upon the form it assumes. Where there exists much irritation, soothing lotions or appli-

cations similar to those required for acute eczema are necessary; but where irritation has subsided, stimulating ointments, such as those of zinc or white precipitate, are often of service. Constitutional remedies, such as iron, arsenic, etc., are an important and often essential part of successful treatment.

(4) *Vesicular.*—*Herpes* is an inflammation of the true skin, attended with the formation of isolated or grouped vesicles of various sizes upon a reddened base. They contain a clear fluid, and either rupture or dry up. Two well-marked varieties of herpes are frequently met with. (*a*) In *herpes labialis et nasalis* the eruption occurs about the lips and nose. It is seen in cases of certain acute febrile ailments, such as fevers, inflammation of the lungs, or even in a severe cold. It soon passes off. (*b*) In *herpes zoster*, zona, or shingles, the eruption occurs in the course of one or more cutaneous nerves, often on one side of the trunk, but it may be on the face, limbs, or other parts. It may occur at any age, but is probably more frequently met with in elderly people. The appearance of the eruption is usually preceded by severe stinging neuralgic pains for several days, and, not only during the continuance of the herpetic spots, but long after they have dried up and disappeared, these pains sometimes continue and give rise to great suffering. The disease seldom recurs. The most that can be done for its relief is to protect the parts with cotton wool or some dusting powder, while the pain may be allayed by opiates or bromide of potassium. Quinine internally is often of service.

Pemphigus consists in large blebs upon a red base. They contain clear or yellowish fluid. This disease appears to show itself most frequently on the bodies and limbs of unhealthy or neglected children. The blebs give rise to much irritation, and when they burst leave raw ulcerated surfaces which are slow of healing. One variety of this malady (*pemphigus foliaceus*) affects the entire skin of the body, from which there exudes a constant discharge. This form is apt sooner or later to prove fatal from its exhausting effects. The treatment is mainly constitutional,—by good nourishment, iron, etc.

(5) *Pustular.*—*Impetigo*, consisting of small pustules situated upon a reddened base, mostly occurs in children. There appears to be a contagious form of this malady. *Ecthyma* consists of large pustules of similar character on the body and limbs. The treatment of these ailments requires special attention to nutrition, since they usually occur in low states of health.

(6) *Squamous or Scaly.*—*Psoriasis*, an inflammatory affection of the true skin, attended with the formation of red spots or patches, which are covered with white silvery scales, may affect any portion of the surface of the body, but is most common about the elbows and knees, and on the head. There is as a rule comparatively little irritation except at the outset, but there is an extensive shedding of the scales from the affected spots. Varieties of this disease are described in relation to the size and distribution of the patches. The causes of psoriasis have given rise to much discussion, and, while some authorities regard its appearance as in many instances connected with some constitutional morbid state, such as gout, rheumatism, etc., the majority deny any such relationship and mention hereditary influence as the only recognizable cause, although it must be admitted that even this evidence is wanting in a large number of cases. The disease appears to be consistent with continued good health. It is usually obstinate to treat, and may, with intervals of comparative immunity, last a lifetime. The remedies most serviceable are arsenic internally and the application externally of preparations of tar. Recently the employment of chrysophanic acid as an ointment or in solution has been resorted to with considerable success.

Pityriasis, a superficial inflammation of the skin, with the formation of minute branny scales, occurs most commonly on the head, and is of chronic duration. The remedies most useful are alkaline lotions and tar preparations. A variety of this disease (*Pityriasis rubra*) affects the whole body, and is most intractable to treatment.

IV. Neuroses (*Nervous Affections*).—Various disorders of nutrition of the skin occur in persons suffering from organic nervous diseases, such as bedsores, atrophic changes, eruptions, etc., but these belong to the symptoms of the several diseases with which they are associated. The most common of the neuroses of the skin is probably *pruritus*, which is an ailment characterized by intense itching of the surface of the body. It may occur in connection with other morbid conditions, such as jaundice, diabetes, digestive disorders, etc., or as the result of the irritation produced by lice or other skin parasites. The most serious form is *pruritus senilis*, which affects old persons, and is often a cause of great suffering, depriving the patient of sleep (the malady being specially troublesome during the night). In such cases it is probably due to atrophic changes in the skin. No eruption is visible, except such marks as are produced by scratching. The treatment consists in the removal of any apparent cause, and measures to strengthen the system, such as the use of quinine, iron, etc. Soothing lotions composed of solutions of alkalies conjoined with chloral, opium, hydrocyanic acid, etc., may be applied to the affected skin at bedtime.

V. Parasitic Diseases.—(1) *Animal.*—The following are the chief animal parasitic diseases. *Phthiriasis* is produced by the presence of lice (*pediculi*), of which there are three varieties, infesting respectively the head, body, and pubes. The cause is in most instances uncleanliness, but occasionally in the aged, and in persons suffering from chronic diseases, there appears to be a liability to development of pediculi, notwithstanding every care to prevent it. The irritation produced by the parasite and the scratching thus occasioned may give rise to abrasions of the skin and eczematous conditions. The treatment consists in thorough cleansing of the parts and the use of parasiticides, such as red or white precipitate, carbolic lotions (one in twenty), or a decoction or ointment of stavesacre. Where clothing is infested it should be destroyed or subjected to a strong heat to get rid both of the parasites and their ova. *Scabies* or *itch* is a skin affection due to the *Acarus scabiei* (see Mite). The female insects burrow into the upper layers of the skin and deposit their eggs in the tract thus made. Great irritation of the skin is set up, and scratching produces eruptions which aggravate the condition, especially at night. The most frequent sites are the parts between the fingers, or the wrists, but by scratching the disease may be conveyed to any part of the body, and in extreme cases the greater portion of the surface of the trunk and limbs may be involved. In infants the feet and buttocks are the parts which suffer. The eruption in mild cases has at first the appearance of small raised vesicles with clear fluid, but it may become pustular or eczematous, and extensive excoriations may result. The treatment consists in thorough cleansing of the skin and the inunction of some form of parasiticide,—sulphur ointment being on the whole the best. The application should be discontinued after a few days, otherwise irritation may be produced by its use.

(2) *Vegetable parasites* consist of fungous growths in the texture of the skin and hair, which are characterized microscopically by minute round bodies or spores often coalesced into clusters or bead-like arrangements, and jointed filaments or *mycelium* of elongate and branching form. They are readily detected by removing a hair, or scraping a portion of the affected skin, treating it with a strong alkaline solution, and submitting it to microscopic examination, by which the slight differences in form and arrangement of the

varieties of the parasite can be easily made out. The common name "tinea" is applied to these parasitic affections. *Tinea tonsurans*, or *ringworm* (parasite *Tricophyton tonsurans*), is a very common form of parasitic disease. It occurs as a result of contagion in the heads of children, and begins as circular patches with a scaly appearance and red border, which tend to spread. The hair at the part becomes thin and brittle and is easily removed. It is often extremely obstinate to treatment, and numerous agents have been proposed as specifics, not one of which, however, appears to possess infallible virtues. Among the best are oleate of mercury (5 to 10 per cent.) and other mercurial preparations, all which, however, must be used with care, and carbolic or sulphurous acid with glycerine, iodine, cantharides, etc.; but isolation of the patient as far as possible, together with strict medical supervision, are essential for the effectual treatment of this disorder. *Tinea sycosis*, or ringworm affecting the beard, and *tinea circinata*, or ringworm affecting the body, require to be dealt with in a similar manner. *Tinea favosa*, or *favus* (parasite *Achorion Schönleinii*), is less frequently seen than the preceding. It occurs mostly on the scalp in unhealthy and neglected children, but it may affect the skin in any part of the body. It is characterized by round, yellow, sulphur-colored, cup-shaped spots or crusts, which, when occurring extensively upon the scalp, have a peculiar mousy odor. It is very destructive of hair growth, and is most difficult to cure. The best treatment is removal of the hairs by epilation, and the employment of some of the parasiticides already mentioned, together with attention to the healthy nutrition of the patient. *Tinea versicolor*, or *pityriasis versicolor* (parasite *Microsporon furfur*), is a brown-colored rash of scaly character occurring mostly in the form of spots or patches on the skin of the trunk, particularly on the front of the chest or between the shoulders, but sometimes also upon the arms and legs. It affects adults in whom the skin-function is not sufficiently attended to, or those who are in ill-health. The parasite affects the epidermic cells, and is readily made out by the microscope, thus enabling the disease to be distinguished from other skin disorders to which it often bears resemblance. It is best treated by the regular washing and brisk friction of the parts, and by the use of some of the applications above referred to. (J. O. A.)

SKINNER, JOHN (1721-1807), author of *Tullochgorum* and *The Ewie wi' the Crookit Horn*, was an Episcopalian minister in the parish of Longside, Aberdeenshire. He held this charge for more than sixty-four years. The son of an Aberdeenshire schoolmaster, born at Balfour in 1721, he had been intended for the Presbyterian ministry, but, after passing through Marischal College, Aberdeen, and teaching for a few years, he took orders in the Episcopal Church, and was appointed to the charge of Longside in 1742. There was a considerable remnant of Episcopacy in Aberdeenshire, but very soon after Skinner joined it it became, in consequence of the Jacobite rebellion in 1745, a much persecuted remnant. The young pastor's church was burnt; his house was plundered; for some years he had to minister to his congregation by stealth; and in 1753 information was lodged that he had broken the law by officiating to more than four persons besides his own family, and he suffered imprisonment for six months. After 1760 the penal laws were less strictly enforced, but throughout the century the lot of the Episcopalian ministers in Scotland was far from comfortable, and only the humblest provisions for church services were tolerated. Skinner's robust nature, however, made light of all privations; and his kindliness, humor, conviviality, ready wit, and generous force of character made him personally a favorite far and near outside the bounds of his own denomination. In 1789 he was presented with the freedom of the town in whose jail he had been a prisoner for conscience sake. It is by his songs, limited in quantity, but some of them of the very highest quality, that Skinner is generally known. An interesting correspondence took place between him and Burns, who considered *Tullochgorum* "the best Scotch song Scotland ever saw," and addressed the reverend poet with touching respect. His best songs had stolen into print; a collection was not published till 1809, under the title of *Amusements of Leisure Hours*. Such literally they seem to have been. Throughout his life he was a vigorous student, and in spite of his scanty resources established a more than local reputation for scholarship, while, according to his latest biographer, he had a paramount influence on the doctrinal views of his clerical brethren in the north. He published in 1788 an *Ecclesiastical History of Scotland*, in the form of letters; and other works in the same form, which best suited his easy unaffected strength, were collected and published by his son after his death (June, 1807), having previously had a wide circulation in manuscript. His prose style has the happiness, ease, and lucid force of a natural master of language. The reasoning of his answer to Beattie's *Essay on Truth* is an evidence of his robust clearness of intellect.

A minutely accurate biography of Skinner, in connection with the history of Episcopacy in the north of Scotland, was published by the Rev. W. Walker in 1883. An edition of his songs and poems by Mr. H. G. Reid, 1859, contains an interesting memoir.

SKIPTON, an ancient market-town in the West Riding of Yorkshire, is situated on the river Aire, on the Leeds and Liverpool Canal, and on the Midland Railway, 9 miles northwest of Keighley and 15 southeast of Settle. It is substantially built of stone. The strong castle built by Robert de Romille in the time of the Conqueror was partly demolished in 1649, but was restored by the countess of Pembroke. Of the ancient building of De Romille all that now remains is the western doorway of the inner castle. In the castle grounds are the ruins of the ancient parish church of St. John. The church of the Holy Trinity, in the Decorated Gothic, was also partly demolished during the Civil War, but was restored by the countess of Pembroke, and again underwent renovation in 1854. The free grammar school was founded in 1548 by William Ermysted, a canon of St. Paul's, London. The town has a considerable general trade. The population of the urban sanitary district (area 4245 acres) in 1871 was 6078 and in 1881 it was 9091.

Skipton was the capital of the ancient district of Craven. At the Norman accession it became part of the possessions of Earl Edwin, and was granted to Robert de Romille, who built the castle about the end of the reign of William. Subsequently it went to the Albemarle family, but was again vested in the crown, and Edward II. bestowed it on Piers de Gaveston. In 1311 it came into the possession of the Cliffords. The castle was taken by the Parliamentary forces in 1645 and demolished in 1649.

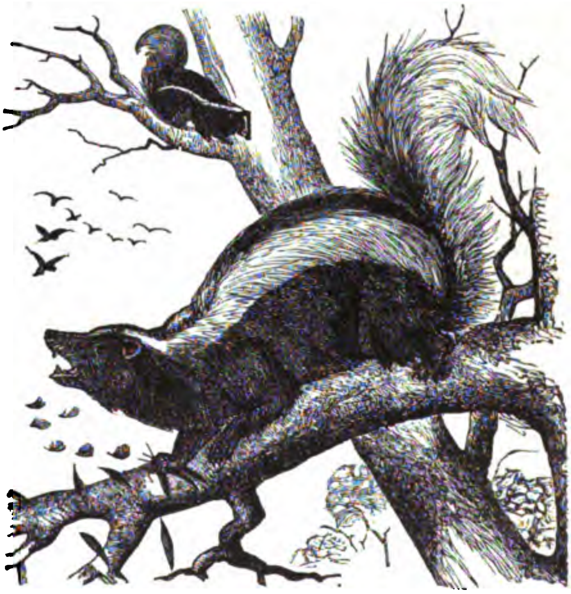
SKITTLES. This English game, which somewhat resembles American bowls (see vol. iv. p. 164), was formerly known as *Kails* (Fr. *quilles*), and first came into vogue in England in the 14th century. Nine large oval-headed pins with flat bottoms, and made of a hard wood, are set up on a wooden frame, three pins square on each side. An angle and not an even side of the said square is presented towards the player, who stands at the distance of 21 feet. There may be one or two players a-side; and the object of each side is to knock down, or "floor," the greatest number of pins in the least possible number of throws, which are generally two or three, though they may extend to five, according to agreement. The roundish ball used for throwing weighs from 8 to 14 lb, and in fair playing only one step forward is allowed in delivery. A firm grasp should be taken of the ball in a slightly slanting position, so as to strike the fore pin on the shoulder and then reach the back ones. A player who clears the board in two throws may be considered a good all-round one. In different localities there are minor variations in playing the game.

SKUA,[1] the name for a long while given to certain of the *Laridæ* (see GULL, vol. xi. p. 243), which sufficiently differ in structure, appearance, and habits to justify their separation as a distinct genus, *Stercorarius* (*Lestris* of some writers), or even Subfamily, *Stercorariinæ*. Swift of flight, powerfully armed, but above all endowed with extraordinary courage, they pursue their weaker cousins, making the latter disgorge their already-swallowed prey, which is nimbly caught before it reaches the water; and this habit, often observed by sailors and fishermen, has made these predatory and parasitic birds locally known as "Teasers," "Boatswains,"[2] and, from a misconception of their intent, "Dunghunters." On land, however, whither they resort to breed, they seek food of their own taking, whether small mammals, little birds, insects, or berries; but even here their uncommon courage is exhibited, and they will defend their homes and offspring with the utmost spirit against any intruder, repeatedly shooting down on man or dog that invades their haunts, while every bird almost, from an Eagle downwards, is repelled by buffets or something worse.

The largest species known is the *Stercorarius catarrhactes* of ornithologists—the "Skooi" or "Bonxie" of the Shetlanders, a bird in size equalling a Herring-Gull, *Larus argentatus*. The sexes do not differ appreciably in color, which is of a dark brown, somewhat lighter beneath; but the primaries have at the base a patch of white, visible even when the wings are closed, and forming, when they are spread, a conspicuous band. The bill and feet are black. This a species of comparatively limited range, breeding only in some two or three localities in the Shetlands, about half a dozen in the Færoes,[3] and hardly more in Iceland. Out of the breeding season it shows itself in most parts of the North Atlantic, but never seems to stray further south than Gibraltar or Morocco, and it is therefore a matter of much interest to find the Southern Ocean inhabited by a bird—the "Port Egmont Hen" of Cook's *Voyages*—which so closely resembles the Skua as to have been for a long while regarded as specifically identical with it, but is now usually recognized as distinct under the name of *S. antarcticus*. This bird, characterized by its stout deep bill and want of rufous tint on its lower plumage, has an extensive range, and would seem to exhibit a tendency to further differentiation, since Mr. Saunders, in a monograph of the group (*Proc. Zool. Society*, .1876, pp. 317–332), says that it presents three local forms—one occurring from New Zealand to Norfolk Island and past Kerguelen Land to the Cape of Good Hope, another restricted to the Falklands, and the third hitherto only met with near the south-polar ice. On the western coast of South America, making its way into the Straits of Magellan, and passing along the coast so far as Rio Janeiro, is found *S. chilensis*, distinguished among other characters by the cinnamon tint of its lower plumage. Three other smaller species of the genus are known, and each is more widely distributed than those just mentioned, but the home of all is in the more northern parts of the earth, though in winter two of them go very far south, and, crossing the equator, show themselves on the seas that wash the Cape of Good Hope, Australia, New Zealand, and Peru. The first of them is *S. pomatorhinus* (often incorrectly spelt *pomarinus*), about the size of a common Gull, *Larus canus*, and presenting, irrespective of sex, two very distinct phases of plumage, one almost wholly sooty-brown, the other particolored—dark above and white on the breast, the sides of the neck being of a glossy straw-color, and the lower part of the neck and the sides of the body barred with brown; but a singular feature in the adults of this species is that the two median tail-feathers, which are elongated, have their shaft twisted towards the tip, so that in flight the lower surfaces of their webs are pressed together vertically, giving the bird the appearance of having a disk attached to its tail. The second and third species so closely resemble each other, except in size, that their distinctness was for many years unperceived, and in consequence their nomenclature is an almost bewildering puzzle. Mr. Saunders (*loc. cit.*) thinks that the larger of them, which is about the size of a Black-headed Gull, should stand as *S. crepidatus*. and the smaller as *S. parasiticus*, though the latter name has been generally used for the larger when that is not termed, as it often is, *S. richardsoni*—a name that correctly applies only to whole-colored examples, for this species too is dimorphic. Even its proper English name[4] is disputable, but it has been frequently called the Arctic Gull or Arctic Skua, and it is by far the commonest of the genus in Britain, and perhaps throughout the northern hemisphere. It breeds abundantly on many of the Scottish islands, and in most countries lying to the northward. The nest is generally in long heather, and contains two eggs of a dark olive color, suffused with still darker brown patches. Birds of either phase of plumage pair indiscriminately, and the young show by their earliest feathers whether they will prove whole or particolored; but in their immature plumage the upper surface is barred with pale reddish-brown. The smallest species, commonly known in English as the Long-tailed or Buffon's Skua is not known to exhibit the remarkable dimorphism to which the two preceding are subject. It breeds abundantly in some seasons on the fells of Lapland, its appearance depending chiefly on the presence of lemmings (*Lemmus norvegicus*), on which it mainly preys. All these three species occasionally visit the southern coasts of Europe in large flocks, but their visitations are highly irregular.

(A. N.)

SKUNK. The existence of the animal to which this name[5] is applied was first notified to European naturalists as long ago as 1636, in Gabriel Sagard-Theodat's *History of Canada*, where, in commencing his quaint account of it (p. 748), he describes it as "enfans du diable, que les Hurons appelle Scangaresse, ... une beste fort puante," etc. This fully shows in what reputation the skunk was then held, a reputa-



Common Skunk.[6]

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[1] Thus written by Hoier (*circa* 1604) as that of a Færoese bird (*hodie* Skúir) an example of which he sent to Clusius (*Exotic. Auctarium*, p. 367). The word being thence copied by Willughby has been generally adopted by English authors, and applied by them to all the congeners of the species to which it was originally peculiar.

[2] This name in seamen's ornithology applies to several other kinds of birds, and, though perhaps first given to those of this group, is nowadays most commonly used for the species of TROPIC-BIRD (*q.v.*), the projecting middle feathers of the tail in each kind being generally likened to the marline-spike that is identified with the boatswain's position; but perhaps the authoritative character assumed by both bird and officer originally suggested the name.

[3] It has long been subjected to persecution in these islands, a reward being paid for its head. On the other hand, in the Shetlands a fine was exacted for its death, as it was believed to protect the sheep against Eagles. Yet for all this it would long ago have been extirpated there, and have ceased to be a British bird in all but name, but for the special protection afforded it by several members of two families (Edmonston and Scott of Melby), whose exertions to that effect deserve the praise and recognition of all ornithologists.

[4] It is the "Fasgadair" of the Hebrides, the "Shooi" of the Shetlands, and the "Scouti-allen" of the fishermen on the east coast of Scotland.

[5] Probably derived from "Seecawk," the Cree name for the skunk. Another form given is "seganku."

[6] [This animal is not arboreal.—AM. ED.]

tion which has lasted to the present time, and has become so notorious that the mere name of skunk is an opprobrious epithet and can hardly be used in polite society.

The skunks, for there are several species of these animals, are members of the Meline or badger-like section of the family *Mustelidæ*, which contains also the martens, stoats, otters, etc., and forms the largest family of the *Arctoidea* or bear-like division of the Land *Carnivora* (see the article MAMMALIA, vol. xv. pp. 446–47, where the zoological characters of these groups are given in detail).

The common skunk (*Mephitis mephitica*) is a native of North America, extending from Hudson's Bay southwards to Guatemala in Central America. It is a beautiful little animal, about the size of a cat, though of a stouter and heavier build, with rich lustrous black fur, strikingly varied on the back by a very variably shaped patch or streak of white. Its muzzle is long and pointed, its eyes sharp and bead-like, and its gray or white tail is long and unusually bushy.

The following account of the habits and disposition of the skunk is extracted from Dr. C. Hart Merriam's *Mammals of the Adirondack Region, New York*, 1884 :

> "The skunk preys upon mice, salamanders, frogs, and the eggs of birds that nest on or within reach from the ground. At times he eats carrion, and if he chances to stumble upon a hen's nest the eggs are liable to suffer; and once in a while he acquires the evil habit of robbing the hen-roost, but as a rule skunks are not addicted to this vice.
>
> "Of all our native mammals perhaps no one is so universally abused and has so many unpleasant things said about it as the innocent subject of the present biography; and yet no other species is half so valuable to the farmer. Pre-eminently an insect-eater, he destroys more beetles, grasshoppers, and the like than all our other mammals together, and in addition to these he devours vast numbers of mice.
>
> "He does not evince that dread of man that is so manifest in the vast majority of our mammals, and when met during any of his circumambulations rarely thinks of running away. He is slow in movement and deliberate in action and does not often hurry himself in whatever he does. His ordinary gait is a measured walk, but when pressed for time he breaks into a low shuffling gallop. It is hard to intimidate a skunk, but when once really frightened he manages to get over the ground at a very fair pace.
>
> "Skunks remain active throughout the greater part of the year in this region, and hibernate only during the severest portion of the winter. They differ from most of our hibernating mammals in that the inactive period is apparently dependent solely on the temperature, while the mere amount of snow has no influence whatever upon their movements.
>
> "Skunks, particularly when young, make very pretty pets, being attractive in appearance, gentle in disposition, interesting in manners, and cleanly in habits—rare qualities indeed! They are playful, sometimes mischievous, and manifest considerable affection for those who have the care of them. Their flesh is white, tender, and sweet, and is delicious eating.
>
> "Skunks have large families, from six to ten young being commonly raised each season ; and as a rule they all live in the same hole until the following spring."

We now come to the consideration of the remarkable and overpowering odor which has brought the skunk into such evil notoriety, and which is not the mere smell of the animal itself, as in the case of most other evil-smelling mammals, but arises from the much-modified secretion of the anal glands. These glands although present in all *Mustelidæ*, are especially developed in the skunks, and are peculiar for being so entirely under the control of the animal that at ordinary times, as Dr. Merriam has stated, the animal is enabled to be both cleanly and free from smell. The glands which secrete the odoriferous fluid are modifications of the ordinary anal glands possessed by nearly all *Carnivora*, but in the skunks they are enormously enlarged, entirely surround the rectum, and are provided with thick muscular gizzard-like coats. The two ducts leading from these glands open at the tips of two small conical papillæ placed just inside the anus, in such a position that by everting the anus the animal can protrude them externally, and with them can guide the direction of the jet of nauseous fluid, which is often propelled by the powerful muscles surrounding the glands to a distance of from 8 to 12 feet.

It is almost needless to state that the old stories about the skunk's smell arising from its urine, and of its splashing the fluid about with its tail are both entirely without foundation. The secretion itself is a clear yellowish liquid, with a marvellously penetrating ammoniacal and nauseous smell. So powerful and penetrating is this smell that Dr. Merriam says, "I have known the scent to become strikingly apparent in every part of a well-closed house, in winter, within five minutes time after a skunk had been killed at a distance of more than a hundred yards," and under favorable conditions it may be distinctly perceived at a distance of more than a mile ; instances are also on record of persons having become entirely unconscious after inhaling the smell. On the other hand it is said to act as a potent remedy in cases of asthma and similar diseases, but to most people such a remedy would be almost worse than the disease itself.

The other species of skunk are the following :

The Long-tailed Skunk (*Mephitis macrura*), a native of central and southern Mexico, differs from the common species by generally having two white stripes along its sides, and by its much longer and bushier tail.

The little Striped Skunk (*Mephitis putorius*), found in the southern United States, and ranging southwards to Yucatan and Guatemala, is much smaller than *M. mephitica*, and its coloring is of a very peculiar and striking nature, consisting of four interrupted longitudinal white stripes on a black ground, the general aspect of the animal being one of the most beautiful and striking in all this brightly marked family. Its skull also differs to such an extent from that of the common skunk that this species has been separated as a distinct genus under the name of *Spilogale*, but there is hardly sufficient reason for this.

Finally, the Conepatl (*Conepatus mapurito*), the skunk of tropical America, ranging from Texas to Chili and Patagonia, differs still more from the true skunks, although in color it is almost precisely similar to the common species, varying in the same way and to the same remarkable extent in the relative development of the black and white. Its build is heavier than in *Mephitis* ; its snout and head are more pig-like; and its nostrils open downwards and forwards instead of laterally on the sides of the muzzle. Its skull has many special characters, and its teeth are different in shape and, as a rule, in number also, the first minute premolar of *Mephitis* being almost invariably absent, so that its dental formula is only $i\,\frac{3}{3}$, $c\,\frac{1}{1}$, $pm\,\frac{2}{3}$, $m\,\frac{1}{2} = 32$.

For descriptions of the anal glands see Wyman, *Pr. Bost. Soc.*, i. p. 110, 1844 ; Warren, *Pr. Bost. Soc.*, iii. p. 175, 1851 ; Parker, *Ann. Nat.*, v. p. 246, 1871 ; Chatin, *Ann. Sci. Nat.*, [5], xix. p. 100, 1874 ; and for general descriptive accounts see Allen, *Bull. Harvard Coll.*, i. p. 178, 1869 ; Coues, *Fur-bearing Animals*, pp. 187–260, 1877 ; Merriam, *ut supra*. (O. T.)

SKVIRA, a district town of European Russia, in the government of Kieff, 77 miles southwest of Kieff, and 27 miles from the Fastova railway-junction. It is merely a big village, with 14,200 inhabitants, mostly engaged in agriculture, and has municipal institutions only as the seat of the administration of the district. There is a considerable export of grain and cattle from the district, which is fertile and has many villages of from 3000 to 5000 inhabitants. In the 14th century Skvira was a far more important town than now, but the wars destroyed it, so that two centuries later it was left uninhabited; it was settled anew by Prince Różinski, and the population slowly reached the number of 1000 by the end of the last century. The town has grown rapidly during the last ninety years.

SKYE, the largest island of the Inner Hebrides, Scotland, is situated between the mainland of Inverness-shire, within which county it is included, and the group of the Outer Hebrides. It lies between 57° 1′ 12″ and 57° 42′ 30″ N. lat. and 5° 38′ 50″ and 6° 47′ 8″ W. long. It is separated from the mainland at its eastern corner by Loch Alsh and Kyle Rhea, the channel at the narrowest point having a breadth of only about 3 furlongs. Southwards Kyle Rhea widens out into the Sound of Sleat, and to the west of Loch Alsh there is a sudden widening of the gap to the extent of about 9 miles. Along the eastern shore are the islands of Pabba, Scalpa, Raasay, Fladda, and Rona. The Minch separating Lewis and the mainland bounds Skye on the north, and the Little Minch to the northwest separates it from North Uist and Harris. The total area is 411,703 acres or 643 square miles. The coast-line is extremely irregular, abounding in inlets of a great variety of form and size, and in the north and west it is wildly precipitous. The island is naturally divided into three parts, each marked off by its distinctive geology and scenery. By much the largest division lies to the north of a line drawn from Loch Brittle to the head of Loch Sligachan. In this area the rocks are almost wholly varieties of basalt, disposed in nearly horizontal sheets, which give a singular tabular shape to the hills and terraced forms to the slopes. To the east of Loch Snizort are the basaltic groups which include the Storr Rock (2360 feet), with its curious columns, and the Quiraing (1774 feet), with its verdant platform in the centre of a range of rugged cliffs. In the northwest are Macleod's Tables (1601 feet) and some smaller summits. The central division may be defined along its southern border by a line drawn from Loch Slapin to Broadford. Its rocks are almost wholly of volcanic origin, and belong mainly to two groups, each characterized by its peculiar mountain outlines. The dark gabbros and dolerites form the jagged ridges of the Cuillins, and reach in Scuir-na-Gillean a height of 3167 feet, and in Blaaven 3042 feet. To the northeast of the Cuillins tower in striking contrast the pyramidal Red Mountains, consisting of granite, syenite, quartz-porphyry, and various allied rocks, and reaching in Glamaig a height of 2670 feet. The third division includes all the rest of the island, and consists of two tolerably distinct tracts. The more northerly of these lies along the base of the Red Hills, and forms the narrow part of Skye between Strathaird and Broadford Bay. It is composed mainly of Secondary rocks (Lias and Oolite), through which the eruptive masses of the Red Hills have been thrust. The more southerly part comprises the district of Sleat, and consists of red sandstone (Torridon sand-stone or Cambrian), rising in Scuir-na-Coinnich to 2401 feet, and of various crystalline schists and quartzites which stretch from Loch Alsh along the Sound of Sleat to the southern point of the island. A considerable tract of limestone lies in the centre of Strath Parish, some of which has been altered by the eruptive rocks into a pure white marble. There are several inland lochs of considerable size, the largest being Loch Coruisk, remarkable for the gloomy grandeur of its situation in the heart of the Cuillins.

On account of the damp climate the land is better adapted for rearing sheep and cattle than for tillage. A large number of cattle of the West Highland breed are grazed on the moors. The sheep are principally blackfaced, but some Cheviots are also kept. The greater portion of the inhabitants are crofters, who inhabit chiefly miserable huts with a fireplace in the middle of the floor, the smoke escaping by a hole in the roof. The number of crofts in Skye, according to the report of the Crofters Commission, 1884, was 2051. The number of families ejected by degrees from their holdings between 1840 and 1860 was 5012, representing a population of 25,060, and between 1860 and 1883 1948, representing a population of 9740. Many of the crofters support themselves partly by fishing. In the Loch Carron and Skye district the number of boats in 1884 was 950, employing 2904 men and boys. From 20,627 in 1821 the population of Skye had increased to 23,082 in 1841, but by 1871 it had decreased to 17,330, and in 1881, to 16,889, of whom 16,099 were Gaelic-speaking. The number of females was 8903 and of males 7986. Portree, the principal town, has a population of 893.

See, besides the works referred to under HEBRIDES, Alexander Smith's *Summer in Skye*, 1865; Robert Buchanan's *The Hebrid Isles*, 1883; and *Report of the Crofters Commission*, 1884.

SLANDER. See LIBEL.

SLATE is an argillaceous rock of various colors—blue, green, purple, gray, and black—and a peculiar structure by which it readily splits into thin plates or laminæ. It is of sedimentary origin, being primarily deposited on ocean floors as fine mud formed by the waste and denudation of pre-existing rocks, and afterwards compressed, hardened, and altered into compact rock. Slate beds occur mainly in the Cambrian, Silurian, and Devonian formations—frequently alternating with bands of grit and limestone, or interstratified with felspathic lava or ashes—and, being tilted up from their original horizontal or nearly horizontal position, stretch across wide districts in a series of undulations, which rise to the surface in crests, or dip into troughs underground and form angles of every inclination with the horizon.[1]

Slate rock splits along cleavage planes which are distinct from and independent of original stratification. These planes are, as a rule, vertical or highly inclined, and intersect the lines of bedding at various angles, but sometimes coincide with them. The strike of cleavage is generally parallel with that of the slate beds, and a uniform direction is often maintained over wide areas, as in North Wales, where it is nearly north-northeast and south-southwest, while in Shropshire it is northeast and southwest, and in Pembrokeshire north-by-west and south-by-east. This peculiar cleavage structure is believed to be the result of a combination of intense forces, chiefly lateral pressure acting at right angles to the planes of cleavage.

Contraction, compression, shearing, and other powerful forces have caused great disturbances in slate beds, since they were first thrown down as fine sediment, and the results are seen in the foldings, contortions, fissures, rents, and dislocations that now exist. The fissures often follow well-defined courses and form divisional planes termed joints,—some running parallel with the strike and called strike joints, others running in the direction of the dip and called dip joints. Dykes of greenstone and other volcanic matter, and also veins of quartz, intersect the beds, and the surfaces of rents are frequently baked by heat ejected from the interior. Faults also occur, and cause displacements of the beds by upheaval or downthrow of one or other side of a rent.

Several varieties of clay slate are met with, and are characterized by the mineral that chiefly prevails. The color—varying shades of blue, green, and purple being the most common—depends mainly on the presence of iron and the form in which it exists. The common roofing slate of commerce is generally fine-grained, and combines great strength and durability with moderate weight. It is also very dense, 1 cubic foot weighing over 170 pounds, while according to Mr. Wilkinson it takes on an average 20,000 pounds to crush 1 cubic inch.

Certain varieties of slate, however, are soft and perishable, particularly the black carbonaceous kinds. Cubes of iron pyrites frequently occur in slate rock, and are generally deleterious, owing to their tendency to decompose and fall out; but this is not always the

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[1] The following table shows the older sedimentary formations in which slate beds mainly occur, in the order of superposition:

Primary or Palæozoic Rocks.

Permian.		Magnesian limestone, marls, sandstones, etc.
Carboniferous.		Coal measures, limestone, slate, etc.
Devonian.		Old red sandstone, slates, etc.
Silurian.	Upper.	Ludlow group.
		Wenlock.
		Upper Llandovery.
	Lower.	Lower Llandovery.
		Caradoc and Bala.
		Llandeilo.
		Arenig.
		Tremadoc.
		Lingula flags.
		Menevian beds.
Cambrian.		Cambrian grits, conglomerates, and slates.
Primitive crystalline rocks.		Gneiss, schists, etc.

case, as some of the most durable slates are sprinkled with pyrites without detriment.

The following percentage analysis of an average sample of Welsh roofing slate is given by Professor Hull:[1]

Silica	60.50	Magnesia	2.20
Alumina	19.70	Potash	3.18
Iron (protoxide)	7.83	Soda	2.20
Lime	1.12	Water	3.30

Slate has been used for roofing during many centuries, and it is said that some of the old castles of North Wales—such as Carnarvon and Conway—were covered with this material. And no doubt the better class of houses, situated in the neighborhood of slate beds, would be roofed with slates obtained by rough surface digging, or from blocks exposed by mountain streams and split by the action of the weather, long before regular quarrying operations commenced. The Delabole quarries of Cornwall had acquired considerable importance as far back as the 16th century, and some of the Welsh slate quarries are very old, as are those of Angers in France. But the slate industry belongs mainly to the present century and latter part of the 18th; and since the opening up of the country by sea and land communications the progress and development of slate quarries have been great and rapid. The largest and most valuable quarries of North Wales are worked in the Cambrian and Lower Silurian beds, those of Llanberis and Penrhyn being worked in the former, and the Festiniog quarries in the latter. Important quarries are worked in Cumberland (Lower Silurian), Westmoreland and Lancashire (Upper Silurian), and also in Devon and Cornwall (Devonian and Carboniferous), the lake districts being specially noted for their rich green slates. Some of the western and midland districts of Scotland—mainly Argyleshire, Dumbartonshire and Perthshire—produce very strong and durable slates (Lower Silurian and Cambrian), the largest and most important quarries being at Ballachulish in Argyllshire, where 15,000 tons are annually made. The Scotch slates are chiefly blue in color, but thin beds of green are found in some of the central districts.

Slate is now almost universally used for roofing houses and buildings of every description, and for such purposes it is unequalled, the better sorts possessing all the qualities necessary for protection against wind, rain and storm. The finer varieties are made into writing slates, and in districts where cross-cleavage exists slate pencils are made. Slabs are also manufactured, and, being readily cut, planed, dressed and enamelled, are used for chimney pieces, billiard tables, wall linings, cisterns, paving, tombstones, ridge rolls and various other architectural and industrial purposes.

Slate rocks are quarried both above ground and below ground, according as they lie near to or distant from the surface. When they are near the surface, and their dip corresponds with the slope of the ground, they are in the most favorable position, and are worked in terraces or galleries formed along the strike of the beds and having a height of about 50 feet. The galleries are generally carried on in sections of ten yards, worked across the beds, and may rise to any height or be sunk below the surrounding level by excavations. When the rock is much removed from the surface, or inconveniently situated for open workings, it is quarried in underground chambers reached by levels driven through the intervening mass and across or along the beds. Or it may be necessary to sink shafts, as in coal-pits, before the rock is arrived at, but the cost of doing so forms a serious drawback. Inclines, wagons, tramways and other machinery are employed in slate quarries as in other quarries, to suit the special circumstances and position of the operations, and need not be detailed.

The sections of a gallery are generally worked by crews of six men, who undertake to perform all operations of quarrying, splitting and dressing at fixed rates. The rock is bored by jumper drills directed and turned by the hand and driven by hammers. When the bore is short and of small diameter one man can do the work, holding the jumper with one hand and using the hammer with the other. But when a large mass of rock has to be thrown down a bore 4 to 6 feet deep and a diameter of 2 to 3 inches is required and three men are employed—one to guide and turn the jumper and two to drive it with heavy hammers. Bores of intermediate size are made by two men, one holding and the other driving the drill. When the boring has to be done on a steep face a staging is fixed to the rock or suspended from the top by means of ropes. The explosive generally used is rock-blasting powder, being the most suitable for the heaving force required to throw out or detach masses of rock without much splintering, which would destroy the blocks for slate making. Advantage is taken of the natural cuts or joints in blasting, as the rock is readily thrown or worked off these. From the mass thrown out by the blast, or loosened so as readily to come away by the use of crowbars, the men carefully select and sort all good blocks and send them in wagons to the slate huts to be split and dressed into slates. Two men are employed at this operation—one splitting and the other dressing, performing their work in a sitting posture. The splitter places a block on end between his knees, and with chisel and mallet splits it into as many plates as possible of the usual thickness for roofing purposes—namely, quarter of an inch more or less, according to the size and strength required. These plates are then placed horizontally by the dresser on a vertical iron "stand," and cut with a sharp knife into slates of various sizes suitable for the market (from 30 in. x 16 in. to 10 in. x 6 in.). Certain sizes are designated by names from the peerage, such as princesses (24 in. x 14 in.), duchesses (24 x 12), marchionesses (22 x 11), countesses (20 x 10), viscountesses (18 x 9), ladies (16 x 10), etc. In every slate rock there is a large amount of waste or bad rock, which is thrown away as rubbish—the proportion of good to bad varying from one in twelve to one in thirty. Attempts are being made at present to have this waste material manufactured into some article of industrial value, and as it consists chiefly of silica and alumina, these attempts should prove successful.

The slate industry of the British Isles is now of very considerable importance, that of North Wales in particular being immense. According to the census of 1881 the number of slate quarriers in the United Kingdom amounted to 15,765, while over half a million tons of slates and slabs are produced annually, the value of which may be estimated at or over £1,250,000 [$6,075,000]. The number of slates exported in 1884 exceeded 49 millions, the declared value being £251,824 [$1,223,864.64], of which over 35 millions went to Germany, valued at £163,321 [$793,740.06], over 5¾ millions to Australasia, valued at £37,474 [$182,123.64], and over 3 millions to Denmark, valued at £34,304 [$166,717.44].

Good slate beds are also worked in the south of Ireland, particularly in the counties of Wicklow, Tipperary, Cork, and Kerry (Lower Silurian, Devonian and Carboniferous). On the continent of Europe slate rock is worked in Devonian and other formations—in France (Lower Silurian and Devonian), Belgium, Sweden, Norway, Germany, Austria and Italy (Oolitic). In North America immense slate beds extend from Newfoundland westwards to the Great Lakes and southwestwards to Arkansas (U. S.); and slate quarries are successfully worked in Newfoundland, Canada and in the States of Maine, Vermont, Massachusetts,[2] New York, Pennsylvania, etc. Writing and roofing slates and slabs of every variety of size and color are manufactured in these; but none of the quarries have hitherto reached the immense developments of the principal ones in North Wales. And yet, with characteristic enterprise, roofing slates have been within recent years imported to Great Britain from Newfoundland and the United States. (D. C.)

SLAUGHTER HOUSE. See ABATTOIR.

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[1] *Building and Ornamental Stones of Great Britain and Foreign Countries*, 1872.

[2] [Massachusetts does not produce slate.—AM. ED.]

SLAVERY.

It appears to be true that, in the words of Dunoyer, the economic régime of every society which has recently become sedentary is founded on the slavery of the industrial professions. In the hunter period the savage warrior does not enslave his vanquished enemy, but slays him; the women of a conquered tribe he may, however, carry off and appropriate as wives or as servants, for in this period domestic labor falls almost altogether on their sex. In the pastoral stage slaves will be captured only to be sold, with the exception of a few who may be required for the care of flocks or the small amount of cultivation which is then undertaken. It is in proportion as a sedentary life prevails, and agricultural exploitation is practiced on a larger scale, whilst warlike habits continue to exist, that the labor of slaves is increasingly introduced to provide food for the master, and at the same time save him from irksome toil. Of this stage in the social movement slavery seems to have been, as we have said, a universal and inevitable accompaniment.

But wherever theocratic organizations established themselves slavery in the ordinary sense did not become a vital element in the social system. The members of the lowest class were not in a state of individual subjection: the entire caste to which they belonged was collectively subject. It is in the communities in which the military order obtained ascendency over the sacerdotal, and which were directly organized for war, that slavery (as the word is commonly understood) had its really natural and appropriate place. And, as war performed an indispensable function in human history, our just horror for some aspects of slavery must not prevent us from recognizing that institution as a necessary step in social progress. It is not merely that in its first establishment slavery was an immense advance by substituting for the immolation of captives, often accompanied by cannibalism, their permanent occupation in labor for the benefit of the victor. This advantage, recalled by an old though erroneous[1] etymology, is generally acknowledged. But it is not so well understood that slavery discharged important offices in the later social evolution—first, by enabling military action to prevail with the degree of intensity and continuity requisite for the system of incorporation by conquest which was its final destination; and, secondly, by forcing the captives, who with their descendants came to form the majority of the population in the conquering community, to an industrial life, in spite of the antipathy to regular and sustained labor which is deeply rooted in human nature, especially in the earlier stages of the social movement, when insouciance is so common a trait, and irresponsibility is hailed as a welcome relief. With respect to the latter consideration, it is enough to say that nowhere has productive industry developed itself in the form of voluntary effort; in every country of which we have any knowledge it was imposed by the strong upon the weak, and was wrought into the habits of the people only by the stern discipline of constraint. From the former point of view the freeman, then essentially a warrior, and the slave were mutual auxiliaries, simultaneously exercising different and complementary functions—each necessary to the maintenance and furthering the activity of the other, and thus co-operating, without competition or conflict, towards a common public end. In modern slavery, on the other hand, where the occupations of both parties were industrial, the existence of a servile class, instead of rendering the citizens disposable for social service in a different field, only guaranteed for some of them the possibility of self-indulgent ease, whilst it imposed on others the necessity of indigent idleness.

It was in the Roman state that military action—in Greece often purposeless and, except in the resistance to Persia, on the whole fruitless—worked out the social mission which formed its true justification. Hence at Rome slavery also most properly found its place, so long as that mission was in progress of accomplishment. As soon as the march of conquest had reached its natural limit, slavery began to be modified; and when the empire was divided into the several states which had grown up under it, and the system of defence characteristic of the Middle Ages was substituted for the aggressive system of antiquity, slavery gradually disappeared, and was replaced by serfdom, which again, with the rise of modern industrial life, gave way to personal freedom.

We have so far dealt with the *political* results of ancient slavery, and have found it to have been in certain respects not only useful but indispensable. When we consider its moral effects, whilst endeavoring to the utmost to avoid exaggeration, we must yet pronounce its influence to have been profoundly detrimental. In its action on the slave it marred in a great measure the happy effects of habitual industry by preventing the development of the sense of human dignity which lies at the foundation of morals, whilst the culture of his ideas and sentiments was in most cases entirely neglected, and the spontaneous education arising from the normal family relations was too often altogether denied him. On the morality of the masters—whether personal, domestic, or social—the effects of the institution were disastrous. The habit of absolute rule, always dangerous to our nature, was peculiarly corrupting when it penetrated every department of daily life, and when no external interference checked individual caprice in its action on the feelings and fortunes of inferiors. It tended to destroy the power of self-command, and exposed the master to the baneful influences of flattery. As regards domestic morality, the system offered constant facilities for libertinism, and tended to subvert domestic peace by compromising the just dignity and ruining the happiness of the wife. The sons of the family were familiarized with vice, and the general tone of feeling of the younger generation was lowered by their intimate association with a despised and degraded class. On social morality, properly so-called, the habits of cruelty, or at least of harshness, engendered by the relation, had a powerful reaction. Hume observes on "the little humanity commonly observed in persons accustomed from their infancy to exercise so great authority over their fellow-creatures and to trample upon human nature. . . . Nor," he adds, "can a more probable reason be assigned for the severe, I might say, barbarous manners of ancient times than the practice of domestic slavery, by which every man of rank was rendered a petty tyrant, and educated amidst the flattery, submission, and low debasement of his slaves." These deplorable results were, of course, not universally produced; there were admirable exceptions both amongst masters and amongst slaves—instances of benevolent protection on the one side and of unselfish devotion on the other, which did honor to human nature; but the evil effects without doubt greatly preponderated.

We proceed to a closer study of the institution of slavery as it existed in the Greek and Roman societies respectively.

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[1] *Servus* is not cognate with *servare*, as has often been supposed; it is really related to the Homeric *εἴρερος* and the verb *εἴρω*, with which the Latin *sero* is to be connected. It may be here mentioned that *slave* was originally a national name; it meant a man of Slavonic race captured and made a bondman to the Germans. "From the Euxine to the Adriatic, in the state of captives or subjects, ... they [the Slavonians] overspread the land, and the national appellation of the *Slaves* has been degraded by chance or malice from the signification of glory to that of servitude" (Gibbon. *Decline and Fall*, ch. lv.). The historian alludes to the derivation of the national name from *slava*, glory. See Skeat's *Etym. Dict.*, *s. v.;* see also SLAVS.

GREECE.

Heroic times.

We find it already fully established in the Homeric period. The prisoners taken in war are rètained as slaves, or sold (*Il.*, xxiv. 752) or held at ransom (*Il.*, vi. 427) by the captor. Sometimes the men of a conquered town or district are slain and the women carried off (*Od.*, ix. 40). Not unfrequently free persons were kidnapped by pirates and sold in other regions, like Eumæus in the *Odyssey*. The slave might thus be by birth of equal rank with his master, who knew that the same fate might befall himself or some of the members of his family. The institution does not present itself in a very harsh form in Homer, especially if we consider (as Grote suggests) that "all classes were much on a level in taste, sentiment, and instruction." The male slaves were employed in the tillage of the land and the tending of cattle, and the females in domestic work and household manufactures. The principal slaves often enjoyed the confidence of their masters and had important duties intrusted to them; and, after lengthened and meritorious service, were put in possession of a house and property of their own (*Od.*, xiv. 64). Grote's idea that the women slaves were in a more pitiable condition than the males does not seem justified, except perhaps in the case of the *aletrides*, who turned the household mills which ground the flour consumed in the family, and who were sometimes overworked by unfeeling masters (*Od.*, xx. 110–119). Part of the agricultural work was sometimes done by poor hired freemen (*thetes*), who are spoken of as a wretched class (*Od.*, xi., 490), and were perhaps employed almost exclusively by the smaller landholders. Having no powerful protector to whom they could look up, and depending on casual jobs, they were probably in a less desirable position than the average slave. Homer conceives the lot of the latter as a bitter one (*Od.*, viii. 528; *Il.*, xix. 302); but it must be remembered that the element of change from a former elevated position usually enters into his descriptions. He marks in a celebrated couplet his sense of the moral deterioration commonly wrought by the condition of slavery (*Od.*, xvii. 322).

Historic period.

It is, however, in historic Greece, where we have ample documentary information, that it is most important to study the system of slavery,—and especially at Athens, where the principal work of Greek civilization found its accomplishment. The case of Sparta, in some respects peculiar, must be separately considered.

Sources of slavery.

The sources of slavery in Greece were: 1. Birth, the condition being hereditary. This was not an abundant source, women slaves being less numerous than men, and wise masters making the union of the sexes rather a reward of good service than a matter of speculation (Xen., *Œcon.*, ix. 5). It was in general cheaper to buy a slave than to rear one to the age of labor. 2. Sale of children by their free parents, which was tolerated, except in Attica, or their exposure, which was permitted, except at Thebes. The consequence of the latter was sometimes to subject them to a servitude worse than death, as is seen in the plays of Plautus and Terence, which, as is well known, depict Greek, not Roman, manners. Freemen, through indigence, sometimes sold themselves, and at Athens, up to the time of Solon, an insolvent debtor became the slave of his creditor. 3. Capture in war. Not only Asiatics and Thracians thus became slaves, but in the many wars between Grecian states, continental or colonial, Greeks were reduced to slavery by men of their own race. Thus Spartans were slaves at Tegea, and Gelon sold out of their country the commonalty of Hyblæan Megara. At Platæa, at Scione, in Melos, the men were massacred or deported, the women enslaved. Athenians were sold at Samos, and in Sicily after the failure of the expedition. In the struggle of parties at Corcyra, each faction, when triumphant, condemned the other to massacre or slavery. Callicratidas pronounced against the enslavement of Greeks by Greeks, but violated his own principle, to which, however, Epaminondas and Pelopidas appear to have been faithful. Philip sold his Olynthian captives, and, after Thebes was taken by Alexander, 30,000 women and children are said to have been sold. 4. Piracy and kidnapping. The descents of pirates on the coasts were a perpetual source of danger; the pirate was a gainer either by the sale or by the redemption of his captives. If ransomed, the victim became by Athenian law the slave of his redeemer till he paid in money or labor the price which had been given for him. Kidnappers (*andrapodistæ*) carried off children even in cities, and reared them as slaves. Whether from hostile forays or from piracy, any Greek was exposed to the risk of enslavement; it was a sword of Damocles suspended over all heads. 5. Commerce. Besides the sale of slaves which took place as a result of the capture of cities or other military operations, there was a systematic slave trade. Syria, Pontus, Lydia, Galatia, and above all Thrace were sources of supply. Egypt and Ethiopia also furnished a certain number, and Italy a few. Of foreigners, the Asiatics bore the greatest value, as most amenable to command, and most versed in the arts of luxurious refinement. But Greeks were highest of all in esteem, and they were much sought for foreign sale. Greece proper and Ionia supplied the petty Eastern princes with courtesans and female musicians and dancers. Athens was an important slave-market, and the state profited by a tax on the sales; but the principal marts were those of Cyprus, Samos, Ephesus, and especially Chios.

Employments of slaves.

The slaves were employed either in domestic service—as household managers, attendants, or personal escorts—or in work of other kinds, agricultural or urban. In early Attica, and even down to the time of Pericles, the landowners lived in the country. The Peloponnesian War introduced a change; and after that time the proprietors resided at Athens, and the cultivation was in the hands of slaves. In manufactures and commerce, also, servile gradually displaced free labor. Speculators either directly employed slaves as artisans or commercial and banking agents, or hired them out, sometimes for work in mines or factories, sometimes for service in private houses, as cooks, flute-players, etc., or for viler uses. There were also public slaves; of these some belonged to temples, to which they were presented as offerings, amongst them being the courtesans who acted as *hierodules* at Corinth and at Eryx in Sicily; others were appropriated to the service of the magistrates or to public works; there were at Athens 1200 Scythian archers for the police of the city; slaves served, too, in the fleets, and were employed in the armies,—commonly as workmen, and exceptionally as soldiers.

Number.

The number of slaves in Greece, or even at Athens, can scarcely be determined with any tolerable approach to certainty. It is stated by Athenæus (vi. 20), on the authority of Ctesicles, that the census of Demetrius Phalereus gave for Athens 21,000 citizens, 10,000 metics (resident foreigners), and 400,000 slaves. It is also stated by the same author that Corinth had possessed 460,000 slaves and Ægina 470,000. Hume, in his *Essay* "On the Populousness of Ancient Nations," maintained that the assertion of Athenæus respecting Athens is quite incredible,—that the number of Athenian slaves "is at least augmented by a whole cipher, and ought not to be regarded as more than 40,000." Boeckh and Letronne have since made the question the subject of fresh studies. The former has fixed the number of Attic slaves at about 365,000, the latter at 100,000 or 120,000. M. Wallon has revised the labors of these scholars, and adduced further considerations of his own.[1] He estimates the number of slaves employed in all Attica in domestic service at 40,000; in agriculture at 35,000; in the mines at 10,000; in manufactures and commerce at 90,000. To these must be added, for old people and children under twelve years of age, 6000 and 20,000 respectively, and also the public slaves, of whom, as we have said, 1200 were Scythian archers. He thus arrives at the conclusion that the servile population of Attica was comprised between the limits of 188,000 and 203,000 souls, the free population being about 67,000, and the metics amounting to 40,000. The slaves thus bore to the free native population the ratio of 3 to 1. The numbers given by Athenæus for Corinth and Ægina, though accepted by Boeckh, appear to be excessive, and are rejected by Clinton and by M. Wallon; the true numbers were no doubt large, but we have no means of determining them even approximately. Next after these cities in the magnitude of their slave population came, on the mainland, Megara, and, amongst the insular states, Chios and Rhodes. Miletus, Phocæa, Tarentum, Sybaris, and Cyrene also had numerous bodies of slaves.

Condition.

The condition of slaves at Athens was not in general a wretched one. Demosthenes (*In Mid.*, p. 530) says that, if the barbarians from whom the slaves were bought were informed of the mild treatment they received, they would entertain a great esteem for the Athenians. Plautus in more than one place thinks it necessary to explain to the spectators of his plays that slaves at Athens enjoyed such privileges, and even license, as must be surprising to a Roman audience. The slave was introduced with certain customary rites into his position in the family; he was in practice, though not by law, permitted to accumulate a private fund of his own; his marriage was also recognized by custom; though in general excluded from sacred ceremonies and public sacrifices, slaves were admissible to religious associations of a private kind; there were some popular festivals in which they were allowed to participate; they had even special ones for themselves both at Athens and in other Greek centres. Their remains were deposited in the family tomb of their master, who sometimes erected monuments in testimony of his affection and regret. They often lived on terms of intimacy either with the head of the house or its younger members; but it is to be feared that too often this intimacy was founded, not on mutual respect, as in the heroic example of Ulysses and Eumæus, but on insolent self-assertion on the one side and a spirit of unworthy compliance on the other, the latter having its *raison d'être* in degrading services rendered by the slave. Aristophanes and Plautus show us how often resort was had to the discipline of the lash even in the case of domestic slaves. Those employed in workshops, whose overseers were themselves most commonly of servile status, had probably a harder lot than domestics; and the agricultural laborers were not unfrequently chained and treated much in the same way as beasts of burden. The displeasure of the master sometimes dismissed his domestics to the more oppressive labors of the mill or the mine. A refuge from cruel treatment was afforded by the temples and altars of the gods and by the sacred groves. Nor did Athenian law leave the slave without protection. He had, as Demosthenes boasts, an action for outrage like a freeman, and his death at the hand of a stranger was avenged like that of a citizen (Eurip., *Hec.*, 288), whilst, if caused by his master's violence, it had to be atoned for by exile and religious expiation. Even when the slave had killed his master, the relatives of the house could not themselves inflict punishment; they were obliged to hand him over to the magistrate to be dealt with by legal process. The slave who had just grounds of complaint against his master could demand to be sold; when he alleged his right to liberty the law granted him a defender and the sanctuaries offered him an asylum till judgment should be given. Securities were taken against the revolt of slaves by not associating those of the same nationality and language; they were sometimes fettered to prevent flight, and, after a first attempt at escape, branded to facilitate their recovery. There were treaties between states for the extradition of fugitives, and contracts of mutual assurance between individuals against their loss by flight. Their inclination to take advantage of opportunities for this purpose is shown by the number that escaped from Athens to join the Spartans when occupying Decelea. There were formidable revolts at the mines of Laurium, and more than once in Chios. The evidence of slaves—women as well as men—was often, with the consent of their masters, taken by torture; and that method is generally commended by the orators as a sure means of arriving at the truth, though sometimes, when it suits their immediate object, they take a different tone. The several forms of the question are enumerated in the *Frogs* of Aristophanes. If the slave was mutilated or seriously injured in the process, compensation was made, not to him, but to his master, by the person who had demanded the use of torture.

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[1] Dr. W. Richter (*Die Sklaverei im Griechischen Altertume*, 1886) maintains the correctness of the statement in Athenæus.

Emancipation.

The slave could purchase his liberty with his peculium by agreement with his master. He could be liberated by will, or during his master's life, by proclamation in the theatre, the law courts, or other public places, or by having his name inscribed in the public registers, or, in the later age of Greece, by sale or donation to certain temples—an act which did not make the slave a hierodule, but a freeman, Conditions were sometimes attached to emancipation, as of remaining for life or a definite time with the former master, or another person named by him, or of performing some special service; payments or rights of succession to property might also be reserved. By manumission the Athenian slave became in relation to the state a metic, in relation to his master a client. He was thus in an intermediate condition between slavery and complete freedom. If the freedman violated his duties to his patron he was subject to an action at law, and if the decision were against him he was again reduced to slavery. He became a full member of the state only, as in the case of foreigners, by a vote in an assembly of six thousand citizens; and even this vote might be set aside by a *graphe paranomón*. Slaves who had rendered eminent services to the public, as those who fought at Arginusæ and at Chæronea, were at once admitted to the status of citizens in the class of (so-called) Platæans. But it would appear that even in their case some civic rights were reserved and accorded only to their children by a female citizen. The number of freedmen at Athens seems never to have been great.

Theoretic views on slavery.

It is well known that Aristotle held slavery to be necessary and natural, and, under just conditions, beneficial to both parties in the relation—views which were correct enough from the political side, regard being had to the contemporary social state. His practical motto, if he is the author of the *Economics* attributed to him, is—"no outrage, and no familiarity." There ought, he says, to be held out to the slave the hope of liberty as the reward of his service. Plato condemned the practice, which the theory of Aristotle also by implication sets aside as inadmissible, of Greeks having Greeks for slaves. In the *Laws* he accepts the institution as a necessary though embarrassing one, and recommends for the safety of the masters that natives of different countries should be mixed and that they should all be well treated. But, whilst condemning harshness towards them, he encourages the feeling of contempt for them as a class. Xenophon also, in urging a mild treatment of them, seems to have in view, not their own well-being, but the security of the masters. The later moral schools of Greece scarcely at all concern themselves with the institution. The Epicurean had no scruple about the servitude of those whose labors contributed to his own indulgence and tranquillity; he would at most cultivate an easy temper in his dealings with them. The Stoic regarded the condition of freedom or slavery as an external accident, indifferent in the eye of wisdom; to him it was irrational to see in liberty a ground of pride or in slavery a subject of complaint; from intolerable indignity suicide was an ever-open means of escape. The poets—especially the authors of the New Comedy—strongly inculcate humanity and insist on the fundamental equality of the slave. The celebrated "homo sum" is a translation from Alexis, and the spirit of it breathes in many passages of the Greek drama. A fragment of Philemon declares, as if in reply to Aristotle, that not nature, but fortune, makes the slave. Euripides, as might be expected from his humanitarian cast of sentiment and the "premature modernism" which has been remarked in him, rises above the ordinary feelings of his time in regard to the slaves. As Mr. Paley says, he loves "to record their fidelity to their masters, their sympathy in the trials of life, their gratitude for kindness and considerate treatment, and their pride in bearing the character of honorable men. . . . He allows them to reason, to advise, to suggest; and he even makes them philosophize on the follies and the indiscretions of their superiors" (compare *Med.*, 54; *Orest.*, 869; *Hel.*, 728; *Ion*, 854; *Frag. Melan.*, 506; *Phrix.*, 823). But we are not to suppose that even he, latitudinarian and innovator as he was, could have conceived the possibility of abolishing an institution so deeply rooted in the social conditions, as well as in the ideas, of his time.

The Helots.

The case of the Helots of Laconia was different from that of the slaves in most Grecian communities. The origin of this class is disputed, and we cannot here enter into the controversy. They were regarded as the property of the state, which gave their services to individuals, but kept in its own hands the power of emancipating them. The domestic servants of the Spartans were all Helots, and they waited on their masters at the *syssitia* or public meal. But they were in the main serfs, living in small country villages or in detached farms, cultivating the lands of the Spartan proprietors and paying to those proprietors a proportion of the produce which could not be increased. They enjoyed their homes, wives, and families, could acquire property, were not to be sold out of the country, and perhaps could not be sold at all. They were, doubtless, employed in public works; in war they commonly acted as light-armed troops attending on the Spartan or Periœcic hoplites, but in particular emergencies themselves served as hoplites (Thucyd., iv. 80). They were sometimes rewarded for good service by emancipation, which, however, did not make them Periœci, but introduced them into a special class known as *neodamodeis*. The condition of the Helot does not seem to have been economically onerous; but his consciousness of Grecian lineage, which Grote regards as an alleviation of his lot, must surely have been one of its bitterest elements, whilst it constantly kept alive the fear and consequent hatred of his Spartan masters and made the relation between the two classes less natural than that of the ordinary Greek masters with slaves of foreign and less civilized races. By the ruling powers of Sparta the Helots were never trusted, and in one memorable case some two thousand of them, selected for special military merit, were massacred in secret (Thucyd., iv. 80). According to Plutarch, whose statement, however, has not always been credited, the ephors declared war against the Helots every year, and there was a practice known as the *krypteia*, of detailing a number of young Spartan citizens for the purpose of assassinating such of them as were considered formidable. Wallon estimates the number of the Helots at 220,000, that of the Spartans being 32,000. The Penestæ in Thessaly and the Clarotæ in Crete seem to have occupied a position somewhat similar to that of the Helots in Laconia.

Rome.

We have already observed that the Roman system of life was that in which slavery had its most natural and relatively legitimate place; and accordingly it was at Rome that, as Blair has remarked, the institution was more than anywhere else "extended in its operations and methodized in its details." Not only on this ground is it especially deserving of our study, but because out of the slave-class, as it was organized by the Romans in the countries subject to the empire, the modern proletariate has been historically evolved.

Sources.

We must distinguish from the later slavery at Rome what Mommsen calls "the old, in some measure innocent," slavery, under which the farmer tilled the land along with his slave, or, if he possessed more land than he could manage, placed the slave—either as a steward or as a sort of lessee obliged to render up a portion of the produce—over a detached farm. Though slaves were obtained by the early victories of Rome over her Italian neighbors, no large number was employed on the small holdings of those periods. But the extension of properties in the hands of the patricians, and the continual absences of citizens required by the expanding system of conquest, necessarily brought with them a demand for slave labor, which was increasingly supplied by captives taken in war. Of the number furnished from this source a few particulars from the time of the mature republic and the first century of the empire will give some idea. In Epirus, after the victories of Æmilius Paullus, 150,000 captives were sold. The prisoners at Aquæ Sextiæ and Vercellæ were 90,000 Teutons and 60,000 Cimbri. Cæsar sold on a single occasion in Gaul 63,000 captives; Augustus made 44,000 prisoners in the country of the Salassi; after immense numbers had perished by famine and hardship and in the combats of the arena, 97,000 slaves were acquired by the Jewish war. But slavery, as Hume has shown, is unfavorable to population, and even the wars of Rome were insufficient to maintain the supply. Hence a regular commerce in slaves was established, which was based on the "systematically prosecuted hunting of man" and indicated an entire perversion of the primitive institution, which was essentially connected with conquest. The pirates sold great numbers of slaves at Delos, where was the chief market for this kind of wares; and these sales went on as really, though more obscurely, after the successful expedition of Pompey. There was a regular importation at Rome of slaves, brought to some extent from Africa, Spain, and Gaul, but chiefly from Asiatic countries—Bithynia, Galatia, Cappadocia, and Syria. A portorium—apparently one-eighth for eunuchs, one-fortieth for others—was paid on their import or export, and a duty of 2 or 4 per cent. on their sale.

There were other sources from which slavery was alimented, though of course in a much less degree. Certain offences reduced the guilty persons to slavery (*servi pœnæ*), and they were employed in public work in the quarries or the mines. Originally, a father could sell his children. A creditor could hold his insolvent debtor as a slave, or sell him out of the city (*trans Tiberim*). The enslavement of debtors, overwhelmed with usury in consequence of losses by hostile raids, or their own absence on military service, led to the revolt of the Mons Sacer (493 B.C.). The Pœtelian law (326 B.C.) restricted the creditor's lien (by virtue of a *nexum*) to the goods of his debtor, and enacted that for the future no debtor should be put in chains; but we hear of debtors *addicti* to their creditors by the tribunals long after—even in the time of the Punic Wars.

Employments.

There were *servi publici* as well as *privati*. The service of the magistrates was at first in the hands of freemen; but the lower offices, as of couriers, servants of the law courts, of prisons, and of temples, were afterwards filled by slaves. The execution of public works also came to be largely committed to them,—as the construction of roads, the cleansing of the sewers, and the maintenance of the aqueducts. Both kinds of functions were discharged by slaves, not only at Rome, but in the rural and provincial municipalities. The slaves of a private Roman were divided between the *familia rustica* and the *familia urbana*. At the head of the *familia rustica* was the *villicus*, himself a slave, with the wife who was given him, at once to aid him and to bind him to his duties. Under him were the several groups employed in the different branches of the exploitation and the care of the cattle and flocks, as well as those who kept or prepared the food, clothing, and tools of the whole staff and those who attended on the master in the various species of rural sports. A slave prison (*ergastulum*) was part of such an establishment, and there were slaves whose office it was to punish the offences of their fellows. To the *familia urbana* belonged those who discharged the duties of domestic attendance, the service of the toilet, of the bath, of the table, of the kitchen, besides the entertainment of the master and his guests, by dancing, singing, and other arts. There were, besides, the slaves who accompanied the master and mistress out of doors, and who were chosen for their beauty and grace as guards of honor, for their strength as chairmen or porters, or for their readiness and address in remembering names, delivering messages of courtesy, and the like. There were also attached to a great household physicians, artists, secretaries, librarians, copyists, preparers of parchment, as well as pedagogues and preceptors of different kinds,—readers, grammarians, men of letters, and even philosophers,—all of servile condition, besides accountants, managers, and agents for the transaction of business. Actors, comic and tragic, pantomimi, and the performers of the circus were commonly slaves, as were also the gladiators. These last were chosen from the most warlike races—as the Samnites, Gauls, and Thracians. *Familiæ* of gladiators were kept by private speculators, who hired them out; they were sometimes owned by men of high rank.

Numbers.

As to the numbers of slaves belonging to individual masters, though we have no distinct general statement in the Roman writers, several special examples and other indirect indications serve to show that the wealthier men possessed very large *familiæ*. This may be inferred from the *columbaria* of the house of Livia and of other great houses. Vettius armed four hundred of his own slaves when he entered on the revolt which was a prelude to the Second Servile War. The slaves of Pedanius Secundus, who, in spite of a threatened outbreak of the indignant populace, were all put to death because they had been under their master's roof when he was murdered, were four hundred in number. Pliny tell us that Cæcilius, a freedman of the time of Augustus, left by his will as many as 4116. The question as to the total number of slaves at Rome or in Italy is a very difficult one, and it is not, perhaps, possible to arrive with any degree of certainty at an approximate estimate. Gibbon supposes that there were in the Roman world in the reign of Claudius at least as many slaves as free inhabitants. But Blair seems right in believing that this number, though probably correct for an earlier period, is much under the truth for the age to which it is assigned. He fixes the proportion of slaves to free men as that of three to one for the time between the conquest of Greece (146 B.C.) and the reign of Alexander Severus (222–235 A.D.). The entire number of slaves in Italy would thus have been, in the reign of Claudius, 20,832,000, that of the free population being 6,944,000.

Laws.

By the original Roman law the master was clothed with absolute dominion over the slave, extending to the power of life and death, which is not surprising when we consider the nature of the *patria potestas*. The slave could not possess property of any kind; whatever he acquired was legally his master's. He was, however, in practice permitted to enjoy and accumulate chance earnings or savings, or a share of what he produced, under the name of *peculium*. A master could not enter into a contract with his slave, nor could he accuse him of theft before the law; for, if the slave took anything, this was not a subtraction, but only a displacement of property. The union of a male and female slave had not the legal character of a marriage; it was a cohabitation (*contubernium*) merely, which was tolerated, and might be terminated at will by the master; a slave was, therefore, not capable of the crime of adultery. Yet general sentiment seems to have given a stronger sanction to this sort of connection; the names of husband and wife are freely used in relation to slaves on the stage, and even in the laws, and in the language of the tombs. For entering the military service or taking on him any state office a slave was punished with death. He could not, in general, be examined as a witness, except by torture. A master, when accused, could offer his slaves for the "question," or demand for the same purpose the slaves of another; and, if in the latter case they were injured or killed in the process, their owner was indemnified. A slave could not accuse his master except of adultery or incest (under the latter name being included the violation of sacred things or places); the case of high treason was afterwards added to these. An accused slave could not invoke the aid of the tribunes. The penalties of the law for crime were more severe on guilty slaves than on freemen; "majores nostri," say the legists, "in omni supplicio severius servos quam liberos punierunt." The capital punishment of the freeman was by the sword or the precipice,—of the slave by the axe or the cross. The lex Cornelia punished the murder of a slave or a freeman alike; but the master who killed his own slave was not affected by this law.

Treatment of slaves.

Columella, like Xenophon, favors a certain friendliness and familiarity in one's intercourse with his farm slaves. Cato ate and drank the same coarse victuals as his slaves, and even had the children suckled by his wife, that they might imbibe a fondness for the family. But that rigid old economist had a strict eye to profit in all his dealings with them. He allowed the contubernium of male and female slaves at the price of a money payment from their peculium. Columella regarded the gains from the births as a sufficient motive for encouraging these unions, and thought that mothers should be rewarded for their fecundity; Varro, too, seems to have taken this view. The immense extension of the rural estates (*latifundia*) made it impossible for masters to know their slaves, even if they were disposed to take trouble for the purpose. Effective superintendence, even by overseers, became less easy; the use of chains was introduced, and these were worn not only in the field during working hours but at night in the ergastulum where the laborers slept—a practice which Pliny lamented as a disgrace to agriculture. Urban slaves had probably often a life as little enviable, especially those who worked at trades for speculators. Even in private houses at Rome, so late as the time of Ovid, the porter was chained. In the *familia urbana* the favorites of the master had good treatment, and might exercise some influence over him which would lead to their receiving flattery and gifts from those who sought his vote or solicited his support. Doubtless, there was often genuine mutual affection; slaves sometimes, as in noted instances during the civil wars, showed the noblest spirit of devotion to their masters. Those who were not inmates of the household, but were employed outside of it as keepers of a shop or boat, chiefs of workshops, or clerks in a mercantile business, had the advantage of greater freedom of action. The slaves of the *leno* and the *lanista* were probably in most cases not only degraded but unhappy. The lighter punishments inflicted by masters were commonly personal chastisement or banishment from the town house to rural labor; the severer were employment in the mill (*pistrinum*) or relegation to the mines or quarries. To the mines speculators also sent slaves; they worked half-naked, men and women, in chains, under the lash, and guarded by soldiers. Vedius Pollio, in the time of Augustus, was said to have thrown his slaves, condemned sometimes for trivial mistakes or even accidents, to the lampreys in his fishpond. Cato advised the agriculturist to sell his old oxen and his old slaves, as well as his sick ones; and sick slaves were exposed in the island of Æsculapius in the Tiber; by a decree of Claudius slaves so exposed, if they recovered, could not be reclaimed by their masters.

Though the Roman slaves were not, like the Spartan Helots, kept obedient by systematic terrorism, their large numbers were a constant source of solicitude in the later period of the republic and under the early empire. The law under which the slaves of Pedanius were put to death, probably first made under Augustus and more fully enacted under Nero, is sufficient proof of this anxiety, which indeed is strongly stated by Tacitus in his narrative of the facts. There had been many conspiracies amongst the slaves in the course of Roman history, and some formidable insurrections. We hear of a conspiracy about 500 B.C. and another in 419 B.C.; again just before the sea-fight of Duilius and between the battles of Trasimenus and Cannæ. In 198 B.C. a servile war had almost broken out; in 196 B.C. there was a rising in Etruria and in 185 B.C. in Apulia. The growth of the latifundia made the slaves more and more numerous and formidable. Free labor was discountenanced. Cato, Varro, and Columella all agree that slave labor was to be preferred to free except in unhealthy regions and for large occasional operations, which probably transcended the capacity of the permanent *familia rustica*. Cicero and Livy bear testimony to the disappearance of a free plebs from the country districts and its replacement by gangs of slaves working on great estates. The policy of the Gracchi and their successors of the popular party was opposed to this reduction of the free working population, which they sought to counteract by agrarian laws and by colonization on a large scale—projects which could not be effectively carried out until civil supremacy was united with military power in the hands of a popular chief, and which, even when this condition was satisfied by the establishment of the empire, were inadequate to meet the evil. The worst form of prædial slavery existed in Sicily, whither Mommsen supposes that its peculiarly harsh features had been brought by the Carthaginians. In Sicily, accordingly, the first really serious servile insurrection took place, at once provoked by the misery of the slaves and facilitated by the habits of brigandage which, it is said, the proprietors had tolerated and even encouraged as lightening the cost of subsistence of their slaves. The rising under Eunus in 133 B.C. was with some difficulty suppressed by Rupilius. Partial revolts in Italy succeeded; and then came the second Sicilian insurrection under Trypho and Athenio, which, after a severe struggle, was put down by Aquilius. These were followed by the Servile War in Italy under Spartacus, which, occurring at an otherwise critical period, severely tested the military resources of Rome. In the subsequent civil conflicts the aid of slaves was sought by both parties, even by Marius himself, and afterwards by Catiline, though he finally rejected their services. Clodius and Milo employed bands of gladiators in their city riots, and this action on the part of the latter was approved by Cicero. In the First Civil War they were to be found in both camps, and the murderers of Cæsar were escorted to the Capitol by gladiators. Antony, Octavius, and Sextus Pompeius employed them in the Second Civil War; and it is recorded by Augustus on the Monumentum Ancyranum that he gave back to their masters for punishment about 30,000 slaves who had absconded and borne arms against the state. Under Tiberius, at the death of Caligula, and in the reign of Nero there were threatening movements of the slaves. In the wars from Otho to Vespasian they were employed, as Tacitus tells us, even by the most scrupulous generals.

Moral and social effects.

Of the moral influences of slavery we have already spoken. In the particular case of Rome it cannot be doubted that it largely contributed to the impurities which disgraced private life, as seen in the pages of Juvenal, Martial, and Petronius. It is shocking to observe the tone in which Horace, so characterized by geniality and bonhomie, speaks of the subjection of slaves to the brutal passions of their masters (*Sat.*, i. 2, 116). The hardening effect of the system appears perhaps most strikingly in the barbarous spectacles of the amphitheatre, in which even women took pleasure and joined in condemning the gladiator who did not by his desperate courage satisfy the demands of a sanguinary mob. It led, further, to a contempt for industry, even agriculture being no longer held in esteem ("quum sit publice accepta et confirmata jam vulgaris existimatio, rem rusticam sordidum opus," Col., i., præf. 20). The existence of slavery, degrading free labor while competing with freemen for urban employment, multiplied the idle and worthless population of Rome, who sought only "panem et circenses." These had to be supported by public distributions, which the emperors found they could not discontinue, and by the bounty of patrons, and like the "mean whites" of modern America, formed a dangerous class, purchasable by selfish ambitions and ready to aid in civil disturbances.

Emancipation.

Blair, in comparing the Greek and Roman systems of slavery, points with justice to the greater facility and frequency of emancipation as the great superiority of the latter. No Roman slave, he says, "needed to despair of becoming both a freeman and a citizen." Manumission was of two kinds—*justa* or regular, and *minus justa*. Of *manumissio justa* there were four modes: (1) by adoption, rarely resorted to; (2) by testament, already recognized in the Twelve Tables; (3) by *census*, which was of exceptional use, and did not exist later than the time of Vespasian; and (4) by *vindicta*, which was the usual form. In the last method the master turned the slave round, with the words "liber esto," in the presence of the prætor, that officer or his lictor at the same time striking the slave with his rod. The *manumissio minus justa* was effected by a sufficient manifestation of the will of the master, as by letter, by words, by putting the *pileus* (or cap of liberty) on the slave, or by any other formality which had by usage become significant of the intention to liberate, or by such an act as making the slave the guardian of his children. This extra-legal sort of manumission was incomplete and precarious; even after the lex Julia Norbana (19 A.D.), which assimilated the position of those so liberated to that of the Latin colonists, under the name of Latini juniores, the person remained in the eye of the law a slave till his death and could not dispose of his peculium.

A freedman, unless he became such by operation of law, remained client of his master, and both were bound by the mutual obligations arising out of that relation. These obligations existed also in the case of freedmen of the state, of cities, temples, and corporations. The freedman took his former master's name; he owed him deference (*obsequium*) and aid (*officium*); and neglect of these obligations was punished, in extreme cases even with loss of liberty. Conditions might be annexed by the master to the gift of freedom, as of continued residence with him, or of general service or some particular duty to be performed, or of a money payment to be made. But the prætor Rutilius, about the beginning of the 1st century B.C., limited the excessive imposition of such conditions, and his restrictions were carried further by the later jurists and the imperial constitutions. Failing natural heirs of an intestate freedman, the master, now patron, succeeded to his property at his death; and he could dispose by will of only half his possessions, the patron receiving the other half. Freedmen and their sons were subject to civil disabilities; the third generation became *ingenui* (full citizens). Thus, by a process of constant infiltration, the slave element tended to merge itself in the general popular body; and Scipio Æmilianus could reply to the murmurs of a plebeian crowd, "Taceant quibus Italia noverca est; non efficietis ut solutos verear quos alligatos adduxi" (Val. Max., vi. 2, 3).

It was often a pecuniary advantage to the master to liberate his slave; he obtained a payment which enabled him to buy a substitute, and at the same time gained a client. This of course presupposes the recognition of the right of the slave to his peculium; and the same is implied in Cicero's statement that a diligent slave could in six years purchase his freedom. Augustus set himself against the undue multiplication of manumissions, probably considering the rapid succession of new citizens a source of social instability, and recommended a similar policy to his successor. The lex Ælia Sentia (about 3 A.D.) forbade manumission, except in strictly limited cases, by masters under 20 years of age or of slaves under 30; and the lex Furia Caninia (about 7 A.D.) fixed the proportion of a man's slaves which he could liberate by testament, and forbade more than a hundred being so enfranchised whatever might be the number of the familia. Under the empire the freedmen rose steadily in influence; they became admissible to the rank of equites and to the senate; they obtained provincial governments, and were appointed to offices in the imperial household which virtually placed them at the head of administrative departments. Pallas and Narcissus are familiar types of the unworthy members of this class, and there were doubtless many outside of official life who exhibited the ostentation and insolence of the parvenu; but there were others who were highly deserving of esteem. Freedmen of humbler rank filled the minor offices in the administrative service, in the city cohorts, and in the army; and we shall find that they entered largely into the trades and professions when free labor began to revive. They appeared also in literature; we hear of several historical and biographical memoirs by freedmen under the republic and the early empire; many of them were professors of grammar and the kindred arts, as Tiro, the amanuensis of Cicero, and Hyginus, the librarian of Augustus; and names of a higher order are those of Livius Andronicus, Cæcilius, Statius, Terence, Publius Syrus, Phædrus, and Epictetus.

Reforms.

In the 2d century of the Christian era we find a marked change with respect to the institution of slavery, both in the region of thought and in that of law. Already the principles of reason and humanity had been applied to the subject by Seneca who, whatever we may think of him as a man, deserves our gratitude for the just and liberal sentiments he expressed respecting the slaves, who, he says, should be treated as "humble friends," and especially for his energetic reprobation of gladiatorial combats and of the brutality of the public who enjoyed those sanguinary shows. But it was in the 2d century, as we have said, that "the victory of moral ideas" in this, as in other departments of life became "decisive. . . . Dio Chrysostom, the adviser of Trajan, is the first Greek writer who has pronounced the principle of slavery to be contrary to the law of nature" (Mark Pattison). And a parallel change is found in the practical policy of the state. The military vocation of Rome was now felt to have reached its normal limits; and the emperors, understanding that, in the future, industrial activity must prevail, prepared the abolition of slavery as far as was then possible, by honoring the freedmen, by protecting the slave against his master, and by facilitating manumissions. The jurists who, in the absence of a recognized spiritual power, provisionally discharged in their own way the office of systematizing practical morals, modified, by means of the useful fiction of the *jus naturale*, the presumptions of law and the interpretation of doubtful instruments. ("Quod ad jus naturale attinet, omnes homines æquales sunt"—Ulpian. "Servitus est constitutio juris gentium, qua quis dominio alieno contra naturam subjicitur"—Florentinus.) The general tendency both of the imperial constitutions and of the maxims of the legists is in favor of liberty. ("Nec ignotum est quod multa contra juris rigorem pro libertate sint constituta"—Ulpian.) The practices of exposure and sale of children, and of giving them in pledge for debt, are forbidden. An edict of Diocletian forbade a free man to sell himself. Manstealers or kidnappers (*plagiarii*) were punished with death. The insolvent debtor was withdrawn from the yoke of his creditor. While the slave trade was permitted, the atrocious mutilation of boys and young men, too often practiced, was punished with exile and even with death. In redhibitory actions (for the annulment of sales), if a slave were returned to the seller, so must also be his parents, brothers, and *personæ contubernio conjunctæ*. In the interpretation of testaments it was to be assumed that members of the same family were not to be separated by the division of the succession. The law also favored in special cases the security of the peculium, though in general principle it still remained the property of the master. The state granted to public slaves the right of bequeathing half their possessions; and private persons sometimes permitted similar dispositions even to a greater extent, though only within the familia. Hadrian took from masters the power of life and death and abolished the subterranean prisons. Antoninus Pius punished him who killed his own slave as if he had killed another's. Already in the time of Nero the magistrates had been ordered to receive the slave's complaint of ill-treatment; and the lex Petronia, belonging to the same or an earlier period, forbade masters to hand over their slaves to combats with wild beasts. Antoninus directed that slaves treated with excessive cruelty, who had taken refuge at an altar or imperial image, should be sold; and this provision was extended to cases in which the master had employed a slave in a way degrading to him or beneath his character. M. Aurelius gave to masters an action against their slaves for any cause of complaint, thus bringing their relation more directly under the surveillance of law and public opinion. A slave's oath could still not be taken in a court of law; he was interrogated by the "question;" but the emperors and jurists limited in various ways the application of torture, adding, however, as we have mentioned, to the cases in which it could previously be appealed to that of the crime of *majestas*. For certain alleged offences of the master the slave could bring an action, being represented for the purpose by an *adsertor*. Emancipation was facilitated; some of the old formalities were dispensed with; obstacles to it were removed, and legal difficulties solved in such a way as to further it. The power of imposing conditions on testamentary manumissions was restricted, and these conditions interpreted in the sense most favorable to freedom. The emperor could confer liberty by presenting a gold ring to a slave with the consent of the master, and the legal process called *restitutio natalium* made him a full citizen. It was decided that liberty could not be forfeited even by a prescription of sixty years' duration.

Influence of Christianity.

The rise of Christianity in the Roman world still further improved the condition of the slave. The sentiments it created were not only favorable to the humane treatment of the class in the present, but were the germs out of which its entire liberation was destined, at a later period, in part to arise. It is sometimes unreasonably objected to the Christian church that it did not denounce slavery as a social crime and insist on its immediate abolition, that on the contrary it recognized the institution, ecclesiastical persons and societies themselves being owners of slaves. We have seen that slavery was a fundamental element of the old Roman constitution, not only incorporated with the laws, but necessarily arising out of, and essential to, the military mission of the state. When the work of conquest had been sufficiently achieved, it could not be expected that a radical alteration should be suddenly wrought either in the social system which was in harmony with it, or even in the general ideas which had grown up under its influence. The latter would, indeed, be gradually affected; and accordingly we have observed a change in the policy of the law, indicating a change in sentiment with respect to the slave class, which does not appear to have been at all due to Christian teaching, but to have arisen from the spontaneous influence of circumstances co-operating with the softened manners which were inspired by a pacific régime. But the institution itself could not be at once seriously disturbed; it was too deeply rooted and too closely bound up with the whole existing order of things. If it could have been immediately abolished, the results must have been disastrous, most of all to the slave population itself. Before that end could be accomplished, an essentially new social situation must come into existence; society must be organized for defence as it had previously been for conquest; and this transformation could not be wrought in a day. But in the meantime much might be done towards further mitigating the evils of slavery, especially by impressing on master and slave their relative duties and controlling their behavior towards one another by the exercise of an independent moral authority. This was the work open to the Christian priesthood, and it cannot be denied that it was well discharged. Whilst the fathers agree with the Stoics of the 2d century in representing slavery as an indifferent circumstance in the eye of religion and morality, the contempt for the class which the Stoics too often exhibited is in them replaced by a genuine sympathy. They protested against the multiplication of slaves from motives of vanity in the houses of the great, against the gladiatorial combats (ultimately abolished by the noble self-devotion of a monk), and against the consignment of slaves to the theatrical profession, which was often a school of corruption. The church also encouraged the emancipation of individual slaves and the redemption of captives. And its influence is to be seen in the legislation of the Christian emperors, which softened some of the harshest features that still marked the institution. There is not, indeed, a uniform advance in this legislation; there is even retrogression in some particulars under Constantine, as in his renewed permission to fathers to sell their children and to the finder of an exposed child to make it his slave—enactments which it is sometimes sought to excuse by the prevailing poverty of his period. But a stronger influence of Christianity appears in Theodosius, and this influence is at the highest in the legislation of Justinian. Its systematic effort is, in his own words, "pro libertate, quam et fovere et tueri Romanis legibus et præcipue nostro numini peculiare est." Law still refused in general to recognize the marriages of slaves; but Justinian gave them a legal value after emancipation in establishing rights of succession. Unions between slaves and free women, or between a freeman and the female slave of another, continued to be forbidden, and were long punished in certain circumstances with atrocious severity. As witness, the slave was still subject to the question; as criminal, he was punished with greater rigor than the freeman. If he accused his master of a crime, unless the charge was of treason, he was burnt. But he could maintain a legal claim to his own liberty, not now merely through an *adsertor*, but in person. A female slave was still held incapable of the offence of adultery; but Justinian visited with death alike the rape of a slave or freedwoman and that of a free maiden. Already the master who killed his slave had been punished as for homicide, except in the case of his unintended death under correction; Constantine treated as homicide a number of specially-enumerated acts of cruelty. Even under Theodosius the combats of the amphitheatre were permitted, if not encouraged, by the state authorities; these sports were still expected from the candidates for public honors. Combats of men with beasts were longest continued; they had not ceased even in the early years of the reign of Justinian. A new process of manumission was now established, to be performed in the churches through the intervention of the ministers of religion; and it was provided that clerics could at any time by mere expression of will liberate their slaves. Slaves who were admitted to holy orders, or who entered a monastery, became freemen, under certain restrictions framed to prevent fraud or injustice. Justinian abolished the personal conditions which the legislation of Augustus had required to be satisfied by the master who emancipated and the slave who was manumitted, and removed the limitation of number. The liberated slave, whatever the process by which he had obtained his freedom, became at once a full citizen, his former master, however, retaining the right of patronage, the abolition of which would probably have discouraged emancipation.

Transition to serfdom.

The slavery of the working classes, justly described by Hume as the most important difference between the social life of antiquity and that of modern times, was not directly changed into the system of personal freedom. There was an intermediate stage which has not always been sufficiently discriminated from slavery, though the confusion of the two leads to endless misconceptions. We mean the régime of serfdom. In studying the origin of this transitional state of things, four principal considerations have to be kept in view. (1) As Gibbon observes, the substantial completion of the Roman system of conquest and incorporation reduced the supply of slaves by restricting the dealings in them to such trade as took place within the now fixed limits of the empire. It is true that, when the barbarian invasions began in the 3d century, many captives were made, who, when not enrolled in the army, were employed in agriculture or domestic service; but the regular importation was greatly and increasingly diminished, and the Romans were obliged to have recourse to "the milder but more tedious method of propagation." The effect of this was to improve the condition of the slave by rendering his existence an object of greater value to his master. It tended, indeed, directly to the transformation of slavery into serfdom by making it the interest of each family to preserve indefinitely its own hereditary slaves, who could not be replaced except with difficulty and at great expense. The abolition of the external slave trade tended, in fact, to put an end to internal sales, and the slaves became attached to the households or lands of their masters. (2) The diminished supply of slaves further acted in the direction of the rehabilitation of free labor. A general movement of this kind is noticeable from the 2d century onwards. Freemen had always been to some extent employed in the public service—(*a*) as subordinate assistants to the magistrates and priests; the places of scribes, viatores, criers could be filled only by citizens; the apparitors attached to the new imperial administration were also free plebeians, with slaves in the lower ranks; but these apparitorships were usually held by freedmen. So also (*b*) public works were in the 2d century divided amongst corporations of free plebeians, with public slaves under them. In private service the superior posts were often filled by freedmen; the higher arts—as medicine, grammar, painting—were partly in the hands of freedmen and even of *ingenui;* the more successful actors and gladiators were often freedmen. In the factories or workshops kept by wealthy persons slave labor was mainly employed; but free artisans sometimes offered their services to these establishments or formed associations to compete with them. We have seen that free persons had all along been to some extent employed in the cultivation of land as hired laborers, and, as we shall presently find, also as tenants on the great estates. How all this operated we shall understand when we examine the remarkable organization of the state introduced by Diocletian and his successors. (3) This organization established in the Roman world a personal and hereditary fixity of professions and situations which was not very far removed from the caste system of the East. The purpose of this was doubtless to resist by a strong internal consolidation the shock of the invasions, to secure public order, to enforce industrious habits, and to guarantee the financial resources of the state. Personal independence was largely sacrificed, but those still more important ends were in a great measure attained. The all-pervading nature of this discipline will be understood from the following particulars. Members of the administrative service were absolutely bound to their employments; they could not choose their wives or marry their daughters out of the collegia to which they respectively belonged, and they transmitted their obligations to their children. If they abandoned their posts, they were sought for everywhere and forced to return. In municipalities, even the *curiales*, or members of the local senates, were bound to their places and their functions; there were other members of the municipal service who might supply a substitute on condition of resigning to him their lands, but this power was rarely used; they commonly remained in their posts; their families, too, were bound to remain; they were attached to the collegia or other bodies to which they belonged. The soldier, procured for the army by conscription, served as long as his age fitted him for his duties, and his sons were bound to similar service. The same sort of compulsion appears to have been exercised upon those belonging to, at least, such free industrial corporations as were recognized and regulated by the state. Every one was treated, in fact, as a servant of the state, and was bound to furnish labor or money, or both; and the nature of his labor was permanently fixed for him; he was, in the language of the law, "conditionis laqueis irretitus." This general system, by diminishing the freeman's mastery over himself and his power to determine his occupation, reduced the interval between him and the slave; and the latter on the one hand, the free domestic servant and workshop laborer on the other, both passed insensibly into the common condition of serfdom. (4) The corresponding change, in the case of the rural slaves, took place through their being merged in the order of *coloni*. The Roman colonus was originally a free person who took land on lease, contracting to pay to the proprietor either a fixed sum annually or (when a *colonus partiarius*) a certain proportion of the produce of the farm. Under the emperors of the 4th century the name designated a cultivator, who, though personally free, was attached to the soil, and transmitted his condition to his descendants; and this became the regular status of the great mass of Roman cultivators. In sanctioning this personal and hereditary fixity, the law probably only recognized a state of things which had previously existed, having been spontaneously brought about by the circumstances of society, and especially by the needs of agriculture. The class of coloni appears to have been composed partly of tenants by contract who had incurred large arrears of rent and were detained on the estates as debtors (*obærati*), partly of foreign captives or immigrants who were settled in this condition on the land, and partly of small proprietors and other poor men who voluntarily adopted the status as an improvement in their position. They paid a fixed proportion of the produce (*pars agraria*) to the owner of the estate, and gave a determinate amount of labor (*operæ*) on the portion of the domain which he kept in his own hands (*mansus dominicus*). The law for a long time took no notice of these customary tenures, and did not systematically constitute them until the 4th century. It was indeed the requirements of the fiscus and the conscription which impelled the imperial Government to regulate the system. The coloni were inscribed (*adscripti*) on the registers of the census as paying taxes to the state, for which the proprietor was responsible, reimbursing himself for the amount. In a constitution of Constantine (332 A.D.) we find the colonus recognized as permanently attached to the land. If he abandoned his holding he was brought back and punished; and any one who received him had not only to restore him but to pay a penalty. He could not marry out of the domain; if he took for wife a colona of another proprietor, she was restored to her original locality, and the offspring of the union were divided between the estates. The children of a colonus were fixed in the same status, and could not quit the property to which they belonged. They and their descendants were retained, in the words of a law of Theodosius, "quodam æternitatis jure," and by no process could be relieved from their obligations. By a law of Anastasius, at the end of the 5th century, a colonus who had voluntarily come into an estate was by a tenure of thirty years forever attached to it. The master (*dominus*) could inflict on his coloni "moderate chastisement," and could chain them if they attempted to escape, but they had a legal remedy against him for unjust demands or injury to them or theirs. In no case could the rent or the labor dues be increased. The colonus could possess property of his own, but could not alienate it without the consent of the master. Thus, whilst the members of the class were personally free, their condition had some incidents of a semi-servile character. They are actually designated by Theodosius, though the lax language of the codes must not be taken too literally, "servi terræ cui nati sunt." And Salvian treats the proposition "coloni divitum fiunt" as equivalent to "vertuntur in servos." This is indeed an exaggeration; a deduction must always be made from the phrases of the mediæval Jeremiah; the colonatus was not an oppressive system; it afforded, on the contrary, real security against unreasonable demands and wanton disturbance, and it was a great advance on the system of cultivation by the *familia rustica*. But the point which it is important for our present purpose to observe is, that there was a certain approximation between the condition of the colonus and the slave which tended towards the fusion of both in a single class. To make this plain, we must go a little further into detail.

Besides the coloni there were on a great estate—and those of the 4th century were on a specially large scale—a number of prædial slaves, who worked collectively under overseers on the part of the property which the owner himself cultivated. But it was a common practice to settle certain of the slaves (and possibly also of the freedmen) on other portions of the estate, giving them small farms on conditions similar to those to which the coloni were subject. These slaves are, in fact, described by Ulpian as *quasi coloni*. They had their own households and were hence distinguished as *casati*. In law these slaves were at first absolutely at the disposal of their masters; they had no property in the strict sense of the word, and could be sold to another proprietor and separated from their families. But the landlord's interest and the general tone of feeling alike modified practice even before the intervention of legislation; they were habitually continued in their holdings, and came to possess in fact a perpetual and hereditary enjoyment of them. By a law of Valentinian I. (377) the sale of these slaves was interdicted unless the land they occupied were at the same time sold. The legal distinction between the coloni and the slave tenants continued to exist after the invasions; but the practical difference was greatly attenuated. The colonus often occupied a servile mansus, and the slave a mansus originally appropriated to a colonus. Intermarriages of the two classes became frequent. Already at the end of the 7th century it does not appear that the distinction between them had any substantial existence. The servile tenures were, no less than the others, stable and hereditary; and the charges to be borne by the former were not necessarily the heavier.

Whilst giving their due weight to the social and economic circumstances which tended thus to merge the free laborer and colonus on the one hand and the slave on the other in a common class of serfs, we must never leave out of account the directly moral agencies which worked towards the same result by modifying slavery. Nor ought we to have in view only the influence of Christian doctrine and precept considered in themselves; we must regard them as constantly applied in daily life by an independent spiritual order, which was revered alike by the two classes whose relations it assisted in regulating, and whose general attitude towards slavery is sufficiently shown by the celebrated declaration of Gregory the Great.

A review of what has been said will make it plain that the Northern invasions had little to do with the transition from slavery to serfdom. Only two modes have been suggested in which they may possibly have accelerated the change. It is not likely that the newly established proprietors would understand, or respect in practice, nice distinctions between classes of cultivators; they would probably regard the coloni and slaves, now that their conditions were so much assimilated, as standing on the same basis. And, secondly, the Germans, if we may believe Tacitus, had in their original seats no menial slaves, whilst, on the other hand, they were familiar with the system of slaves settled on separate portions of a domain and paying a fixed share of the produce to its owner. There may be a certain value in these considerations. But, on the whole, it appears that, as in the case of the rise of the feudal system generally, so in the particular respect of the qualified personal freedom which accompanied it, the influence of the Northern nations was really of little account, and that both changes would have equally, though perhaps not so speedily, taken place if the invasions had never occurred.

Whilst ancient slavery was, as we have seen, a system fitted to endure under given social conditions, and had a definite political function to fulfil, serfdom, which succeeded when that function was exhausted, was a merely transitory condition, with no other destination than that of leading the working population up to a state of entire personal freedom.

Disappearance of serfdom.

How the serf in cities and towns became a free laborer for hire can be easily conceived; he doubtless in many cases purchased his liberty out of his earnings, and in others it was not the master's interest to retain his services at the cost of his maintenance. The emancipation of this entire class was favored by the movement (not, however, to be confounded with it) which established free industrial communities and gave them municipal jurisdiction. But it is very difficult to trace the steps by which the rural serf was transmuted into a free tenant. "The time and manner," says Adam Smith, "in which so important a revolution was brought about is one of the most obscure points in modern history." Smith himself attributes the change to two causes—(1) the greater advantage to the proprietor derived from the exertions of the cultivator when he worked entirely for himself, and (2) the encouragement which sovereigns, jealous of the great lords, gave to the villeins (under which term Smith seems to comprehend the whole mixed class of non-free tenants) to encroach on their authority. To these economic and political reasons, though doubtless real and important, Smith appears to attribute too exclusive an efficacy, neglecting the moral and religious causes which conspired to the same result, especially the personal influence of the clergy, who were natural mediators between the serfs and the proprietors. The serfs were best treated on the ecclesiastical estates, and many on private properties were liberated "pro amore Dei" and "pro remedio animæ."

Let us examine more particularly the circumstances of the transition in France and in England.

France.

M. Guérard has shown that from the conquest by Cæsar to the abolition of feudalism there was a steady improvement in the condition of the class originally enslaved. He distinguishes three periods—one of slavery proper, lasting till the conquest of Gaul by the barbarians; the second, ending about the close of the reign of Charles the Bald (d. 877), in which slavery is replaced by an intermediate state which he calls by the indeterminate name of "servitude," the rights of the *servus* being recognized, respected, and protected, if not yet in a sufficient degree by the civil laws, at least by those of the church and by social manners; and a third in which, under the developed régime of feudalism, serfdom proper is fully established and the serf-tenant has become simply a tributary under various appellations (*homme de corps* or *de pôté, main-mortable, taillable, serf, vilain*). The three personal conditions here described coexisted to some extent in all these periods, one of them, however, greatly preponderating in each. Towards the end of the 9th century the serf-tenants were already proprietors of their holdings; under the third dynasty they were rather subjects than tenants, and the dues they paid were rather taxes than rents; they were, in short, vassals occupying the lowest round of the feudal ladder. Guérard enumerates as immediate causes which led to the liberation of serfs (besides the master's voluntary gift or bequest) their flight,—with the prescription which arose after a certain interval of absence,—ordination, redemption by themselves or others, marriages with women of higher status, and the action of law in the case of certain wrongs inflicted by the master. The church co-operated to the same result, as might be shown by many instances. Thus St. Benedict of Aniane (d. 821), the reformer of the monasteries in the Carolingian territories, received a number of donations of lands from the faithful; but, whilst accepting them for his religious establishments, he enfranchised the serfs who inhabited them. All the serfs, not merely in a village, bourg, or city, but in whole districts, were liberated by charters of sovereigns or lords. Such documents are most common in the 13th century. The general edicts of Louis X. (1315) and Philip V. (1318) are little more than recognitions of a *fait accompli*, and were dictated, at least in part, by financial motives. Some relics of serfdom continued to exist in local customs down to the Revolution, and were not abolished till the night of the 4th August, 1789. But these survivals do not affect the truth of the proposition that the work of emancipation was essentially accomplished early in the 14th century.

England.

Guérard has observed on the difficulty created by the ambiguity of the word *servus* in the mediæval authorities. In the study of English serfdom, even eminent writers like Robertson, Hallam, and Kemble have obscured the subject by the use of the term *slave*, sometimes in its proper sense, sometimes in relation to the *serf*. Dr. Stubbs has avoided this equivocal nomenclature, and by attending more to social fact than to the letter of the law has placed the history of the class in a clear light. The slaves of Anglo-Saxon times were "regarded as the stock of their owner; . . . their offences against a third person he must answer for, as for the mischief done by his cattle; . . . they had no credibility, no legal rights; wrongs done to them were regarded as wrongs done to their master." Practice, indeed, was kinder to them than legal theory; as in the case of the Roman peculium, they were "in some unexplained way" allowed to keep their savings, and so to purchase their freedom; and "the spiritual law could enforce a penance on the master for ill-treating them." There were laws of Ethelbert and Canute forbidding the sale of men to heathen masters, and the slave trade, the principal seat of which was Bristol, was put down by the preaching of St. Wulfstan. The villein of Domesday Book is not a slave; he represents the Anglo-Saxon *ceorl;* he is an irremovable cultivator, now regarded as customary tenant of a lord. The Norman knights probably confounded with the *villanus* the *bordarii* and other tenants who stood on a less favorable footing. Whilst the free ceorl became a villein the *servus* (*theow*) disappeared altogether. The position which the class constituted by this fusion came to occupy was one "compatible with much personal comfort and some social ambition." The villeins "were safe in the possession of their homes; they had a remedy against the violence of their masters; they could, if they chose to renounce their holdings and take refuge in a town, become members of the guild, and there, when unclaimed for a year and a day, obtain the full rights of freemen; they could obtain manumission by the intervention of the church, which always proclaimed the liberation of the villein to be a work of merit on the part of the master. . . . Under a fairly good lord, under a monastery or a college, the villein enjoyed immunities and security that might be envied by his superiors; he had a ready tribunal for his wrongs, a voice in the management of his village; he might with a little contrivance redeem his children and start them in a higher state of life." Walter Map declares that in his time (12th century) the villeins were educating their ignoble offspring in the liberal arts. In the early part of the 14th century "it was by a mere legal form that the villeins were described as less than free." In the reign of Richard II. it seems that "the legal theory of their status has become hardened and sharpened so as to warrant almost wanton oppression;" but social causes, on the other hand, have ameliorated their actual lot. It was not their normal condition that led to the insurrection of 1381, but the enforcement of the Statute of Laborers and the attempt of the lords to reassert legal claims which were practically obsolete. Serfdom died out in England without any special legislation against it. It survived in exceptional instances, as in France; Hallam mentions as the latest deed of enfranchisement one of Elizabeth in 1574 in favor of the bondmen on some of her manors; and it appears that in Scotland the workers in coal and salt mines were in a state of serfdom until they were liberated by Acts of the 15th and 39th years of the reign of George III.

Italy.

Essentially similar movements took place in the other countries of the West. In Italy "the 11th and 12th centuries," says Hallam, "saw the number of slaves" (by which word he means serfs) "begin to decrease; early in the 15th a writer quoted by Muratori speaks of them as no longer existing. . . . The greater part," he adds, "of the peasants in some countries of Germany had acquired their liberty before the end of the 13th century; in other parts . . . they remained in a sort of villenage till the present age."

Germany.

The most rigorous forms of serfdom (*Leibeigenschaft*) existed in those German districts which were once Wendish,—as Lusatia, Pomerania, and Mecklenburg,—and in Holstein. The last remains of the system in Germany were abolished in 1832 and 1848.

Spain.

In Castile the serfs were slowly converted into *solariegos*, who cultivated the land of the lord under obligations similar to those of the colonus. Alphonso X. (El Sabio) declared that the solariego could quit his holding when he wished, though he could not alienate it or demand anything for his improvements. Alphonso XI. (El Justiciero) decreed that no lord should take the *solar* (holding) from the tenant, nor from his sons or grandsons, so long as they paid the fixed dues. They thus became irremovable, and their tenures were hereditary.

By these gradual processes every form of servitude disappeared from the social order of western Europe, whilst at the same time was bequeathed to the modern world the inexorable problem, still but partially solved, of the definitive position of the classes whose origin is traceable to that condition.

Modern slave trade.

But not very long after the disappearance of serfdom in the most advanced communities comes into sight the new system of colonial slavery, which, instead of being the spontaneous outgrowth of social necessities and subserving a temporary need of human development, was politically as well as morally a monstrous aberration, and never produced anything but evil.

Spanish colonies.

In 1442, when the Portuguese under Prince Henry the Navigator were exploring the Atlantic coast of Africa, one of his officers, Antam Gonsalves, who had captured some Moors, was directed by the prince to carry them back to Africa. He received from the Moors in exchange for them ten blacks and a quantity of gold dust. This excited the cupidity of his fellow-countrymen; and they fitted out a large number of ships for the trade, and built several forts on the African coast. Many negroes were brought into Spain from these Portuguese settlements, and the colonial slave trade first appears in the form of the introduction into the newly-discovered western world of children or descendants of these negroes. When Ovando was sent out in 1502 as governor of Hispaniola, whilst regulations, destined to prove illusory, were made for the protection of the natives of the island, permission was given to carry to the colony negro slaves, born in Seville and other parts of Spain, who had been instructed in the Christian faith. It appears from a letter of Ovando in 1503 that there were at that time numbers of negroes in Hispaniola; he requested that no more might be permitted to be brought out. In 1510 and the following years King Ferdinand ordered a number of Africans to be sent to that colony for the working of the mines.

Before this time Columbus had proposed an exchange of his Carib prisoners as slaves against live stock to be furnished to Hispaniola by Spanish merchants. Infidels, he represented, would thus be converted, the royal treasury enriched by a duty on the slaves, and the colonists supplied with live stock free of expense. He actually sent home in the ships of Antonio Torres, in 1494, above 500 Indian prisoners taken in wars with the caciques, who, he suggested, might be sold as slaves at Seville. But, after a royal order had been issued for their sale, Queen Isabella, interested by what she had heard of the gentle and hospitable character of the natives and of their docility, procured a letter to be written to Bishop Fonseca, the superintendent of Indian affairs, suspending the order until inquiry should be made into the causes for which they had been made prisoners, and into the lawfulness of their sale. Theologians differed on the latter question, and Isabella directed that these Indians should be sent back to their native country, and that a policy of conciliation should be followed there instead of one of severity.

Bartolomé de las Casas, the celebrated bishop of Chiapa, accompanied Ovando to Hispaniola, and was a witness of the cruelties from which the Indians suffered under his administration. He came to Spain in 1517 to obtain measures in their favor, and he then made the suggestion to Charles that each Spanish resident in Hispaniola should have license to import a dozen negro slaves. Las Casas, in his *Historia de las Indias* (lib. iii. cap. 101), frankly confesses the grave error into which he thus fell. "This advice that license should be given to bring negro slaves to these lands the clerigo Casas first gave, not considering the injustice with which the Portuguese take them and make them slaves; which advice, after he had apprehended the nature of the thing, he would not have given for all he had in the world." Other good men appear to have given similar advice about the same time, and, as has been shown, the practice was not absolutely new; indeed the young king had in 1516, whilst still in Flanders, granted licenses to his courtiers for the importation of negroes into the colonies, though Ximenes, as regent of Castile, by a decree of the same year forbade the practice. The suggestion of Las Casas was no doubt made on the ground that the negroes could, better than the Indians, bear the labor in the mines, which was rapidly exhausting the numbers of the latter.[1] He has sometimes on this plea been exonerated from all censure; but, as we have seen, he did not exculpate himself; and, though entitled to honor for the zeal and perseverance which he showed on behalf of the natives of the New World, he must in justice bear the blame due from posterity for his violation or neglect of moral principle. His advice was unfortunately adopted. "Charles," says Robertson, "granted a patent to one of his Flemish favorites, containing an exclusive right" of supplying 4000 negroes annually to Hispaniola, Cuba, Jamaica, and Porto Rico. "The favorite sold his patent to some Genoese merchants for 25,000 ducats"; these merchants obtained the slaves from the Portuguese; and thus was first brought into a systematic form that odious "commerce between Africa and America which has since been carried on to such an amazing extent," the action of the Spaniards being "imitated by all the nations of Europe who have acquired territories in the warmer climates of the New World."

England.

The first Englishman who engaged in the hateful traffic was Captain John HAWKINS (*q.v.*). The English slave traders were at first altogether occupied in supplying the Spanish settlements. Indeed the reign of Elizabeth passed without any English colony having been permanently established in America. But in 1620 a Dutch ship from the coast of Guinea visited Jamestown in Virginia, and sold a part of her cargo of negroes to the tobacco-planters. This was the first beginning of slavery in British America; the number of negroes was afterwards continually increased—though apparently at first slowly—by importation, and the field-labor was more and more performed by servile hands, so that in 1790 the State of Virginia, which is only a small part of the original colony so named, contained 300,000 negroes.

The African trade of England was long in the hands of exclusive companies; but by an Act of the first year of William and Mary it became free and open to all subjects of the crown. The African Company, however, continued to exist, and obtained from time to time large parliamentary grants. By the treaty of Utrecht the asiento,[2] or contract for supplying the Spanish colonies with 4800 negroes annually, which had previously passed from the Dutch to the French, was transferred to Great Britain; an English company was to enjoy the monopoly for a period of thirty years from 1st May, 1713. But the contract came to an end in 1739, when the complaints of the English merchants on one side and of the Spanish officials on the other rose to such a height that Philip V. declared his determination to revoke the asiento, and Sir Robert Walpole was forced by popular feeling into war with Spain. Between 1680 and 1700 about 140,000 negroes were exported by the African Company, and 160,000 more by private adventurers, making a total of 300,000. Between 1700 and the end of 1786 as many as 610,000 were transported to Jamaica alone, which had been an English possession since 1655. Bryan Edwards estimated the total import into all the British colonies of America and the West Indies from 1680 to 1786 at 2,130,000, being an annual average of 20,095. But this, he admits, is much less than was in his time commonly supposed. The British slave trade reached its utmost extension shortly before the War of American Independence. It was then carried on principally from Liverpool, but also from London, Bristol, and Lancaster; the entire number of slave ships sailing from those ports was 192, and in them space was provided for the transport of 47,146 negroes. During the war the number decreased, but on its termination the trade immediately revived. When Edwards wrote (1791), the number of European factories on the coasts of Africa was 40; of these 14 were English, 3 French, 15 Dutch, 4 Portuguese, and 4 Danish. As correct a notion as can be obtained of the numbers annually exported from the continent about the year 1790 by traders of the several European countries engaged in the traffic is supplied by the following statement: "By the British, 38,000; by the French, 20,000; by the Dutch, 4000; by the Danes, 2000; by the Portuguese, 10,000; total 74,000." Thus more than half the trade was in British hands. "At present," said Robertson, writing in 1791, "the number of negro slaves in the settlements of Great Britain and France in the West Indies exceeds a million; and, as the establishment of servitude has been found, both in ancient and modern times, extremely unfavorable to population, it requires an annual importation of at least 58,000 to keep up the stock." The slaves in the Spanish dominions and in North America, he thought, probably amounted to an additional million.

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[1] The Spaniards, in the space of fifteen years subsequent to the discovery of the West Indies, had, as Robertson mentions, reduced the natives of Hispaniola from a million to 60,000.

[2] The Spaniards were prevented from forming establishments on the African coast by the Bull of Demarcation ("Inter cætera") of Pope Alexander VI. (1493), which forbade their acquiring territory to the east of the meridian line of 100 miles west of the Azores. They could, therefore, supply their American possessions with slaves only by contracts with other powers.

Effects of the slave trade.

The hunting and stealing of human beings to make them slaves, which were already practiced in Africa for the supply of the central states of that continent, as well as of the markets of northern Africa, Turkey, and other Mohammedan countries, were greatly aggravated by the demand of the European colonies. The native chiefs engaged in forays, sometimes even on their own subjects, for the purpose of procuring slaves to be exchanged for Western commodities. They often set fire to a village by night and captured the inhabitants when trying to escape. Thus all that was shocking in the barbarism of Africa was multiplied and intensified by this foreign stimulation. To the miseries thus produced, and to those suffered by the captives in their removal to the coast, were added the horrors of the middle passage. Exclusive of the slaves who died before they sailed from Africa, 12½ per cent. were lost during their passage to the West Indies; at Jamaica 4½ per cent. died whilst in the harbors or before the sale, and one-third more in the "seasoning." Thus, out of every lot of 100 shipped from Africa 17 died in about 9 weeks, and not more than 50 lived to be effective laborers in the islands. The circumstances of their subsequent life on the plantations were not favorable to the increase of their numbers. In Jamaica there were 40,000 in 1690; from that year till 1820 there were imported 800,000; yet at the latter date there were only 340,000 in the island. One cause which prevented the natural increase of population was the inequality in the numbers of the sexes; in Jamaica alone there was in 1789 an excess of 30,000 males.

Movement against the slave trade.

England.

It may be truly said that from the latter part of the 17th century, when the nature of the slave trade began to be understood by the public, all that was best in England was adverse to it. Among those who denounced it—besides some whose names are now little known, but are recorded with the honor they deserve in the pages of Clarkson—were Baxter, Sir Richard Steele (in *Inkle and Yarico*), the poets Southerne (in *Oroonoko*), Pope, Thomson, Shenstone, Dyer, Savage, and above all Cowper (see his *Charity*, and *Task*, bk. 2), Thomas Day (author of *Sandford and Merton*), Sterne, Warburton, Hutcheson, Beattie, John Wesley, Whitfield, Adam Smith, Millar, Robertson, Dr. Johnson, Paley, Gregory, Gilbert Wakefield, Bishop Porteus, Dean Tucker. The question of the legal existence of slavery in Great Britain and Ireland was raised in consequence of an opinion given in 1729 by York and Talbot, attorney-general and solicitor-general at the time, to the effect that a slave by coming into those countries from the West Indies did not become free, and might be compelled by his master to return to the plantations. Chief-Justice Holt had expressed a contrary opinion; and the matter was brought to a final issue by Mr. Granville Sharp in the case of the negro Somerset. It was decided by Lord Mansfield, in the name of the whole bench, on June 22d, 1772, that as soon as a slave set his foot on the soil of the British islands he became free. In 1776 it was moved in the House of Commons by David Hartly, son of the author of *Observations on Man*, that "the slave trade was contrary to the laws of God and the rights of men"; but this motion—the first which was made on the subject—failed; public opinion on the question was far from being yet fully ripe.

The first persons in England who took united practical action against the slave trade were the Quakers, following the expression of sentiment which had emanated so early as 1671 from their founder George Fox. In 1727 they declared it to be "not a commendable or allowed" practice; in 1761 they excluded from their Society all who should be found concerned in it, and issued appeals to their members and the public against the system. In 1783 there was formed amongst them an association "for the relief and liberation of the negro slaves in the West Indies, and for the discouragement of the slave trade on the coast of Africa." This was the first society established in England for the purpose. The Quakers in America had taken action on the subject still earlier than those in England. The Pennsylvanian Quakers advised their members against the trade in 1696; in 1754 they issued to their brethren a strong dissuasive against encouraging it in any manner; in 1774 all persons concerned in the traffic, and in 1776 all slave holders who would not emancipate their slaves, were excluded from membership. The Quakers in the other American provinces followed the lead of their brethren in Pennsylvania. The individuals amongst the American Quakers who labored most earnestly and indefatigably on behalf of the Africans were John Woolman (1720–1773) and Anthony Benezet (1713–1784), the latter a son of a French Huguenot driven from France by the revocation of the edict of Nantes. The former confined his efforts chiefly to America and indeed to his coreligionists there; the latter sought, and not without a large measure of success, to found a universal propaganda in favor of abolition. A Pennsylvanian society was formed in 1774 by James Pemberton and Dr. Benjamin Rush, and in 1787 (after the war) was reconstructed on an enlarged basis under the presidency of Franklin. Other similar associations were founded about the same time in different parts of the United States. The next important movement took place in England. Dr. Peckard, vice-chancellor of the university of Cambridge, who entertained strong convictions against the slave trade, proposed in 1785 as subject for a Latin prize dissertation the question, "An liceat invitos in servitutem dare." Thomas Clarkson resolved to compete for the prize. Reading Anthony Benezet's *Historical Account of Guinea* and other works in the course of his study of the subject, he became so powerfully impressed with a sense of the vile and atrocious nature of the traffic that he ere long determined to devote his life to the work of its abolition, a resolution which he nobly kept. His essay, which obtained the first prize, was translated into English in an expanded form by its author, and published in 1786 with the title *Essay on the Slavery and Commerce of the Human Species.* In the process of its publication he was brought into contact with several persons already deeply interested in the question; amongst others with Granville Sharp, William Dillwyn (an American by birth, who had known Benezet), and the Rev. James Ramsay, who had lived nineteen years in St. Christopher, and had published an *Essay on the Treatment and Conversion of the African Slaves in the British Sugar Colonies.* The distribution of Clarkson's book led to his forming connections with many persons of influence, and especially with William Wilberforce, who, having already occupied himself with the subject, went fully into the evidence bearing on it which Clarkson laid before him, and, as the result of his inquiries, undertook the parliamentary conduct of the movement which was now decisively inaugurated. A committee was formed on 22d May, 1787, for the abolition of the slave trade, under the presidency of Granville Sharp, which after twenty years of labor succeeded, with the help of eminent public men, in effecting the object of its foundation, and thus removing a grave blot on the character of the British nation, and mitigating one of the greatest evils that ever afflicted humanity. It is unquestionable that the principal motive power which originated and sustained their efforts was Christian principle and feeling. The most earnest and unremitting exertions were made by the persons so associated in investigating facts and collecting evidence, in forming branch committees and procuring petitions, in the instruction of the public and in the information and support of those who pleaded the cause in parliament. To the original members were afterwards added several remarkable persons, amongst whom were Josiah Wedgwood, Bennet Langton (Dr. Johnson's friend), and, later, Zachary Macaulay, Henry Brougham, and James Stephen.

In consequence of the numerous petitions presented to parliament, a committee of privy council was appointed by the crown in 1788 to inquire concerning the slave trade; and Mr. Pitt moved that the House of Commons should early in the next session take the subject into consideration. Wilberforce's first motion for a committee of the whole House upon the question was made on 19th March, 1789, and this committee proceeded to business on 12th May of the same year. After an admirable speech, Wilberforce laid on the table twelve resolutions which were intended as the basis of a future motion for the abolition of the trade. The discussion of these was postponed to the next session, and in 1790–91 evidence was taken upon them. At length, on 18th April of the latter year, a motion was made for the introduction of a bill to prevent the further importation of slaves into the British colonies in the West Indies. Opinion had been prejudiced by the insurrections in St. Domingo and Martinique, and in the British island of Dominica; and the motion was defeated by 163 votes against 88. Legislative sanction was, however, given to the establishment of the Sierra Leone Company for the colonization of a district on the west coast of Africa and the discouragement of the slave trade there. It was hoped at the time that that place would become the centre from which the civilization of Africa would proceed; but this expectation was not fulfilled. On 2d April, 1792, Wilberforce again moved that the trade ought to be abolished; an amendment in favor of gradual abolition was carried, and it was finally resolved that the trade should cease on 1st January, 1796. When a similar motion was brought forward in the Lords the consideration of it was postponed to the following year, in order to give time for the examination of witnesses by a committee of the House. A bill in the Commons in the following year to abolish that part of the trade by which British merchants supplied foreign settlements with slaves was lost on the third reading; it was renewed in the Commons in 1794 and carried there, but defeated in the Lords. Then followed several years during which efforts were made by the abolitionists in parliament with little success. But in 1806, Lord Grenville and Fox having come into power, a bill was passed in both Houses to put an end to the British slave trade for foreign supply, and to forbid the importation of slaves into the colonies won by the British arms in the course of the war. On 10th June of the same year Fox brought forward a resolution "that effectual measures should be taken for the abolition of the African slave trade in such a manner and at such a period as should be deemed advisable," which was carried by a large majority. A similar resolution was successful in the House of Lords. A bill was then passed through both Houses forbidding the employment of any new vessel in the trade. Finally, in 1807, a bill was presented by Lord Grenville in the House of Lords providing for the abolition of the trade, was passed by a large majority, was then sent to the Commons (where it was moved by Lord Howick), was there amended and passed, and received the royal assent on 25th March. The bill enacted that no vessel should clear out for slaves from any port within the British dominions after 1st May, 1807, and that no slave should be landed in the colonies after 1st March, 1808.

In 1807 the African Institution was formed, with the primary objects of keeping a vigilant watch on the slave traders and procuring, if possible, the abolition of the slave trade by the other European nations. It was also to be made an instrument for promoting the instruction of the negro races and diffusing information respecting the agricultural and commercial capabilities of the African continent.

The Act of 1807 was habitually violated, as the traders knew that, if one voyage in three was successful, they were abundantly remunerated for their losses. This state of things, it was plain, must continue as long as the trade was only a contraband commerce, involving merely pecuniary penalties. Accordingly, in 1811, Brougham carried through parliament a bill declaring the traffic to be a felony punishable with transportation. Some years later another Act was passed, making it a capital offence; but this was afterwards repealed. The law of 1811 proved effectual, and brought the slave trade to an end so far as the British dominions were concerned. Mauritius, indeed, continued it for a time. That island, which had been ceded by France in 1810, three years after the abolition, had special facilities for escaping observation in consequence of the proximity of the African coast; but it was soon obliged to conform.

France.

The abolition of the French slave trade was preceded by stormy struggles and by many deplorable excesses. The western part of St. Domingo, nominally belonging to Spain, had been occupied by buccaneers, who were recognized and supported by the French Government, and had been ceded to France at the peace of Ryswick in 1697. So vast was the annual importation of enslaved negroes into this colony before 1791 that the ratio of the blacks to the whites was as 16 to 1. In that year there were in French St. Domingo 480,000 blacks, 24,000 mulattoes, and only 30,000 whites. The French law for the regulation of slavery in the plantations, known as the *Code Noir* (framed under Louis XIV. in 1685), was humane in its spirit; but we are informed that its provisions were habitually disregarded by the planters, whilst the free mulattoes labored under serious grievances and were exposed to irritating indignities. A "Société des Amis des Noirs" was formed in Paris in 1788 for the abolition, not only of the slave trade, but of slavery itself. The president was Condorcet, and amongst the members were the Duc de la Rochefoucault, the Abbé Gregoire, Brissot, Clavière, Pétion, and La Fayette; Mirabeau was an active sympathizer. The great motor of the parallel effort in England was the Christian spirit; in France it was the enthusiasm of humanity which was associated with the revolutionary movement. There were in 1789 a number of mulattoes in Paris, who had come from St. Domingo to assert the rights of the people of color in that colony before the national assembly. The Declaration of the Rights of Man in August, 1789, seemed to meet their claims, but in March, 1790, the assembly, alarmed by rumors of the discontent and disaffection of the planters in St. Domingo, passed a resolution that it had not been intended to comprehend the internal government of the colonies in the constitution framed for the mother country, and added that the assembly would not cause any innovation to be made, directly or indirectly, in any system of commerce in which the colonies were already concerned,—a declaration which could only be interpreted as sanctioning the continuance of the slave trade. Vincent Ogé, one of the mulatto delegates in Paris, disgusted at the overthrow of the hopes of his race, returned to St. Domingo, and on landing in October, 1790, addressed a letter to the governor, announcing his intention of taking up arms on behalf of the mulattoes if their wrongs were not redressed. He rose accordingly with a few followers, but was soon defeated and forced to take refuge in the Spanish part of the island. He was afterwards surrendered, tried, and sentenced to be broken on the wheel. When the news of this reached Paris, it created a strong feeling against the planters; and on the motion of the Abbé Gregoire it was resolved by the assembly on 15th May, 1791, "that the people of color resident in the French colonies, born of free parents, were entitled to, as of right, and should be allowed, the enjoyment of all the privileges of French citizens, and among others those of being eligible to seats both in the parochial and colonial assemblies." On the 23d August a rebellion of the negroes broke out in the northern province of St. Domingo, and soon extended to the western province, where the mulattoes and blacks combined. Many enormities were committed by the insurgents, and were avenged with scarcely inferior barbarity. The French assembly, alarmed by these scenes, and fearing the loss of the colony, repealed on 24th September the decree of the preceding May. This lamentable vacillation put an end to all hope of a reconciliation of parties in the island. Civil commissioners sent out from France quarrelled with the governor and called the revolted negroes to their assistance. The white inhabitants of Cape François were massacred and the city in great part destroyed by fire. The planters now offered their allegiance to Great Britain; and an English force landed in the colony. But it was insufficient to encounter the hostility of the republican troops and the revolted negroes and mulattoes; it suffered dreadfully from disease, and was obliged to evacuate the island in 1798. On the departure of the British the government remained in the hands of Toussaint l'Ouverture, the noblest type ever produced by the African race. Slavery had disappeared; the blacks were employed as hired servants, receiving for their remuneration the third part of the crops they raised; and the population was rapidly rising in civilization and comfort. The whole island was now French, the Spanish portion having been ceded by the treaty of Basel. The wish of Toussaint was that St. Domingo should enjoy a practical independence whilst recognizing the sovereignty and exclusive commercial rights of France. Of the violent and treacherous conduct of Bonaparte towards the island and its eminent chief we cannot here give an account; the final issue was that the blacks drove from their soil the forces sent to subdue them, and founded a constitution of their own, which was more than once modified. There can be no doubt that the Government of the Restoration, in seeking to obtain possession of the island, had the intention of reestablishing slavery, and even of reopening the slave trade for the purpose of recruiting the diminished population. But Bonaparte abolished that trade during the Hundred Days, though he also failed to win back the people of St. Domingo, or, as it was now called by its original name, Hayti, to obedience. The Bourbons, when again restored, could not reintroduce the slave trade; the notion of conquering the island had to be given up; and its independence was formally recognized in 1825. Thus France lost her most important colonial possession, which had yielded produce to an amount almost as great as that of all the rest of the West Indies; and the negro race obtained its first and hitherto its only independent settlement outside of the African continent.

Progress of the movement.

England had not been the first European power to abolish the slave trade; that honor belongs to Denmark; a royal order was issued 16th May, 1792, that the traffic should cease in the Danish possessions from the end of 1802. The United States had in 1794 forbidden any participation by American subjects in the slave trade to foreign countries; they now prohibited the importation of slaves from Africa into their own dominion. This Act was passed 2d March, 1807; it did not, however, come into force till 1st January, 1808. At the congress of Vienna (opened November 1, 1814) the principle was acknowledged that the slave trade should be abolished as soon as possible; but the determination of the limit of time was reserved for separate negotiation between the powers. It had been provided in a treaty between France and Great Britain, May 30, 1814, that no foreigner should in future introduce slaves into the French colonies, and that the trade should be absolutely interdicted to the French themselves after June 1, 1819. This postponement of abolition was dictated by the wish to introduce a fresh stock of slaves into Hayti, if that island should be recovered. Bonaparte, as we have seen, abolished the French slave trade during his brief restoration, and this abolition was confirmed at the second peace of Paris, November 20, 1815, but it was not effectually carried out by French legislation until March, 1818. In January, 1815, Portuguese subjects were prohibited from prosecuting the trade north of the equator, and the term after which the traffic should be everywhere unlawful was fixed to end on 21st January, 1823, but was afterwards extended to February, 1830; England paid £300,000 as a compensation to the Portuguese. A royal decree was issued on 10th December, 1836, forbidding the export of slaves from any Portuguese possession. But this decree was often violated. It was agreed that the Spanish slave trade should come to an end in 1820, England paying to Spain an indemnification of £400,000. The Dutch trade was closed in 1814; the Swedish had been abolished in 1813. By the peace of Ghent, December, 1814, the United States and England mutually bound themselves to do all in their power to extinguish the traffic. It was at once prohibited in several of the South American states when they acquired independence, as in La Plata, Venezuela, and Chili. In 1831 and 1833 Great Britain entered into an arrangement with France for a mutual right of search within certain seas, to which most of the other powers acceded; and by the Ashburton treaty (1842) with the United States provision was made for the joint maintenance of squadrons on the west coast of Africa. By all these measures the slave trade, so far as it was carried on under the flags of European nations or for the supply of their colonies, ceased to exist.

Anti-slavery movement.

Meantime another and more radical reform had been in preparation and was already in progress, namely, the abolition of slavery itself in the foreign possessions of the several states of Europe. When the English slave trade had been closed, it was found that the evils of the traffic, as still continued by several other nations, were greatly aggravated. In consequence of the activity of the British cruisers the traders made great efforts to carry as many slaves as possible in every voyage, and practiced atrocities to get rid of the slaves when capture was imminent. It was, besides, the interest of the cruisers, who shared the price of the captured slave-ship, rather to allow the slaves to be taken on board than to prevent their being shipped at all. Thrice as great a number of negroes as before, it was said, was exported from Africa, and two-thirds of these were murdered on the high seas. It was found also that the abolition of the British slave trade did not lead to an improved treatment of the negroes in the West Indies. The slaves were overworked now that fresh supplies were stopped, and their numbers rapidly decreased. In 1807 there were in the West Indies 800,000; in 1830 they were reduced to 700,000. It became more and more evident that the root of the evil could be reached only by abolishing slavery altogether. At the same time, by the discussions which had for years gone on throughout English society on the subject of the slave trade, men's consciences had been awakened to question the lawfulness of the whole system of things out of which that trade had taken its rise.

An appeal was made by Wilberforce in 1821 to Thomas Fowell Buxton to undertake the conduct of this new question in parliament. An anti-slavery society was established in 1823, the principal members of which, besides Wilberforce and Buxton, were Zachary Macaulay, Dr. Lushington, and Lord Suffield. Buxton moved on 5th May of the same year that the House should take into consideration the state of slavery in the British colonies. The object he and his associates had then in view was gradual abolition by establishing something like a system of serfdom for existing slaves, and passing at the same time a measure emancipating all their children born after a certain day. Canning carried against Buxton and his friends a motion to the effect that the desired ameliorations in the condition and treatment of the slaves should be recommended by the home Government to the colonial legislatures, and enforced only in case of their resistance, direct action being taken in the single instance of Trinidad, which, being a crown colony, had no legislature of its own. A well-conceived series of measures of reform was accordingly proposed to the colonial authorities. Thereupon a general outcry was raised by the planters at the acquiescence of the Government in the principles of the anti-slavery party. A vain attempt being made in Demerara to conceal from the knowledge of the slaves the arrival of the order in council, they became impressed with the idea that they had been set free, and accordingly refused to work, and, compulsion being resorted to, offered resistance. Martial law was proclaimed; the disturbances were repressed with great severity; and the treatment of the missionary Smith, which was taken up and handled with great ability by Brougham, awakened strong feeling in England against the planters.

The question, however, made little progress in parliament for some years, though Buxton, William Smith, Lushington, Brougham, Mackintosh, Butterworth, and Denman, with the aid of Z. Macaulay, James Stephen, and others, continued the struggle, only suspending it during a period allowed to the local legislatures for carrying into effect the measures expected from them. In 1828 the free people of color in the colonies were placed on a footing of legal equality with their fellow-citizens. In 1830 the public began to be aroused to a serious prosecution of the main issue. It was becoming plain that the planters would take no steps tending to the future liberation of the slaves, and the leaders of the movement determined to urge the entire abolition of slavery at the earliest practicable period. The Government continued to hesitate and to press for mitigations of the existing system. At length in 1833 the ministry of Earl Grey took the question in hand and carried the abolition with little difficulty, the measure passing the House of Commons on 7th August, 1833, and receiving the Royal assent 28th of the same month. A sum of 20 millions sterling [$97,200,000] was voted as compensation to the planters. A system of apprenticeship for seven years was established as a transitional preparation for liberty. The slaves were bound to work for their masters during this period for three-fourths of the day, and were to be liable to corporal punishment if they did not give the due amount of labor. The master was, in return, to supply them with food and clothing. All children under six years of age were to be at once free, and provision was to be made for their religious and moral instruction. Many thought the postponement of emancipation unwise. Immediate liberation was carried out in Antigua, and public tranquility was so far from being disturbed there that the Christmas of 1833 was the first for twenty years during which martial law was not proclaimed in order to preserve the peace. Notwithstanding protracted and strenuous opposition on the part of the Government, the House of Commons passed a resolution against the continuance of the transitional system. When this was done the local legislatures saw that the slaves would no longer work for the masters; they accordingly cut off two years of the indentured apprenticeship, and gave freedom to the slaves in August, 1838, instead of 1840.

The example of Great Britain was gradually followed by the other European states, and some American ones had already taken action of the same kind. The immediate emancipation of the slaves in the French colonies was decreed by the Provisional Government of 1848. In 1858 it was enacted that every slave belonging to a Portuguese subject should be free in twenty years from that date, a system of tutelage being established in the meantime. This law came into operation on 29th April, 1878, and the status of slavery was thenceforth illegal throughout the Portuguese possessions. The Dutch emancipated their slaves in 1863. Several of the Spanish American states, on declaring their independence, had adopted measures for the discontinuance of slavery within their limits. It was abolished by a decree of the Mexican republic on 15th September, 1829. The Government of Buenos Ayres enacted that all children born to slaves after 31st January, 1813, should be free; and in Colombia it was provided that those born after 16th July, 1821, should be liberated on attaining their eighteenth year.

Three of the most important slave systems still remained in which no steps towards emancipation had been taken—those of the Southern United States, of Cuba, and of Brazil.

United States.

Slavery was far from being approved in principle by the most eminent of the fathers of the American Union. Washington in his will provided for the emancipation of his own slaves; he said to Jefferson that it was "among his first wishes to see some plan adopted by which slavery in his country might be abolished by law," and again he wrote that to this subject his own suffrage should never be wanting. John Adams declared his abhorrence of the practice of slaveholding, and said that "every measure of prudence ought to be assumed for the eventual total extirpation of slavery from the United States." Franklin's opinions we have already indicated; and Madison, Hamilton, and Patrick Henry all reprobated the principle of the system. Jefferson declared that in the presence of the institution "he trembled for his country when he remembered that God was just." The last-named statesman, at the first continental congress after the evacuation by the British forces, proposed a draft ordinance (1st March, 1784) for the government of the territory—including the present Tennessee, Alabama, and Mississippi—ceded already or to be ceded by individual States to the United States; and it was an article of this ordinance that "after the year 1800 there should be neither slavery nor involuntary servitude in any of the said States, otherwise than in punishment of crime." This proviso, however, was lost. At the convention of Philadelphia in 1787, where the constitution was settled, the sentiments of the framers were against slavery; but South Carolina and Georgia insisted on its recognition as a condition of their joining the Union, and even an engagement for the mutual rendition of fugitive slaves was embodied in the federal pact. The *words* "slave" and "slavery" were, however, excluded from the constitution, "because," as Madison says, "they did not choose to admit the right of property in man" in direct terms; and it was at the same time provided that Congress might interdict the foreign slave trade after the expiration of twenty years. It must not be forgotten that either before or soon after the formation of the Union the Northern States—beginning with Vermont in 1777, and ending with New Jersey in 1804—either abolished slavery or adopted measures to effect its gradual abolition within their boundaries. But the principal operation of (at least) the latter change was simply to transfer Northern slaves to Southern markets.

We cannot follow in detail the several steps by which the slave power for a long time persistently increased its influence in the Union. The acquisition of Louisiana—including the State so named, Arkansas, Missouri, and Kansas—(1803), though not made in its interest, the Missouri compromise (1820), the annexation of Texas (1845), the Fugitive Slave Law (1850), the Kansas-Nebraska bill (1854), the Dred Scott decision (1857), the attempts to acquire Cuba (1854), and to reopen the foreign slave trade (1859–60), were the principal steps—only some of them successful—in its career of aggression. They roused a determined spirit of opposition, founded on deep-seated convictions. The pioneer of the more recent abolitionist movement was Benjamin Lundy (1789–1839). He was followed by William Lloyd Garrison (1805–1879), Elijah P. Lovejoy (1802–1837)—a martyr, if ever there was one—Wendell Phillips, Charles Sumner, John Brown (b. 1800, hanged 1859), all of whom were in their several ways leading apostles or promoters of the cause. The best intellect of America outside the region of practical politics has been on the anti-slavery side. William E. Channing, R. W. Emerson, the poets Bryant, Longfellow, pre-eminently Whittier, and more recently Whitman, have spoken on this theme with no uncertain sound. The South, and its partisans in the North, made desperate efforts to prevent the free expression of opinion respecting the institution, and even the Christian churches in the slave States used their influence in favor of the maintenance of slavery. But in spite of every such effort opinion steadily grew. Public sentiment in the North was deeply stirred by the *Uncle Tom's Cabin* of Mrs. Harriet Beecher Stowe (1852), which, as Senior said, under the disguise of a novel was really a pamphlet against the Fugitive Slave Law. It gradually became apparent that the question could not be settled without an armed conflict. The designation of Abraham Lincoln as president in November, 1860, was the signal for the rising of the South. The North at first took arms simply to maintain the Union; but the far-sighted politicians from the first, and soon the whole nation, saw that the real issue was the continued existence or the total abolition of slavery. See UNITED STATES.

The war was closed by the surrender at Appomattox (9th April, 1865), but already in 1862 slavery in the District of Columbia had been abolished by Congress; on 22d of September of the same year Lincoln had issued his proclamation of freedom to the slaves; and in 1864 a constitutional amendment had been passed abolishing and forever prohibiting slavery throughout the United States.

Cuba.

The Spanish slave code, promulgated in 1789, is admitted on all hands to have been very humane in its character; and, in consequence of this, after Trinidad had become an English possession, the anti-slavery party resisted—and successfully—the attempt of the planters (1811) to have the Spanish law in that island replaced by the British. But, notwithstanding this mildness of the code, so habitually and glaringly were its provisions violated in the colonies of Spain, that Dr. R. R. Madden, who had personal knowledge of the affairs of Cuba, declared in 1840 that "slavery in Cuba was more destructive to human life, more pernicious to society, degrading to the slave and debasing to the master, more fatal to health and happiness, than in any other slaveholding country on the face of the habitable globe." "It is in Cuba at this day," wrote Cairnes in 1862, ". . . that we see in the servile class the coarsest fare, the most exhausting and unremitting toil, and even the absolute destruction of a portion of its numbers every year by the slow torture of overwork and insufficient sleep and rest." The slave population of the island was estimated in 1792 at 84,000; in 1817 at 179,000; in 1827 at 286,000; and in 1843 at 436,000. An act was passed by the Spanish legislature in 1870, providing that every slave who had then passed, or should thereafter pass, the age of sixty should be at once free, and that all yet unborn children of slaves should also be free. The latter, however, were to be maintained at the expense of the proprietors up to their eighteenth year, and during that time to be kept, as apprentices, to such work as was suitable for their age. This is known as the Moret Law, having been carried through the house of representatives by Señor Moret y Prendergast, then minister for the colonies. By the census of 1867 there was in Cuba a total population of 1,370,211 persons, of whom 764,750 were whites and 605,461 black or colored; and of the latter number 225,938 were free and 379,523 were slaves. In 1873 the Cubans roughly estimated the population at 1,500,000,—of whom 500,000, or one-third, were slaves. Mr. Crowe, consul-general in the island, has lately (1885) stated that "the institution is rapidly dying,—that in a year, or at most two, slavery, even in its present mild form, will be extinct."[1]

Brazil.

There was a convention between Great Britain and Brazil in 1826 for the abolition of the slave trade, but it was habitually violated in spite of the English cruisers. In 1830 the traffic was declared piracy by the emperor of Brazil. England asserted by the Aberdeen Act (1845) the right of seizing suspected craft in Brazilian waters. Yet by the connivance of the local administrative authorities 54,000 Africans continued to be annually imported. In 1850 the trade is said to have been decisively put down. The planters and mine proprietors cried out against this as a national calamity. The closing of the traffic made the labor of the slaves more severe, and led to the employment on the plantations of many who before had been engaged in domestic work; but the slavery of Brazil has always been lighter than that of the United States. On 28th September, 1871, the Brazilian chambers decreed that slavery should be abolished throughout the empire. Though existing slaves were to remain slaves still, with the exception of those possessed by the Government, who were liberated by the Act, facilities for emancipation were given; and it was provided that all children born of female slaves after the day on which the law passed should be free. They were, however, bound to serve the owners of their mothers for a term of 21 years. A clause was inserted to the effect that a certain sum should be annually set aside from fines to aid each province in emancipating slaves by purchase. Seven years before the passing of this Act the emperor, whose influence has always been exerted in favor of freedom, had liberated his private slaves, and many Brazilians after 1871 followed his example. According to the census of 1835 there were then in Brazil 2,100,000 slaves. It was estimated that at the beginning of 1875 there were not more than 1,476,567. But in 1884 they are spoken of as 3,000,000 in number. A gradual separation has been for some time taking place between the parts of the country in which slave labor is used and the free-labor regions. Slavery is being concentrated in the districts between Maranhão and São Paulo. In 1880 the deputy Joachim Nabuco, leader of the anti-slavery movement, obtained leave to introduce a bill for a more rapid liberation of slaves than was attainable under the law of 1871, and for the final extinction of slavery in Brazil by 1st January, 1890. The Government, however, refused to sanction the further progress of the bill; but the question has since become again of present political interest, being the principal subject of discussion in the parliament which opened 1st March, 1885. A bill has been passed, known as the Saraiva Law, on which we cannot yet form a definitive judgment, but which is understood to have disappointed the expectations of the abolitionists. It is said to provide exorbitant compensation for the slave-owners; and, although slaves over 60 years of age are to obtain their freedom, it appears that all slaves, on being set free, as well as the indentured children of slaves, are to remain three years longer with their masters at very low wages, the planters thus practically receiving an additional indemnity.[1]

Disguised slave trade.

In the colonies of more than one European country, after the prohibition of the slave trade, attempts were made to replace it by a system of importing laborers of the inferior races under contracts for a somewhat lengthened term; and this was in several instances found to degenerate into a sort of legalized slave traffic. About 1867 we began to hear of a system of this kind which was in operation between the South Sea Islands and New Caledonia and the white settlements in Fiji. It seems to have begun in really voluntary agreements; but for these the unscrupulous greed of the traders soon substituted methods of fraud and violence. The natives were decoyed into the labor ships under false pretences, and then detained by force; or they were seized on shore or in their canoes and carried on board. The nature of the engagements to go and work on the plantations was not fully explained to them, and they were hired for periods exceeding the legal term. The area of this trade was ere long further extended. In 1884 attention was drawn in a special degree to the Queensland traffic in Pacific Islanders by the "Hopeful" trials, and a Government commission was appointed to inquire into the methods followed by labor ships in recruiting the natives of New Guinea, the Louisiade Archipelago, and the D'Entrecasteaux group of islands. The result of the investigations, during which nearly five hundred witnesses were examined, was the disclosure of a system which in treachery and atrocity was little inferior to the old African slave trade. These shameful deeds have made the islanders regard it as a duty to avenge their wrongs on any white man they can entice upon their shores. The noble-hearted bishop of Melanesia, John Coleridge Patteson, fell a victim to this retaliation on the island of Nukapu 20th September, 1871. The tendency of the whole system is to create a war of races. It may be questioned whether this trade in labor can be safely continued at all; if so, it must be under a constant and vigorous system of surveillance and regulation.

We have seen that the last vestiges of the monstrous anomaly of modern colonial slavery are disappearing from all civilized states and their foreign possessions. It now remains to consider the slavery of primitive origin which has existed within recent times, or continues to exist, outside of the Western world.

Russian serfdom.

In Russia, a country which had not the same historical antecedents with the Western nations, properly so-called, and which is in fact more correctly classed as Eastern, whilst slavery had disappeared, serfdom was in force down to our own days. The rural population of that country, at the earliest period accessible to our inquiries, consisted of (1) slaves, (2) free agricultural laborers, and (3) peasants proper, who were small farmers or cottiers and members of a commune. The sources of slavery were there, as elsewhere, capture in war, voluntary sale by poor freemen of themselves, sale of insolvent debtors, and the action of the law in certain criminal cases. In the 18th century we find the distinction between the three classes named above effaced, and all of them merged in the class of serfs, who were the property either of the landed proprietors or of the state. They were not even *adscripti glebæ*, though forbidden to migrate; an imperial ukase of 1721 says, "the proprietors sell their peasants and domestic servants, not even in families, but one by one, like cattle." This practice, at first tacitly sanctioned by the Government, which received dues on the sales, was at length formally recognized by several imperial ukases. Peter the Great imposed a poll-tax on all the members of the rural population, making the proprietors responsible for the tax charged on their serfs; and the "free wandering people" who were not willing to enter the army were required to settle on the land either as members of a commune or as serfs of some proprietor. The system of serfdom attained its fullest development in the reign of Catherine II. The serfs were bought, sold, and given in presents, sometimes with the land, sometimes without it, sometimes in families and sometimes individually, sale by public auction being alone forbidden, as "unbecoming in a European state." The proprietors could transport without trial their unruly serfs to Siberia, or send them to the mines for life, and those who presented complaints against their masters were punished with the knout and condemned to the mines. The first symptoms of a reaction appear in the reign of Paul (1796-1801). He issued an ukase that the serfs should not be forced to work for their masters more than three days in each week. There were several feeble attempts at further reform, and even abortive projects of emancipation, from the commencement of the present century. But no decisive measures were taken before the accession of Alexander II. (1855). That emperor, after the Crimean War, created a secret committee composed of the great officers of state, called the chief committee for peasant affairs, to study the subject of serf-emancipation. Of this body the grand-duke Constantine was an energetic member. To accelerate the proceedings of the committee advantage was taken of the following incident. In the Lithuanian provinces the relations of the masters and serfs were regulated in the time of Nicholas by what were called inventories. The nobles, dissatisfied with these, now sought to have them revised. The Government interpreted the application as implying a wish for the abolition of serfdom, and issued a rescript authorizing the formation of committees to prepare definite proposals for a gradual emancipation. A circular was soon after sent to the governors and marshals of the nobility all over Russia proper, informing them of this desire of the Lithuanian nobles, and setting out the fundamental principles which should be observed "if the nobles of the provinces should express a similar desire." Public opinion strongly favored the projected reform; and even the masters who were opposed to it saw that, if the operation became necessary, it would be more safely for their interests intrusted to the nobles than to the bureaucracy. Accordingly, during the year 1858 a committee was created in nearly every province in which serfdom existed. From the schemes prepared by these committees, a general plan had to be elaborated, and the Government appointed a special imperial commission for this purpose. The plan was formed, and, in spite of some opposition from the nobles, which was suppressed, it became law, and serfdom was abolished (19th February = 3d March, 1861). Its nature and results have been indicated in RUSSIA, vol. xxi. p. 90. The total number of serfs belonging to proprietors at the time of the emancipation was 21,625,609, of whom 20,158,231 were peasant serfs and 1,467,378 domestic serfs. This number does not include the state serfs, who formed about one-half of the rural population. Their position had been better, as a rule, than that of the serfs on private estates; it might, indeed, Mr. Wallace says, be regarded as "an intermediate position between serfage and freedom." Amongst them were the serfs on the lands formerly belonging to the church, which had been secularized and transformed into state demesnes by Catherine II. There were also serfs on the apanages affected to the use of the imperial family; these amounted to nearly three and a half millions. Thus by the law of 1861 more than forty millions of serfs were emancipated.

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[1] [Slavery was absolutely abolished in Cuba by law in 1886; and by promulgation 13th May, 1888, of law by Countess D'Eu, acting as regent, in Brazil, without compensation.—AM. ED.]

Mohammedan slavery.

The slavery of the Mohammedan East is usually not the slavery of the field but of the household. The slave is a member of the family, and is treated with tenderness and affection. The Koran breathes a considerate and kindly spirit towards the class, and encourages manumission. The child of a slave girl by her master is born free, and the mother is usually raised to be a free wife. But behind this slavery, however mild in itself, stands the slave trade, with its systematic man-hunting, which has been, and still is, the curse of Africa. The traffic in slaves has been repeatedly declared by the Ottoman Porte to be illegal throughout its dominions, and there have been several conventions between Great Britain and the khedive for its suppression in Egypt; but it is still largely carried on both in the latter country and in Turkey, owing to the laxity and too often the complicity of the Government officials.

Africa.

In the days of the colonial slave trade its African centre was the region about the mouths of the rivers Calabar and Bonny, whither the captive negroes were brought from great distances in the interior. As many slaves, Clarkson tells us, came annually from this part of the coast as from all the rest of Africa besides. At present, it is commonly said,—though Cameron in 1875 was otherwise informed,—no slaves are exported from the western side of the continent. The principal centres from which the supply is now furnished to Egypt, Turkey, Arabia, and Persia are three in number. (1) The Soudan, south of the Great Sahara, appears to be one vast hunting-ground. Captives are brought thence to the slave market of Kuka in Bornu, where, after being bought by dealers, they are to the number of about 10,000 annually, marched over arid desert tracts under a burning sun to Murzuk in Fezzan, from which place they are distributed to the northern and eastern Mediterranean coasts. Their sufferings on the route are dreadful; many succumb and are abandoned. Rohlfs informs us that "any one who did not know the way" by which the caravans pass "would only have to follow the bones which lie right and left of the track." Negroes are also brought to Morocco from the Western Soudan and from Timbuktu. The centre of the traffic in Morocco is Sidi Hamed ibn Musa, seven days' journey south of Mogador, where a great yearly fair is held. The slaves are forwarded thence in gangs to different towns, especially to Morocco city, Fez, and Mequinez. About 4000 are thus annually imported, and an *ad valorem* duty is levied by the sultan, which produces about £4800 of annual revenue. The total number of negro slaves in Morocco appears to be about 50,000. (2) The basin of the Nile, extending to the great lakes, is another region infested by the slave trade; the slaves are either smuggled into Egypt or sent by the Red Sea to Turkey. The khedive Ismail in 1869 appointed Sir Samuel Baker to the command of a large force with which he was "to strike a direct blow at the slave trade in its distant nest." The instructions in the firman issued to him were as follows: "To subdue to our authority the countries situated to the south of Gondokoro, to suppress the slave trade, to introduce a system of regular commerce, to open to navigation the great lakes of the equator, and to establish a chain of military stations and commercial depôts throughout Central Africa." The work energetically commenced by him was continued by Colonel C. G. Gordon (1874 to 1879), but since the revolt of the Soudan, it is to be feared, no trace of his or of Baker's work remains in the scene of their labors. The most effectual direct methods of dealing with the slave trade in the present territories of Egypt seem to be those suggested by the Anti-Slavery Society to Mr. Gladstone's Government in 1881—extended consular supervision, and a compulsory registration of all existing slaves. (3) There has long been a slave trade from the Portuguese possessions on the East African coast. The stream of supply came mainly from the southern Nyassa districts by three or four routes to Ibo, Mozambique, Angoche, and Kilimane. Madagascar and the Comoro Islands obtained most of their slaves from the Mozambique coast. It was believed in 1862 that about 19,000 passed every year from the Nyassa regions to Zanzibar, whence large supplies were drawn for the markets of Arabia and Persia up to 1873. The mission of Sir Bartle Frere to the sultan of Zanzibar in 1873 brought about a treaty for the suppression of the slave trade, but it is to be feared that the cessation of the traffic from that port has not extinguished the traffic, but has in part only given it a different direction, through Somâli markets. In Madagascar, which has been supplied from the Mozambique coast, the import and sale of slaves were prohibited within the Hova dominions by Queen Ranavalona II. in June 1877. The rulers of the Comoro Islands, Mohilla and Anjuan (or Johanna), have signed treaties for the abolition of the status of slavery in their dominions after 1890, the fulfilment of which, however, it will probably be difficult to enforce. The stations established by the English universities in the valley of the Rovuma and by the Established and Free Churches of Scotland on Lake Nyassa doubtless contributed much to the diminution of the traffic in those parts. It is said that, whereas no less than 10,000 slaves formerly passed the southern end of the Nyassa every year, in 1876 not more than 38 were known to have been conveyed by that route. Lieutenant O'Neill, British consul at Mozambique, writing in 1880, fixed at about 3000 the number then annually exported from the coast between the rivers Rovuma and Zambesi. But since that date the traffic seems to have received a fresh impetus from an increased demand for ivory, the slave and ivory trades being "hand and glove." The Portuguese appear to be the most determined upholders of the evil system, and in consequence are everywhere detested by the natives.

There are other minor branches of the trade elsewhere in Africa. Thus from Harar in Somâli-land caravans are sent to Berbera on the coast, where there is a great annual fair. The slaves are collected from the inland Galla countries, from Gurâgwe, and from Abyssinia.

Clarkson first, and Buxton afterwards, whilst they urged all other means for the suppression or discouragement of the slave trade and slavery, saw clearly that the only thoroughly effectual method would be the development of legitimate commerce in Africa itself. When Buxton published in 1840 his book entitled *The Slave Trade and its Remedy*, this was the remedy he contemplated. The unfortunate Niger expedition of 1841 was directed to similar ends; and it has been more and more felt by all who were interested in the subject that here lies the radical solution of the great problem. It was for some time thought that from Sierra Leone as a centre industry and civilization might be diffused amongst the nations of the continent; and in 1822 the colony (which in 1847 became the independent republic) of Liberia had been founded by Americans with a similar object; but in neither case have these expectations been fulfilled. A new, and it would seem really hopeful, effort for the same great end has recently been undertaken.

Congo Free State.

Leopold II., king of the Belgians, invited in September, 1876, representative geographers to a conference in his palace, to discuss the question of the exploration and civilization of Africa through the development of commerce and the abolition of the slave trade. Six European nations were represented, and an International African Association was formed. The central committee organized seven successive expeditions from the east coast to Lake Tanganyika. The exploration of the Congo by Stanley turned attention to the west coast, and he went out to the Congo in 1879 as commander-in-chief of the association, to open up that river. The association obtained, by treaties with the native chiefs, the cession of certain territories. The recognition of its flag and its territorial rights by the European powers has transformed the association into the Congo Free State. A conference was held at Berlin on 15th November, 1884, attended by plenipotentiaries from all the European states, to regulate the position of the new state, and one of its declarations was that "these regions shall not be used as markets or routes of transit for the trade in slaves, no matter of what race; each of these powers binds itself to use all the means at its disposal to put an end to this trade and to punish those engaged in it." The territory of the new state was fixed so as to comprise 1,065,200 square miles, with an estimated population of 42,608,000 souls. Stations have been built at points extending for nearly 1500 miles into the centre of Africa.

There are, it cannot be denied, real dangers connected with this great enterprise for the civilization of Africa. Disputes may arise between the powers having interests in the territories of the new state, and, still worse, the natives may be led to take sides in such disputes. That the African population should be sometimes oppressed, or have justice denied them, by European traders or officials is by no means unlikely in the present state of opinion with respect to our duties towards the retarded races. Difficulties, too, may be created by the rivalries and mutual jealousies of the missionaries of the several Western communions. But, whilst foreseeing these possibilities and urging the necessity of guarding, as far as possible, against the evils referred to, we ought not to view in a grudging or suspicious spirit, an enterprise which is begun with pure intentions, and will probably do much to right the wrongs and improve the position of a deeply-injured portion of our race. The establishment of the state will be no reason for the cessation of any effort which Western Governments can make, by the exercise of influence and by remonstrance, to induce Turkey and Egypt to fulfil their engagements respecting the slave trade. The rulers of those states are well disposed to appropriate the results of more advanced civilization; and we need not despair of the disappearance in Mohammedan communities of slave-holding and its ally polygamy, since those practices are not enjoined, but only tolerated, by a religious code which social progress will inevitably lead its adherents to modify by interpretation.

Bibliography.—On the several branches of the subject of slavery and serfdom fuller information may be obtained from the following works, which have been amongst those used in the preparation of the preceding sketch.

On Ancient Slavery: H. Wallon, *Histoire de l'Esclavage dans l'Antiquité*, 3 vols., 1847, 2d ed. 1879; A. Boeckh, *Public Economy of Athens*, Eng. transl. by G. Cornewall Lewis, 1828, 2d ed. 1842; William Blair, *Inquiry into the State of Slavery among the Romans, from the Earliest Period to the Establishment of the Lombards in Italy*, 1833; Dureau de la Malle, *Économie Politique des Romains*, 2 vols., 1840; M. Troplong, *De l'Influence du Christianisme sur le Droit Civil des Romains*, 2d ed. 1855. On Mediæval Slavery and Serfdom: G. Humbert, article "Colonat" in the *Dictionnaire des Antiquités Grecques et Romaines* of Daremberg and Saglio (now in course of publication); J. Yanoski, *De l'Abolition de l'Esclavage Ancien au Moyen Âge et de sa Transformation en Servitude de la Glèbe* (Wallon and Yanoski had jointly composed a memoir to compete for a prize offered by the Academy of Moral and Political Sciences in 1837; Wallon's portion of the memoir became the foundation of his *Histoire de l'Esclavage dans l'Antiquité* above mentioned; Yanoski's part, the expansion of which was prevented by his early death, was posthumously published in 1860; it is no more than a slight sketch); Benjamin Guérard, *Prolegomènes au Polyptyque d'Irminon*, 1844; Fustel de Coulanges[a] *Histoire des Institutions Politiques de l'ancienne France* (only the first part has been published, 2d ed. 1877), and *Recherches sur quelques Problèmes d'Histoire*, 1885 (the latter work contains the best extant discussion of the whole subject of the *colonatus*, founded throughout on the original texts); Stubbs, *Constitutional History of England*, 3 vols., 1874–78. On the Colonial Slave Trade and Slavery: Washington Irving, *Life and Voyages of Christopher Columbus*, 1828, several times reprinted; Arthur Helps, *Life of Las Casas*, 1868; Bryan Edwards, *History, Civil and Commercial, of the British West Indies*, 1793, 5th ed. in 5 vols., 1819; Thomas Clarkson, *History of the Rise, Progress, and Accomplishment of the Abolition of the African Slave Trade by the British Parliament*, 2 vols., 1808; T. Fowell Buxton, *African Slave Trade*, 2d ed. 1838, and *The Remedy, a Sequel*, 1840; *Memoirs of Sir T. F. Buxton*, edited by his son Charles Buxton, 3d ed. 1849. On North American Slavery: G. M. Stroud, *Laws Relating to Slavery in America*, 2d ed. 1856; H. Greeley, *The American Conflict*, 1865; and John E. Cairnes, *The Slave Power; its Character, Career, and Probable Designs*, 1862, 2d ed. 1863. On Brazilian: Fletcher and Kidder, *Brazil and the Brazilians*, 9th ed. 1879. On Russian Serfdom: D. Mackenzie Wallace, *Russia*, 1877. For the existing state of the African slave trade, and of Egyptian and Turkish slavery, the *Ismailia* of Sir S. Baker. the writings of Livingstone, and the biographies of Gordon may be consulted, besides the many documents on these subjects published by the British and Foreign Anti-Slavery Society. There are two volumes by A. Tourmagne, entitled respectively *Histoire de l'Esclavage Ancien et Moderne*, 1880, and *Histoire du Servage Ancien et Moderne*, 1879, which bring together many facts relating to slavery and serfdom; but they are somewhat loose and uncritical; the author, too, repeats himself much, and dwells on many topics scarcely if at all connected with his main themes. The largest and most philosophical views on slavery generally will be found in Hume's *Essay* "On the Populousness of Antient Nations," and in Comte's *Philosophie Positive*. vol. v., and *Politique Positive*, vol. iii. For its economic effects, when it is regarded as an organization of labor, reference may be had to Smith's *Wealth of Nations*, book iii., chap. 2, J. S. Mill's *Political Economy*, book ii. chap. 5, and J. E. Cairnes's *Slave Power*, chap. 2.

(J. K. I.)

SLAVONIA. See CROATIA AND SLAVONIA.

SLAVS.

ACCORDING to the tables published by Boudilovich in connection with the admirable ethnological map of Mirkovich (St. Petersburg, 1875), the Slavs may be grouped geographically as follows:

Geographical distribution.

I. SOUTHEASTERN DIVISION.—1. *Russians.*—(*a*) The Great Russians (*Velikorousskie*), who occupy the governments round Moscow and extend as far north as Novgorod and Vologda, south to Kieff and Voronezh, east to Penza, Simbirsk, and Vyatka, and west to the Baltic provinces and Poland; they number about 40,000,000. (*b*) The Little Russians (*Malorossiane*), who include the Rousines or Rousniaks in Galicia and the Boiki and Gouzouli in Bukovina; they number 16,370,000. Drawing a straight line from Sandec near Cracow to the Asiatic frontier of Russia, we shall find their language the dominant tongue of Galicia and all the southern parts of Russia till we come to the Caucasus. It is also spoken in a strip of territory in the north of Hungary. (*c*) The White Russians, inhabiting the western governments; they number 4,000,000.

2. *Bulgarians*, including those in Russia, Austria, Roumania, Bulgaria, eastern Roumelia, and those under Turkish government in Macedonia; their total number is 5,123,592.

3. *Servo-Croats*, including those of Servia, Montenegro, the southern part of Hungary, and a few in the south of Russia; they are returned as numbering 5,940,539. Here also may be placed the Slovenes, including those in Styria, Carinthia, and Carniola, amounting to 1,287,000.

II. WESTERN DIVISION.—1. *Poles*, divided between Russia, Austria, and Prussia; they number 9,492,162; under this head may be included the Kashoubes near Dantzic, numbering 111,416.

2. *Chekhs*[1] and *Moravians*, 4,815,154 in number, here also may be included the Slovaks, numbering 2,223,820.

3. *Lusatian Wends* or *Sorbs*, Upper and Lower, partly in Saxony and partly in Prussia. The *Upper Wends* number 96,000, the *Lower* 40,000.

Total number of Slavs in both divisions 89,499,683.

Originally the Slavs were spread over a great part of northern Germany, extending as far as Utrecht, which was anciently called Wiltaburg and was a city of the Wilzen. Thus Slavonic was certainly spoken in Pomerania, Mecklenburg, Brandenburg, Saxony, west Bohemia, Lower Austria, the greater part of Upper Austria, north Styria and north Carinthia, a large part of what is now Hungary, and in the localities now occupied by Kiel, Lübeck, Magdeburg, Halle, Leipsic (=Lipsk, the city of lime-trees, Baireuth, Linz, Salzburg, Gratz (= Gradetz, Gorodetz), and Vienna. The names of the old Slavonic tribes originally settled in these parts of Germany are given in Schafarik's *Slawische Alterthümer*, to which work the reader desiring further information must be referred. They are mentioned frequently in such writers as Helmold, Dietmar, Arnold, Wittekind, and others. We hear of a commercial city of importance, which some writers have rather fantastically termed the Slavonic Amsterdam, called Wolin, on an island of the same name, which was known as Winetha to the Germans and as Julin to the Danes. Schafarik even wished to see the Slavonic tribe of the Wilzen in English Wiltshire. This, however, cannot be accepted; the original name is Wilsætas and that of the town Wiltun, the town on the river Wily. It has long been a generally received opinion that the modern Greeks have a large Slavonic admixture. This opinion was boldly asserted some years ago by Fallmerayer and has not been upset even by the labors of M. Sathas. He dwells much upon the form Σθλαβηνοι as distinct from Σκλαβηνοι; but this corruption seems to be owing to some such false analogy as ἐσθλός. Miklosich, in his *Etymologisches Wörterbuch der slavischen Sprachen* (1886); considers the two forms to be identical. In like fashion Procopius connects Serbi with Σπόροι and Constantine Porphyrogenitus turns Svatopluk into Σφενδόπλοκος. Mediæval Greece, especially the Peloponnesus, abounded with Slavonic names, which are now being replaced by others drawn from classical sources. Kollar and Wolanski wished to find a Slavonic population in Italy; but their opinions are considered the wild dreams of unscientific patriots, though these views found their way into such works as the *Varronianus* of Dr. Donaldson. Equally unfounded appears to be the belief that a Slavonic element may be traced in Spain and Asia Minor. If the Slavs have lost in the west of Europe, they have gained in the east considerably, as Russia has encroached upon the Ugro-Finnish tribes of the northern and eastern portions of its empire, and many of these races are now in various stages of Russification.

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[1] This spelling has been adopted as best calculated to show the pronunciation of the name Czech, in the same way as the French write the word *Tchèque*.

[a] [A Strasburg and Sorbonne professor of history (1830–1889), who wrote *La Cité Antique* and *Institutions politiques de la France* on classical and French social antiquities.—AM. ED.]

Original home of Slavs.

As to the original home of the Slavonic race there are three leading opinions: (1) the Slavs settled in Europe at a period contemporaneous with or shortly after the arrival of the Teutonic and other Indo-European families; (2) they first made their appearance in Europe with the Huns, Avars, and other Asiatic barbarians in the 3d century after Christ; (3) they originated in Europe, as did the so-called Indo-European race altogether. This last view has been maintained by Penka[1] and Schrader[2] (see below).

Schafarik's view.

The first of these views has been supported by Schafarik. He considers that the Slavs left Asia in very early times for the following reasons:—(*a*) the fact that the Slavonic languages are more closely connected with European tongues than those of Asia, even granting the many affinities of Slavonic with Zend or (as has been recently shown by Hübschmann) with Armenian; (*b*) the similarity of the manners and customs of the Slavs to those of the Celts, Germans, and other European populations; (*c*) the occurrence of many mountains, rivers, and towns having Slavonic names which are mentioned long before the Slavs themselves are found in history; (*d*) the fact that the Slavs are always spoken of by the earlier writers in terms which show that these writers considered them to be an ancient European nation, and were struck with the large area over which their populations extended. Moreover, the arrival at a comparatively late period of such large hordes would have made a great impression upon the surrounding nations at the time, and this would certainly have found an echo in their historians and chroniclers.

Schafarik believes that the Slavs or Wends (as they were called by their Teutonic neighbors) were settled at a very early period on the southern coast of the Baltic. The word "Wend" he connects with a Slavonic (*voda*) and Lithuanian (*wandů*) root meaning "water"; thus it would signify the people dwelling about the water. He appears to include under the Slavs all people bearing the name Wends, notably the Veneti on the Adriatic. Other writers, however, consider that the word was applied generally to any maritime people; and this view appears probable. The name also occurs in Switzerland. The Wends, then, according to Schafarik, were the earliest inhabitants of the Baltic coast; but they were expelled by the Goths in the 4th century B.C. Nestor makes other tribes of Slavs to have been established at an early period on the Danube and to have been driven thence by the Vlachs, a people whom scholars are inclined to identify with the Latin colonists from whom in a great measure the modern Roumans are descended. We find other tribes settled in the neighborhood of the Carpathians.

Classical accounts.

The first historian who relates anything about the Slavs is probably Herodotus, whose account of the north of Europe is very vague. Among the Scythian tribes mentioned by him two have been identified with the Slavs by Schafarik with considerable probability,—the Budini and the Neuri. Of the former we are told that they were a large nation and had blue eyes and red hair. The description of the country they inhabited corresponds pretty closely to Volhynia and portions of White Russia. The Neuri are placed by Schafarik on the river Bug, which flows through Podolia. There at the present day we find a river named Nureff, and the surrounding country is called Nurska. This opinion is supported by Schrader, who places the original home of the Slavs in Scythia. Pösche[3] goes so far as to consider the eastern part of Europe—especially that portion of Russia which constitutes the basin of the Pripet, the Beresina, and the Dnieper—as the primary abode of the Indo-European race. Dr. Kurd von Schlözer interprets Herod. iv. § 6—the story of Targitaus and his three children—as an allusion to the Slavs. The falling of a plough with its yoke from heaven would hardly be a characteristic tale of a nomad people. We seem to have an echo of the stories of the peasants Mikoula, Selianinovich, Piast, and Přemysl, all dear to Slavonic legend, The view that the ancestors of the Slavs are to be found among the Scythian tribes has been supported in recent times by the Russian author Zabielin.[4] He also thinks that their original settlement was in Volhynia and White Russia. The specimens of the Scythian language which have come down in Herodotus and elsewhere can certainly best be explained by Indo-European roots. The name Slav does not occur in any writer before the time of Jordanes, unless it be in the Σταυανοί of Ptolemy. Jordanes says of them—"quorum nomina licet nunc per varias familias et loca mutentur, principaliter tamen Sclavini et Antes.". It is probably connected with the root *slovo*, "the word," which is related to the Greek κλύω (Slav. *slĭt*, "to be called"); and in a Polabish vocabulary we get the form *sliro*. The Slav thus comes to mean "the intelligibly speaking man" in contrast to "the dumb man," *Niemetz*, which in the modern Slavonic languages has come to mean simply "German." Miklosich (*Etym. Wörterb.*)

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[1] *Origines Ariacæ*, Vienna, 1883.

[2] *Sprachvergleichung und Urgeschichte*, 1885.

[3] *Die Arier, ein Beitrag zur historischen Anthropologie*, Jena, 1878.

[4] See, however, the arguments on the other side in the article SCYTHIA.

thinks that the termination *-ene* in Slovene shows the word to be derived from the name of a place and rejects the explanation from *slovo*. Some Slavonic scholars have sought an explanation of the name in the word *slava*, "glory."

Penka,[1] however, attempts to upset the ordinary etymology. According to him the Slavs are non-Aryan and belong rather to the Ugro-Finnish race. Their name, he tells us, shows that they were subjected by the Aryans and became their dependants. He considers it to be derived from the present participle of the root *klu* ("to hear," Slav. *sli*), and thus identifies it with "client." The name Wend is used by Tacitus, who speaks of the Peucini, the Venedi, and the Fenni. Ptolemy also alludes to the Wendic mountains. He tells us that Sarmatia, *i.e.*, all the territory east of the Vistula and north of Dacia, was inhabited by widely scattered races and that the Wenedæ were established along the whole of the Wendish gulf. Jordanes calls them Winidæ. The other name, Antes, applied by this historian to the Slavs, which, like the word Wend, they never used themselves, Schafarik connects with a Gothic root. Duchinski, Henri Martin, and others have denied to the Russians the right of being called Aryan. Penka,[2] as stated before, carries this opinion much further and refuses the appellation to the whole Slavonic family. Finding that many of the Slavs have chestnut-colored curly hair and dark eyes, that the White Russians are blonde, that the southern Slavs are darker and have a shorter head than those in the north, he is inclined to see in the Slavs a very mixed race, and quotes Procopius[3] in support of his opinion.

Wocel's view.

The second of the opinions alluded to above has been adopted by Wocel,[4] according to whom the Slavs in the north of Germany on the Elbe, Moldau, Sale, Spree, as also those living south of the Danube, were not living in juxtaposition in the Bronze Age, but wandered into those regions some centuries after the birth of Christ. In proof of this assertion he cites many names of objects which are common to the Slavonic languages and yet could not have been known to any people in the Bronze Period,—as, for example, iron (O.S. *želeso*),[5] objects made of iron, as scythe (O.S. *kosa*), chisel (O.S. *dlato*), tongs (O.S. *klěšta*), knife (*nůž*), saw (*pila*), hoe (*motyka*), sword (*meč*), stirrup (*střemen*), spur (*ostruha*), needle (*jehla*), anchor (*kotva*). Common to all the Slavonic languages are the names for gold (*zlato*), silver (*stříbro*), copper (*měd*), tin (*olovo*). All these words must have been formed while the Slavonic people dwelt together in a comparatively narrow space,—according to Wocel between the Baltic, the Vistula, and the Dnieper; otherwise, according to this author, if we suppose that the Lutitzes, Obotrites, Sorbs, and Chekhs were autochthonous, it is difficult to see how they could have had the same names for many objects which did not exist in the Bronze Age, *e.g.*, iron, as the Slavs on the Dnieper, the Balkans, and the Adriatic had. Wocel considers the Slavs to have been a pastoral people who entered Europe through the passes of the Caucasus. He compares the agricultural words which all branches of the family have in common, as *ploug*, "plough" (and also *ralo*); *lemesh*, "ploughshare"; *zhito*, "corn"; *pshenitze*, "wheat"; *yechmen*, "barley"; *oves*, "oats"; *proso*, "millet"; *snop*, "sheaf." On the other hand, as Wocel maintains, objects connected with civilization the knowledge of which only dates from the introduction of Christianity have not a common name in the Slavonic languages, such as "paper," "pavement," "steel," "velvet," etc. So also there is no common term for "property" or "inheritance," for the simple reason that the Slavs knew nothing of private property,—the land being held in common under the care of the *vladika* or *stareshina*, as in the Servian *zadrugas* at the present day.

The condition of the original Slavs has also been investigated from the linguistic point of view by Gregor Kreck.[6] According to this writer, besides the cereals previously mentioned the Slavs cultivated the rape (*repa*), the pea (*sochivo*, *grakh*), the lentil (*leushta*), the bean (*bob*), the poppy (*mak*), hemp (*konop*), the leek (*louk*), etc.; corn ground by hand-mill or water-mill (*zhrinouv*, *malin*) into meal (*manka*) and baked into bread (*khleb*), honey (*med*)—the collection of which was an important occupation among the Slavs, as we find by the Polish laws—meat (*menso*), milk (*mleko*), and fruit (*ovoshtiye*) formed their food. The drinks were *ol* and *vino*,[7] beer and wine. Kreck considers that the minute details of house-building point to a habit of living in fixed residences,—thus the house (*dom*), the stable (*khlev*), the threshing-floor (*goumno*), the court (*dvor*), the village (*ves*). In opposition, however, to this view of Kreck we have the opinion of Hehn, who contends that all the words used among the Slavs for stone buildings are borrowed, and seeks to prove that till comparatively recent times they had only huts made of osiers and led a half nomadic life. Certainly municipal institutions are no feature of Slavonic life, and the paucity of large towns in Russia is striking even at the present day. According to Kreck, words are to be found very early which show the development of the nation from the family. Thus the commune (*obstchina*, *rod*) becomes the family (*plemya*) and the family the people (*narod*, *yenzik*). There are common terms for law (*pravo pravdu*, "right"; *zakon*, "law"). Besides agricultural pursuits we have mention of the arts of braiding (*plesti*), weaving (*tkati*), tailoring in a series of common expressions for portions of apparel, carpentering (*tesati*), working in iron, etc. Of the primitive Slavonic flora we have the oak (*doub*), the lime tree (*lipa*), the acorn (*yavor*), the beech (*bouky*), the willow (*vr'ba*), the birch (*brěza*), the pine (*bor*), as also special kinds of fruit, the apple (*yabl'ko*), the pear (*grousha*), the cherry (*vishnya*), the nut (*orekh*), and the plum (*sliva*).

Other views.

Pictet placed the original home of the German and Litu-Slavic races on the northern bank of the Oxus. Thence he thought they came over the extensive plains of Scythia to the Pontus Euxinus.

The doctrine of the European origin of the Aryans appears to be steadily gaining ground. It is supported by Professors Rhys and Sayce of Oxford. The last-named is inclined to see the home of the Indo-European race in "the district in the neighborhood of the Baltic." Dr. Ludwig Wilser[8] makes Sweden and the north German shores the centre of the primitive Aryans, from which the Germanic tribes, Celts, Latins, Greeks, Slavs, Lithuanians, Iranians, and the invaders of India gradually detached themselves, migrating mostly southwards and eastwards.[9]

Leaving now the attempts to determine the primitive home of the Slavs and the date of their immigration into Europe, and also the names which they have in common, whether used by themselves or given by foreigners, we will trace as far as possible the derivation of the chief appellations of the Slavonic peoples. (1) *Russians.*—For an analysis of this name see RUSSIA

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[1] *Op. cit.*, p. 126.

[2] *Op. cit.*, p. 125.

[3] *Bell. Goth.*, iii. 14—"τὰ δε σώματα καὶ τὰς κόμας οὔτε λευκοὶ ἐς ἄγαν ἢ ξανθοί εἰσιν, οὔτε πη ἐς τὸ μέλαν αὐτοῖς παντελῶς τέτραπται, ἀλλ' ὑπέρυθροί εἰσιν ἅπαντες."

[4] *Pravěk Země České* (The Early Days of Bohemia), Prague, 1868. It is cited by Schrader, p. 90.

[5] The words not specified as Old Slavonic are Bohemian.

[6] *Einleitung in die slavische Litteratur-Geschichte*, Gratz, 1874; see Schrader, p. 92.

[7] A word which some recent scholars are inclined to think of Armenian origin.

[8] *Die Herkunft der Deutschen: Neue Forschungen über Urgeschichte, Abstammung, und Verwandtschaftsverhältnisse unseres Volkes*, Carlsruhe, 1885.

[9] See an interesting article in the American *Nation* (3d December, 1885), where it is shown that the first person to advocate this theory, which seems to be gaining ground among scholars, was Dr. Latham, in his edition of the *Germania* of Tacitus. This view was supported by Theodor Benfey in 1868.

Names of the Slavonic peoples.

(vol. xxi. p. 86 *sq.*). (2) *Bulgarians.*—By the 3d century we find Slavs settled between the Danube and the Balkans. Immigrations were going on till the middle of the 7th century, as these hordes were driven southwards by new invaders. About 681 the Slavonic settlers fell under the yoke of the Bulgarians, a Ugro-Finnish race, if we accept the views of Schafarik, Drinoff, and others. The origin of the Bulgarians themselves is obscure. Some have made them Tatars. Professor Ilovaiski believes them to have been Slavs. The theory which connects the name "Bulgarian," "Bolgare," with the Volga is now no longer held. Early modifications of the name, such as Burgari, Wurgari, etc., show its analogy with forms like Onoguri, Uturguri, Kutriguri. The elements of the word are *bul* and *gari*. Professor Vambéry attempts to derive the name from the Turkish verb *bulga-mak*, "to revolt"; but this seems little better than a guess. We are told that Koubrat, a Bulgarian prince, made himself independent of the Avars, and that on his death his territories were divided among his five sons. The eldest remained in the ancient settlement on the Volga, where the ruins of their former capital, Bolgari, are still to be seen. The third son, Asparoukh, crossed the Dnieper and the Dniester, and settled in a place called Onklus, probably the Old Slavonic *ongl*, "angulus," between the Transylvanian Alps and the Danube.[1] From this place they migrated to the localities which they have since occupied, where they became mixed with the original settlers, to whom they gave their name, just as the German Franks imposed theirs on the Gauls, and a branch of the Slavonians took the Finnish name of their conquerors. (3) *Serbs.*—See SERVIA (vol. xxi. p. 720). The name "Croat" has been already explained under SERVIA (*l. c.*). (4) The *Slovenes* have preserved an old form of the family name, and therefore no explanation is necessary. (5) *Poles.*—The first authentic date of their history is the year 963. Perhaps they are the Bulanes of Ptolemy. See POLAND, vol. xix. p. 321. (6) *Bohemians* or *Chekhs.*—The word "Bohemia"—"home of the Boii," a Celtic tribe—has nothing to do with the Slavs who came into the country about 495, after the Marcomanni, who had dispossessed the Boii. The derivation of the name "Chekh" or Czech has never been satisfactorily traced. Dobrovsky sought to connect it with a word *četi*, signifying "to begin," and thus makes the name imply the original inhabitants. Schafarik, however, does not indorse this etymology. Perwolf[2] connects it with a root *čak*, "to beat," and thus makes the name mean "the warriors." Whatever the word "Chekh" may signify, it occurs, as Schafarik has shown, in other Slavonic countries. (7) *Lusatian Wends* or *Sorbs.*—The word "Lusatia" (German *Lausitz*) is derived from the Slavonic *lug* or *luza*, signifying a low, marshy country.

SLAVONIC LANGUAGES AND LITERATURES.

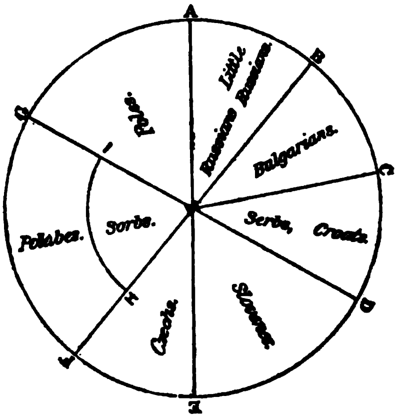
Classification and characteristics of languages.

The first to attempt a classification of the Slavonic languages was Dobrovsky,[3] who was followed by Schafarik and Schleicher. These agree in the main, except that Schafarik was so little acquainted with Bulgarian—at that time almost a lost language—that he grouped it with Servian.[4] The following are the characteristics of the two divisions, which we take from Schafarik's account with some trifling omissions:

	SOUTHEASTERN.	WESTERN.
(1)	*raz, razoum.*	*roz, rozum.*
(2)	*iz, izdati.*	*wy, wydati.*
(3)	*korabl, zemlia.*	*korab, zemia.*
(4)	*pravilo, molitisa.*	*prawidlo, modliti se.*
(5)	*moč, noč.*	*moc, noc.*
(6)	*zviezda, tzvet.*	*hwiezda, gwiazda, kwiet.*
(7)	*ago.*	*ego, eho.*
(8)	*omou, toj.*	*emu, ten.*

This division, however, has been repeatedly challenged. Schleicher insisted upon the two following as important principles: (1) primitive Slavonic *dj*, *tj* become in all west Slavonic dialects *dz*, *ts* (= *c*); among the Chekhs and Sorbs *dz* becomes at a later period *z*; (2) *d*, *t* before *l*, *n* are preserved in the western dialects, but disappear in the southeastern. Upon this last canon Johannes Schmidt[5] remarks as follows: "The dentals are preserved in Slovenish, certainly in the western part of its area; thus *modlim* in the Freisingian documents, in the perfect participles, as *predel, bodel, pletel, cretel*, fem. *dla, tla*, and in the suffix *dlo*, as *kresadlo, motovidlo, židlo*. *D* is also preserved in Slovenish before *n*, as *omladnem, osladnem, zbodnem, padnem, kradnem*. *T*, on the other hand, appears everywhere to vanish before *n*, as *obernem*, 'I go round.'" He also criticises two of the principles of difference given by Schafarik. The nom. sing. masc. of pronouns appears in western Slavonic to be increased by *n*, thus Chekh, Polish, Lower Sorb, *ten*; Upper Sorbish, *ton*; Polabish, *to*; this, however, occurs in the Freisingian monuments, the earliest form of Slovenish, as *ton*. This *n* belongs to the stem, and is not a particle which has become fused with it; *ten, ton*, original form *t'n*, correspond to the Old Prussian *tans*. The use of the preposition *vi* instead of *iz* is not a criterion; *vi* is as much used in Russian as in west Slavonic, thus *viborni*, "the village deputy"; there are traces of it in Slovenish; it is only in Bulgarian and Servian that it is entirely wanting. The principle laid down that *moč, noč* represent a southeastern variation and *moc, noc* a western is far from being universally true; in Servian we have *tsrn*, "black," as against Bohemian *černy*, Russian *chërni*. Compare too Servian *tsesta*, "a road," also Slovenish, with Chekh *česta*.

Schmidt gives a completely new table of differences, illustrating them by the accompanying diagram. Casting aside some of the distinguishing marks previously adopted, he makes great use of the phonetic law found in the Slavonic languages which will be explained shortly. The reader will easily identify the divisions of the circle to which the rules refer. (1) *dj*, *tj* become among the western Slavs *dz*, *ts* (= *c*). (2) *d*, *t* disappear before *l* and *n* among the Russians, Little Russians, Bulgarians, Serbs, and Croats, but are preserved by the Slovenes, with the exception of *tn*, and by the western Slavs. (3) *vi* is not used by the Bulgarians, Serbs, and Croats, but is kept by the Slovenes, Russians, and western Slavs. (4) (*a*) *ere* by *svarabhakti*[6] became *rě* at an early period among the southern Slavs and Chekhs, but is preserved in its original form among the rest. It became *re* at a later period among the Poles, Polabes, and Sorbs. (*b*) *ele* became *le* not only among the southern Slavs and Chekhs but also among the Polabes. Among the Poles and Sorbs *ele*



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[1] See Drinoff's "Settlement of the Balkan Peninsula by the Slavs" (*Zaselenie Balkanskago Poluostrova Slavyanami*), Moscow, 1873.

[2] *Arch. f. slaw. Phil.*, vii. 622.

[3] *Institutiones Linguæ Slavicæ Veteris Dialecti*, Vienna, 1822.

[4] *Geschichte der slawischen Sprache und Literatur nach allen Mundarten*, Pesth, 1826, p. 32.

[5] *Zur Geschichte des Indo-Germanischen Vocalismus*, part ii. p. 178, Vienna, 1871-75.

[6] This is the name given by the Indian grammarians to the vowel developed between the liquids *l* and *r* and the consonant with which they come into contact, as *vlas, volos*. It has been called in Russian *polnoglasie*, and in Greek ἀνάπτυξις. It means in Sanskrit "voice-breaking." It is a marked feature in the Slavonic languages.

and the cognate *olo* became simplified into *le* and *lo*. (*c*) *ărd*[1] in *inlaut* became *ra* among the southern Slavs and Chekhs. As in early times the Chekhs and southern Slavs were in close connection with the Poles and Sorbs, the mutation developed among them; thus Polish *straż* with *stroż*, Upper Sorbish *straža* with *stroža*, Polish and Upper Sorbish, *trapić*. (*d*) *ăld* in *inlaut* became *la* not only among the southern Slavs and Chekhs but also among the Polabes. This contraction spread over a wider region than that of *ărd* into *ra*. That the Polish also adopted it is shown by the form *płasić się* compared with *płosić się*.

Litu-Slavic languages.

Various opinions have been held as to what languages are to be considered the closest congeners of the Slavonic branch. That they stand in intimate relations to Lithuanian and Lettish has long been agreed; and as a convenient classification it is customary to speak of them together as the Litu-Slavic family. In Russia there are 1,900,000 Lithuanians (including the Samogitians or Zhmudes). There are also 1,100,000 Letts. The rest of the Lithuanians, numbering 146,312, are in Eastern Prussia, commencing not far from Königsberg and extending along the shores of the Kurisches Haff. The Lithuanian language in many respects exhibits an earlier type than the Slavonic. It has preserved the *s* of the nominative singular, as in Sanskrit; but, on the other hand, the verb exhibits a much poorer form. As Leskien truly remarks,[2] "it has degenerated most remarkably in its conjugation, and in this respect is far inferior to the oldest known Slavonic." He adds that Lithuanian is of primary importance in the comparative treatment of the Slavonic languages. Very closely connected with Lithuanian was Old Prussian, which died out in the 16th century; the remains which have come down to us belong to the 15th and 16th centuries. Old Prussian extended from the lower Vistula (from Thorn downwards) to the Niemen. The exact course of the boundary-line which separated it from Lithuanian can only be approximately determined by historical arguments. Leskien has proposed "Baltic" as a generic name for Lithuanian, Lettish, and Prussian. The general opinion of philologists is that Litu-Slavic is most closely connected with the Germanic branch of the Indo-European family. Jacob Grimm was the first to assert this. Hübschmann has shown that Slavonic has affinities with Armenian, and he seeks to make the latter language a link between the European and Asiatic branches of this family. Kuhn[3] writes, "The Slavonic languages remained a longer time in close connection with the Indian, or more probably with the Zend and Persian than with the remaining Indo-European languages." Bopp regards the separation of the Litu-Slavic languages as having taken place before the division of the Asiatic branch of the family into Indian and Iranian.

Old Slavonic.

If we examine the Old or Palæo-Slavonic,[4] the oldest known form of the Slavonic languages, we may note the following characteristics.[5] It has the vowels *a*, *e*, *i*, *o*, *u*, *ĭ*, a guttural *i*, a short *e* sometimes pronounced as *ya*, and the semi-mutes *ĭ* and *ŭ*. It has also two nasals equivalent to the French *in* and *on*, now only found in Polish and Kashoubish, and in some of the Bulgarian dialects; traces of them, however, occur in Slovenish and in the words which Magyar has borrowed from Slovenish.

General characteristics of Slavonic tongues.

The Aryan diphthongs have been contracted to single vowels and the hiatus is frequently avoided by the interposition of *j* (= Eng. *y*) or *v*, both of which constantly occur at the beginning of words which formerly commenced with a vowel. The addition of a *y* sound before vowels is one of the great characteristics of the Slavonic languages, called "præiotization"; and the inability to mark this distinctly is one of the deficiencies of the Cyrillic alphabet. It is also worthy of note that in the provincial dialects *v* is frequently put before vowels, as by the lower classes in Bohemia and Russia. The Aryan aspirates *gh*, *dh*, *bh* have been changed into the simple explosives *g*, *d*, *b*; on the other hand, a number of fricatives have been developed, as *sh*, *z*, and the French *j*—all unknown to the common Aryan—and *k* is frequently changed to the palatal *ch*. Servo-Croatian, Slovenish, Slovakish, and Bohemian possess the vocal *r*, while the vocal *l* is found in both Bohemian and Slovakish. The latter has also *l* and *r*, both short and long.

As regards grammar, the following peculiarities of the Slavonic family may be noted. A trace of the article exists in the adjectival termination, as in *velik-i*; but this has been forgotten, and attempts have been made to supply it in the use of the demonstrative pronoun in Sorbish, which appears to have been used in the more corrupt stages of Slovenish also, but has been expelled since the regeneration of the language. Primus Truber, who translated the New Testament into Slovenish in the 16th century, was not free from this vice. The languages being in a high state of synthesis, the nouns and adjectives are fully declined, having three genders and seven cases,—the nominative, genitive, dative, accusative, vocative, instrumental, and prepositional. Sorbish and Slovenish have the dual number in both nouns and verbs. More of the numerals are declined than in most Aryan languages. The verbs have the so-called aspects, *e.g.*, the iterative, perfect, imperfect, etc., whereby very delicate shades of meaning are expressed, and this partly atones for the poverty of tenses in some of them: Russian, for example, has only one past tense, which is inflected according to gender, having been originally a past participle. Traces of these verbal aspects have been detected in Celtic and in Greek.

We now proceed to classify the Slavonic languages according to their dialects. The following table has been adapted (in the main) from the valuable Russian *History of Slavonic Literatures* by Pîpin and Spasovich.

SOUTHEASTERN BRANCH.—*Russian.*—(1) Great Russian: Moscow, Novgorod and northern, Siberian, and central Russian. (2) Little Russian: eastern, western (sometimes called Red Russian), and Carpathian. (3) White Russian. *Bulgarian.*—(1) Old Bulgarian (the ecclesiastical language; see below). (2) Modern Bulgarian: Upper Mœsian, Lower Mœsian, and Macedonian. *Servo-Croatian* and *Slovenish.*—(1) Servo-Croatian: southern or Herzegovinian, Syrmian, Resanian, and language of the coast or Dalmatian. (2) Slovenish: dialects of Upper, Middle, and Lower Carniola, Styrian, Ugro-Slovenish, Resanian, and Croato-Slovenish.

WESTERN BRANCH.—(1) Polish: Masovian or Mazurian, Great Polish, Silesian, and Kashoubish. (2) Bohemian: Chekish, Moravian, and Slovakish. (3) Lusatian Wendish or Sorbish: Upper Lusatian and Lower Lusatian. (4) Polabish (extinct).

Southeastern Branch.

Russian.

Russian Dialects.—These as yet have rarely been scientifically treated; but that can hardly be a ground of complaint against the Russian people, as our own are only just beginning to be properly studied. The work entitled *Opït Oblastnago Velikorousskago Slovara* (Attempt at a Provincial Dictionary of the Great Russian Language), published at St. Petersburg in 1852, can, as its name implies, only be regarded as tentative: it is no more a scientific production than is Halliwell's *Provincial Dictionary of English.* Traces of Ugro-Finnish words and idioms occur in the northern and eastern dialects, but their importance has been much exaggerated. Whitney's theory that the Russian verb has been modified by Ugro-Finnish influence claims attention. Some have supposed that the origin of the *svarabhakti* is to be traced to it; it occurs, however, in Little Russian and the western languages, as previously shown. It is much more frequent in Russian than in any other Slavonic language, and is even more developed in its dialects.[6] An account of Russian literature is given under RUSSIA, vol. xxi. p. 111 *sq.* Siberian Russian is spoken by the descendants of prisoners and convicts who have settled in that vast tract of northern Asia since Yermak conquered it for Ivan the Terrible. Specimens of it are occasionally quoted in the letters of Küchelbecker, the Decabrist, and other exiles. Little Russian is spoken in all the southern governments of Russia. As current in Galicia and Bukovina it is called Red Russian; an interesting variety is the Gouzoulian dialect in which Fedkovich composed his poems (see RUSSIA, vol. xxi. p. 118). Mention has already been made of the same language as spoken in Hungary.[7] There is a good grammar by Osadtza, a pupil of Miklosich. The latter justly regards it as a language and not a dialect. Till quite recently there were very poor aids by way of lexicons: of the *Deutsch-Ruthenisches Handwörterbuch* by Professor Partitzki of Lemberg the Ruthenish-German portion never appeared; the vocabularies of Piskunoff and Verkhratzki are but fragmentary. A good dictionary, however, is now in course of publication by Professor Żelechowski of Stanislau, which promises to be all that could be desired. The orthography of Malo or Little Russian is not yet settled. A peculiar type is used for some of the books issued at Lemberg, especially the excellent *Chitanka* (Reading Book) of Alexander Barvinski. An altogether whimsical orthography was adopted by Hatzouk in his *Oushinok Ridnogo Pola* (Gleanings from a Native Field), which appeared at Moscow in 1857.

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[1] This is the way adopted by Schmidt to express the unaccented Slavonic *o*, which is pronounced *a*; the form is taken from Swedish.

[2] *Proc. Phil. Soc.*, 1877, p. 49.

[3] *Zur ältesten Gesch. d. indog. Völker*, Berlin, 1845, p. 324.

[4] Sometimes called "the church language."

[5] See Hovelacque, *Science of Language*, p. 280, London, 1877.

[6] The quaint little English-Russian vocabulary compiled by Richard James in Russia at the beginning of the 16th century, and still preserved in manuscript in the Bodleian, gives some interesting examples; thus for modern Russian *sram*, "shame," he gives *sorom*, etc.

[7] An excellent map of this district is given in the *Slavianski Sbornik* (Slavonic Miscellany), vol. ii.

The following are some of the chief characteristics which mark off the Little from the Great Russian language. The G. R. *ie* passes into *i*, as *povist* = *poviest*, L. R. *richka* = G. R. *riechka; o* undergoes the same mutation, especially in monosyllables, L. R. *pid* = G. R. *pod*, L. R. *kin* = G. R. *kon*, L. R. *vivsa* = G. R. *ovsa*, where we may note the tendency to put *v* before the initial vowel already alluded to. The Russian *ou* is changed into L. R. *v*, and *vice versa*, thus *vmirayou* = G. R. *oumirayou; ouchora*, on the other hand, is G. R. *vchera*. The Russian *g* is pronounced *h;* the strong *ł* (Polish *l*) is changed (especially at the end of a word or before other consonants) into *v* or *ou*, thus G. R. *pisal*, L. R. *pisaou*. The Russian *ɨ* is wanting, and L. R. changes the Old Slavonic *k* and *g* into *ch* and French *j* oftener than Russia does. In the conjugations and declensions Little very much resembles Great Russian. It has, however, like Polish, lost the present participle passive, which is retained in Russian, and it possesses infinitive forms with diminutive meanings. Moreover, the accent differs considerably from Russian. The peculiarities of the Little Russian spoken in the north of Hungary are fully treated by De Vollant in his *Ougro-Rousskia Narodnía Piesni* (Ugro-Russian Popular Songs), St. Petersburg, 1885.

White Russian abounds with Polonisms, and in its orthography expresses the unaccented Russian *o* as *a*, which is in accordance with the pronunciation; thus we have *starana* for *storona*, *kago* for *kogo*. As in Malo-Russian, *g* is pronounced *h* as *aharod*, "a garden"; gutturals are softened before *ie*, as *na routsie*, "on the hand." The collection of poems published at Vilna in 1844, entitled *Piosnki Wieśniacze* (Rustic Songs), in what is called the Krevichian dialect, is in reality White Russian. There is a good White Russian dictionary by Nosovich.

Bulgarian.

Bulgarian.—Connected with the Bulgarian division is the difficult question as to which of the Slavonic languages, ancient or modern, exhibits the earliest form. The original tongue is, of course, lost, and only an elder sister remains, but to which language shall that title be assigned? In the early days of Slavonic philology many curious ideas prevailed on this point. According to the old-fashioned views the church language was the old and stately mother-tongue from which all the living dialects had sprung. Russians considered it to be Old Russian, Serbs Old Servian, and those who used the Glagolitic ritual held it to be Old Croatian. These opinions were very natural. The fragments of the Old Slovenish language had not yet been found at Freising, and the only accessible manuscripts in the infantine state of the study of Slavistic were recent ones, in which Russian, Servian, and Croatian forms were mixed. The Russians had forgotten many of their historical traditions during their long servitude under the Mongols, and the same was the case with the Serbs and Bulgarians under the yoke of the Turks. The names of Cyril and Methodius were hardly remembered. The two precursors of Dobrovsky, but of inferior intellectual calibre, were the Bohemian Fort. Durich (1738–1802), who was the first to have sound views on the relations of Old Slavonic to the later languages, and the Russian Kalaidovich (1792–1832), who threw considerable light on the question by his edition of the works of John, the exarch of Bulgaria. He, however, considered the Palæo-Slavonic to be Old Moravian. But the foundation of Slavonic scholarship was laid by Dobrovsky (1753–1829) and Vostokoff (1781–1864); the former treated the subject scientifically in his *Institutiones Linguæ Slavicæ Dialecti Veteris* (Vienna, 1822), and the latter edited the *Ostromir Codex*, a Palæo-Slavonic manuscript of the Gospels, written in Russia in the 11th century. Dobrovsky at first considered Palæo-Slavonic to be Old Servian, afterwards an early language out of which both Servian and Bulgarian were formed. Vostokoff was nearer the truth when he discovered elements of Old Slovenish.

Mother-tongue of Slavonic languages.

The views held by scholars with regard to the country from which the Palæo-Slavonic, as preserved to us, has come may be briefly stated as follows. (1) It is Old Bulgarian. This opinion has been held by Schleicher, Schafarik, J. Schmidt, and Leskien. In the latter part of his life Schafarik[1] appears to have somewhat modified his views and to have looked upon it as a mixture of Bulgarian and Slovenish. (2) It is Old Slovenish, *i.e.*, the older form of the language now spoken in Styria, Carinthia, and a part of southern Hungary. This opinion was first held by Kopitar and afterwards by his pupil Miklosich. Among its supporters may also be mentioned Danichich and Jagić. (3) Geitler,[2] now a professor at Agram, leans to the theory that the Russian language is a much earlier form of Slavonic than old Slovenish. The case for Old Slovenish is clearly put by Miklosich[3] as follows:

> "So far as the linguistic grounds of the Bulgarian hypothesis are concerned, it is undoubtedly true that Old Slovenish [Palæo-Slavonic agrees with a dialect of Bulgarian with regard to the combinations *št*, *žd*, whereas the Carinthian (Carantanian) Slovenish employs generally *č* and *j;* but how do we know that the Pannonian Slovenes pronounced *č* and not *žd*, *j* and not *žd*? The Hungarian *mostoha* (pr. *moshtoha*), *pest*, (pr. *pesht*), and *palast* (*palasht*) for the Old Slovenish *mašteha*, *pešt*, and *plašt*, and *rozsda* (pr. *rozhda*) for the Old Slovenish *ržda*, postulate the existence of *št* and *žd* in the dialect of the Pannonian Slovenes. The nazalized syllables (to express the Old Slavonic nasals) in (modern) Slovenish and in the oldest loan words in Magyar from Slavonic separate the language from which these words are borrowed from Bulgarian.[4] Let us also consider the following fact: Modern Bulgarian is more unlike Palæo-Slavonic than any other language of the eastern branch. Perhaps it may be observed with reference to this that these corruptions have only crept in during the last centuries. But the language of the *Tale of the Trojan War* (of date 1350) is already Bulgarian, and, whatever may be said to the contrary, Modern Bulgarian. In the same stage of vocalic corruption is the Gospel of Trnov (Tirnova), which belongs to the year 1273. And does not the same remark hold good of the Psalter of Bologna, of the date 1186–1196? A Bulgarian language identical with Palæo-Slavonic fades from our eyes like a *fata morgana* however far we follow it."

The same author considers that even before the 9th century the Slavonic languages were separated as they are to-day. The most able exponent of the Old Bulgarian theory, Schleicher, writes as follows:

> "The proofs which Kopitar and Miklosich have brought forward in support of their opinion appear capable of being overthrown, while facts speak irresistibly for the opposite opinion that church Slavonic was the language of the Old Bulgarians, especially the softening of original Aryan *t* and *d* into *sht* and *zhd*. And besides linguistic there are also historical grounds. Cyril and his Slavonic fellow-workers were Bulgarians.[5] Why, then, should they not have written in their own language, especially since they found no written language among the other Slavs?"

Schleicher asks, "How came the Bulgarisms in the *Codex Suprasliensis* [see below], which, according to the opinion of Miklosich, was written 'in ipsa linguæ palæoslovenicæ patria'?" He sums up: "We, therefore, hold the language which we regard in this work[6] as alone the oldest to be Old Bulgarian." Schleicher appears to the present writer to have the best of the argument.

Modern Bulgarian.

Modern Bulgaria embraces ancient Mœsia, Thrace, and Macedonia; the Danube separates it from Roumania; on the west it has Servian, on the south-west Albanian, and on the south Greek, which begins to prevail from a line drawn from Salonica to Constantinople. Its area is dotted by Turkish colonies—the Turks, however, are now fast emigrating—and there is a considerable admixture of Greeks. Modern Bulgarian is a very corrupt form of Slavonic. The vocabulary, to begin with, is full of Turkish words. The wonder is that the language did not altogether disappear. It uses the Slavonic demonstrative pronoun as an article, which is placed at the end of words, as in Rouman, Albanian, and the Scandinavian languages. The cases are very defective, and are mostly expressed by prepositions. There is no regular form of the infinitive, for which a periphrasis is used. The language has only been resuscitated of late years. An American missionary named Riggs published a sketch of the grammar and a short vocabulary. In 1852 the brothers Tzankoff compiled a grammar in which Latin letters were employed. There are other grammars in Bulgarian by Momchiloff and Grouyeff. A dictionary (Bulgarian-French) has since been published by Bogoroff, and there are indications that the language will be scientifically treated, to judge by some excellent papers in the *Archiv für slawische Philologie*. From these we learn that in the Bulgarian dialects the nouns are much more fully inflected, and traces of nasals are found. The Upper Mœsian dialect is also called the *Shopsko narechie* or dialect of the Schopi. Jireček says that these Schopi differ very much in language, dress, and habits from the other Bulgarians, who regard them as simple folk. Their name he connects with the old Thracian tribe of the Sapæi. Those Bulgarians who have embraced Islam are called Pomaks,—a word of which no satisfactory derivation has been given.

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[1] *Ueber den Ursprung und die Heimath des Glagolitismus*, Prague, 1858

[2] See his *Starobulharska Fonologie se stálym zřetelem k Jazyku Litevskemu* (Old Bulgarian Phonology in Relation to Lithuanian), Prague, 1873.

[3] *Altslovenische Formenlehre in Paradigmen*, Vienna, 1874.

[4] But, as previously stated, nasals have been found in Bulgarian dialects.

[5] This is rather strongly stated. They are said to have been of Greek origin, but had probably become thoroughly Bulgarized; yet the argument used by Schleicher remains quite as strong, for they would use the form of Slavonic with which they were familiar.

[6] *Die Formenlere der Kirchen-Slawischen Sprache*, Bonn, 1852.

Bulgarian literature.

As for the sake of convenience we group Palæo-Slavonic under Old Bulgarian, we shall divide Bulgarian itself into Old and New. (1) *Old Bulgarian.*—We have space here only to mention some of the more remarkable codices. (*a*) *Codex Assemani* in the Vatican, edited by Rački, perhaps belonging to the 11th century, contains extracts from the Gospels for each day of the year. (*b*) *Codex Clozianus*, so called because it once belonged to Count Cloz of Trent, contains homilies by Chrysostom, Athanasius, and Epiphanius, supposed to be of the 11th century. (*c*) *Codex Marianus*, found by Grigorovich in a monastery on Mount Athos, edited by Jagić, of the 11th century. (*d*) *Codex Zographensis*, also edited by Jagić, assigned to the 12th century. These are the chief Glagolitic[1] manuscripts. One of the oldest Cyrillic[2] manuscripts is (*a*) the *Ostromir Codex* (see RUSSIA, vol. xxi. p. 111). It is of the 11th century and was written by the *diak* or deacon Gregory for Ostromir, the *posadnik* or governor of Novgorod. Other Cyrillic documents are (*b*) certain legends and homilies which originally belonged to the monks of the abbey of Suprasl near Bialystok in Poland. They have been edited by Miklosich. The half Cyrillic and half Glagolitic manuscript called the *Texte du Sacre* must not be forgotten, because on it the French kings were accustomed to take the oath at their coronation at Rheims; part of it is of the 14th century. There are also many translations from the Byzantine writers in Old Bulgarian, as from John Malalas, George Hamartolus, and others. (2) *Modern Bulgarian.*—The Bulgarians have some fine collections of popular songs. We can only allude here to the most celebrated. (*a*) The edition of the brothers Miladinoff published at Agram in 1861,—a very interesting collection, with notes on Bulgarian proverbs and customs; these unfortunate men were murdered in a Turkish prison. (*b*) The popular songs of the Macedonian Bulgarians collected by Verkovich; of this only one volume appeared, now very scarce. Verkovich has since published a work entitled *Veda Slovena*, in which he professes to have discovered Old Bulgarian ballads relating to Orpheus; but the production is regarded by most critics as an imposture. (*c*) The collection published in 1875 by Auguste Dozon, containing many interesting ballads. (*d*) The Bulgarian Popular Miscellany (*Bulgarski Narodni Slovnik*) of Basil Cholakoff, published in 1873. The rise of Modern Bulgarian literature is altogether recent. The father of it was the monk Paisi, who lived towards the end of the 18th century. He wrote a book on the history of Bulgaria in Bulgarian, which may be compared to the similar one of Raich in Servian. One of his pupils was Sophronius, bishop of Vracha (Vratza), who wrote his own life and adventures (1804). A translation of the New Testament was published by Sapernoff in 1821. George Venelin (1802–1834), a Little Russian from the neighborhood of the Carpathians, travelled in Bulgaria in search of manuscripts and had some remarkable adventures there, which are related in the account of him by Bezsonoff; he may be said to have revealed the existence of Bulgaria to the west. Among other writers may be mentioned Rakovski, the author of some eccentric works, but a true patriot, and Slaveikoff. Vazoff is a living poet of some reputation. The Bulgarian Literary Society has now been removed from Braila to Sofia, where it issues its journal (*Periodichesko Spisanie*).

Servian.

Servo-Croatian and Slovenish.—Of these languages the southern or Herzegovinian dialect has become the literary language of Servia. It is sometimes called the "shtokavstchina" from its use of the word *shto* for the interrogative "what." The language of the coast or Dalmatian littoral is called "chakavstchina" from the use of *cha* in the same way, and Slovenish "kajkavstchina" from the use of *kaj*. There is practically no difference between the Servian and Croatian dialects, but a quasi-difference has been created between them, much more apparent than real, by the employment of the Latin alphabet by the Croats and of the Cyrillic by the Serbs. The reasons for this divergence being theological, it is probable that it will not soon be put an end to. The Servian language is the softest of all the Slavonic tongues and elides many of the consonants. It is rich in tense forms, having preserved the Old Slavonic aorist. The accent is capricious.[3] The vocabulary has incorporated many Turkish words; but these will probably be gradually eliminated as the nation wakes to greater self-consciousness. For an account of Servian literature, see SERVIA, vol. xxi. p. 722.

Slovenish.

The Slovenes are sometimes called "Wends" and their language "Windish" or "Wendish," an inconvenient term, as it causes some confusion with the tongue of the Lusatian Wends, of which more will be said shortly. Slovenish begins in Styria just south of Klagenfurt (Celovec). Besides Carinthia and Carniola, it is also the vernacular of a small part of Hungary, being spoken in the corner adjoining the river Mur. It is somewhat tiresome to find the few books printed in this part of the country using Magyar orthography. These Slovenish provinces formed a margravate and have long been attached to the domains of the house of Hapsburg. In 1883 they celebrated the six hundreth anniversary of this union and a handsome volume was published in commemoration of the event. For a time they were seized by Ottocar of Bohemia, but regained by Rudolph I., who divided them among his sons. The theory that Old Slovenish exhibits the oldest known form of Slavonic has already been discussed. The language has preserved a dual both in the noun and the verb and its vocabulary teems with interesting Slavonic forms. The attempt of Ljudevit Gaj to fuse Slovenish and Servo-Croatian and make one great South Slavonic literary language is alluded to in SERVIA (vol. xxi. p. 724). Slovenish exhibits an older form of Slavonic than Servian, just as Slovak is earlier than Bohemian. A good grammar was published by Kopitar at Laibach in 1808.* To this is prefixed a valuable essay on the Slavonic languages, which was the first treatment of Slavonic philology in a scientific way; nothing so valuable appeared till the epoch-making *Institutiones* of Dobrovsky (1822). Grammars were afterwards published by Metelko and Murko, but these have been far surpassed by that of Šuman, a pupil of Miklosich.[4] The orthography of the language has been much improved and it is to be hoped that some of the Germanisms which now disfigure it will be expelled. The Slovenes must banish from their vocabulary such words as *farba* (farbe), *farar* (pfarrer), and *britoff* (friedhof).

Slovenish literature.

The earliest specimens of the literature are the manuscripts from Freising in Bavaria now preserved in the library of Munich. They have been assigned to the 9th or 10th century and are written in Latin letters. From that time we find no more trace of the language till the Reformation, when Truber (in 1557) translated the New Testament into Slovenish. He was obliged, however, to quit his country. In 1584 the whole Bible appeared at Tübingen under the superintendence of Juri Dalmatin; in 1584 the first Slavonic grammar was published by Bohorić, a schoolmaster of Laibach and pupil of Melanchthon; and in 1592 appeared the first Slovenish dictionary by Megiser.[5] After the Protestant movement had been stopped by Ferdinand II., the country fell into a torpor, as did Bohemia. In this condition it remained during almost the whole of the 18th century,—the only productions of that barren period being a few plays and religious works without merit, and the grammars of Pochlin and Gutsmann. Valentine Vodnik (1758–1819) was a poet of some eminence. He flourished during the existence of the short-lived Illyrian kingdom which had been evoked by Napoleon and was destined to fall to pieces rapidly. About this time he composed his *Iliria Oživljena* (The Revival of Illyria); but, sympathizing too much with the French, he incurred the wrath of the Austrians when they came back into possession, and was deprived of his posts, dying soon afterwards in poverty. Other writers are Jarnik and Ravnikar. The most celebrated poet was Francis Prešern (1800–1849), whose lyrics enjoy great popularity among his countrymen. The Matica Slovenska (Slovenish Literary Society) issues a journal and publishes useful works. In a recent number there is an interesting article by M. Erjavec, entitled "Fragments from a Traveller's Wallet," where we have lists of words gathered by the author from rural districts inhabited by Slovenes. The Resanian dialect of Slovenish may be said to have been discovered by Professor Baudouin de Courtenay; certainly no one before his time had made any study of it. The Rezani, amounting to about 27,000, live on the northeastern corner of the Italian frontier, in two valleys of the Julian Alps, and are Italian subjects. There is also a work on this dialect by Carlo Podrecca, called *Slavia Italiana*. The Ugro-Slovenish dialect, although it has not been used much as a literary language, is interesting, because it shows some connection with Slovakish, and is thus a link between the southeastern and western branches of the Slavonic languages.

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[1] The origin of the Glagolitic alphabet still remains a puzzle. It is now considered older than the Cyrillic. According to some, it is a modification of Greek cursive writing. Others connect it with Armenian and Albanian alphabets. But none of these views have found general acceptance. The alphabet is now only used by the Dalmatian Slavs in their liturgical books.

[2] An account of the Cyrillic alphabet is given in vol. i. p. 539 *sq.*

[3] The accent in Russian and Servo-Croatian is especially difficult. Professor Grote of St. Petersburg has already written with great learning on the subject, and Professor Leskien of Leipsic is now publishing a work, *Untersuchungen über Quantität und Betonung in den slawischen Sprachen*, of which the first part or quantity in Servian has already appeared.

[4] *Slovenska Slovnica*, by Spisal J. Šuman, Laibach, 1882.

[5] Others have since appeared by Murko and Janežić. The Slovenish Literary Society is now publishing a dictionary, of which the German-Slovenish part has appeared in two stout volumes,—a very valuable work.

* [This Slavic philologist (1780–1844) served [illegible] in the Imperial Library at Vienna.—AM. ED.]

Western Branch.

Polish.

Polish.—The dialect of Great Poland has become the literary language. It is a vigorous tongue, but has incorporated too many German and Latin words. The "macaronic" style of Polish writing which did so much to disfigure the language is discussed in POLAND (vol. xix. p. 313). Polish has preserved the nasals ą and ę. Its accent is almost invariably on the penultimate. There are excellent grammars by Małecki and Malinowski, and the monuments of Old Polish have been well edited by Nehring and Baudouin de Courtenay. The splendid lexicon of Linde in six large volumes is a monumental work. The Silesian dialect is threatened with rapid extermination by the encroachment of the Germans. It has been treated of by Malinowski.[1] Here also may be mentioned a book by Krynski on the dialect of Zakopan at the foot of the Tatra mountains to the south of Cracow. Under POLAND (vol. xix. p. 310 *sq.*) will be found an account of Polish literature.

Kashoubish.

The Kashoubish dialect is spoken by about 200,000 persons according to Hilferding (others, however, make the number less) in the neighborhood of Dantzic. This dialect presents some very interesting variations; among others the accent is free and not confined to the penultimate as in Polish, and it has more nasals. Its philology has been treated by Dr. Cenova,[2] who has also collected their songs and published a small volume of dialogues and literary miscellanies. The word "Kashoub" appears to be a nickname, their proper appellation being "Slovintzi." Schafarik makes the word signify "goats." The position of Kashoubish in the Slavonic family has formed the subject of controversy. In his *Beiträge zur Slavischen Dialektologie*, Herr Leon Biskupski has written an interesting pamphlet in which he essays to prove that it is only a dialect of Polish. This is in opposition to the opinions of Schleicher and Hilferding, who have connected it with the extinct Polabish. The pamphlet contains curious details on the varieties of Kashoubish: the author tells us that every district has its own local dialect. For Kashoubish and its dialects Prince Lucien Bonaparte proposes the term "Baltic";[3] this appellation, however, would be more appropriate to group together Lithuanian, Lettish, and Old Prussian, and in this way it has been used by Leskien.

Bohemian.

(2) *Bohemian* (*Chekh*).—This language has several dialects, some too small to be specified here; they will be found enumerated along with other Slavonic dialects in Erben's work.[4] Connected with the Moravian is the Hanacky. Both the grammar and the lexicography of Chekh have been copiously treated, the latter in the excellent work of Jungmann. Schafarik wrote a grammar of the old language. The vocalization of both *r* and *l* has been previously mentioned; *h* has crept in in many places instead of *g*, but this is not found earlier than the 13th century. The accent is always on the ante-penultimate.

Bohemian literature may be divided into the three following periods, in which we follow Tieftrunk in his *History*:[5] (1) the early period, the productions of which are chiefly of poetry from the beginning of Chekh literature till the Hussite wars (1410); (2) the second period, which shows a great development of prose, but also a great decline in literature generally, extends from the time of Hus to the latter part of the 18th century; (3) from the renaissance of Chekh literature till the present time.

Bohemian literature—early period.

(1) The earliest period of Bohemian civilization was subjected to both Latin-German and Greek-Slavonic influences. The Latin alphabet may have been introduced even in heathen times. Rostislaff of Moravia invited to his kingdom Methodius, who was appointed archbishop of the country by the pope. We hear even in the 11th century of a Slavonic school in the Vyšehrad (Wyscherad, Prague) where St. Procopius studied, to whom tradition assigned a hand in the transcription of the *Texte du Sacre*, previously alluded to. Professor Jagić has printed an extract from an old service book the language of which shows Chekh influences. He has assigned the book to the 10th century. Some other very early specimens of the language are contained in the so-called Glagolitic fragments, *Zlomky Hlaholské*. Two ancient hymns belonging to this orthodox period of the Bohemian Church have come down to us, *Hospodine, pomiluj ny* (Lord, have mercy upon us) and *Svaty Vá'clave, Vevodo Ceské Zeme* (Holy Wenceslaus, Lord of the Bohemian land). In 1817 a fragment called *Libušin Soud* (The Judgment of Libuša) was anonymously forwarded to the newly founded Bohemian museum. The sender was afterwards found to have been one Kovař, the steward of Count Colloredo. Some critics assigned it to the 9th century; according to others it is a forgery. With the limited space at our disposal it would be impossible to discuss the question here. The same year also witnessed the discovery by Hanka of the so-called Königinhof manuscript (*Kralodvorsky Rukopis*), consisting of epic and lyric pieces, the authenticity of which some critics have attempted to bring into doubt. The chief hand in these forgeries is alleged to have been Wenceslaus Hanka (1791–1861), who was for some time head of the museum library and the author of some mediocre verse. The next poem of any importance is the *Alexandreis*, a free Chekh version of the Latin work of Philip Walter ab Insulis, surnamed "De Castellione." The Bohemian version was composed by an unknown author probably between 1240 and 1253. To this time belong many versified lives of saints and legends, such as those of St. Procopius and St. Catherine. The manuscript of the latter poem has been brought back from Sweden, whither it had been removed during the Thirty Years' War, and is now preserved at Brünn in Moravia. The so-called *Chronicle* of Dalimil, a work of some importance, belongs to the 14th century. It is a tedious production, written in octosyllabics, and extends from the creation of the world till 1314. The author is supposed to have been a Bohemian knight, but there is no ground for believing that his name was Dalimil. The work is inspired by great hatred of the Germans. We have a good deal of tedious moral poetry belonging to the 13th century. More interesting matter can be found in the "Satires on Craftsmen" (*Satyry o Remeslnicich*), and a poem on the Ten Commandments. Most of these pieces are anonymous, but the name of one author is known, Smil of Pardubitz, surnamed "Flaška," a leading Bohemian of his day. But little is known of the events of his life, except that he was killed in a skirmish in 1403. His chief work is the *New Council*, one of the beast epics so much in vogue in the Middle Ages. Others, however, are assigned to him, of which the most original and amusing is the "Dialogue between the Groom and Scholar" (*Podkoni a Zak*). A valuable legal document belonging to this period is the *Book of the Old Lord of Rosenberg*, which is one of the earliest specimens of Bohemian prose. Rosenberg was royal chamberlain from 1318 to 1346 and died the following year. Another legal work of importance is the "Exposition of the Law of the Land of Bohemia" (*Vyklad na Pravo Zeme Česke*), by Andrew of Duba, chief justice of the country. Considerable portions of the Bible were translated into Bohemian during the 13th and 14th centuries. The version was completed at the beginning of the 15th century. Wickliffe says of Anne of Luxemburg, the first wife of Richard II., "Nobilis regina Angliæ, soror Cæsaris, habet evangelium in lingua triplici exaratum, scilicet in lingua Bohemica, Teutonica, et Latina." There are two early versions of the Psalter,—the Clementine at the end of the 13th or beginning of the 14th century, and the Wittenberg also at the beginning of the 14th. The doubts which have been thrown on the fragments of the early version of the Gospel of St. John appear to be completely dissipated by the well-timed work of Dr. Jan Gebauer. Dr. Adolf Patera has discovered recently another religious poem of this period.[6] Another early prose chronicle deserving of mention is that of Pulkava, a priest, who died in 1380. It extends from the earliest times to the year 1330, and was originally written in Latin, but he afterwards translated it into Chekh. "The Weaver" (*Tkadleček*), called after the name of its author, who lived in the first half of the 14th century, is a curious prose poem, in which the author celebrated the fair Adlička, one of the beauties of the Bohemian court. The piece is full of the usual conceits of the age; it has not yet been ascertained whether it is original or only an adaptation. It very much resembles *Der Ackermann aus Böhmen*, of which four manuscripts have been preserved. Perhaps, as Gebauer has surmised, they are both adaptations of a piece which is now lost. Passing over a quantity of mediæval legends and tales, such as *Flore et Blanchflore*, we need only mention, as dealing with native

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[1] *Beiträge zur slavischen Dialectologie; über die Oppelnsche Mundart in Oberschlesien*, Leipsic, 1873.

[2] *Die Kassubisch-Slovinische Sprache.*

[3] Trans. Phil. Soc., 1883.

[4] *Sto Prostoná'rodnich Pohadek*, etc. (A Hundred Popular Tales), Prague, 1865.

[5] Second ed., Prague, 1880.

[6] See *Arch. f. slaw. Phil.*, vol. vii.

subjects, the two chronicles of *Stilfrid* and *Bruncvik*, supposed to have been originally written in verse. The most remarkable Bohemian writer of the 14th century is Thomas of Štitny, who writes on ethical and religious subjects. He was born of a noble family about 1330, and probably lived till the close of the century. He appears to have studied at the university of Prague, then newly founded. His chief works are a treatise on *General Christian Matters*, in six books (edited in 1852), and the *Books of Christian Instruction*, printed with an introduction by Vrtátko in 1873. His style is easy and flowing. Loserth has rightly said that the object of Štitny was to put into a popular form the sum total of the scholastic knowledge of his age. There is also a Chekh version of the *History of the Trojan War*, composed by Guido di Colonna from Dictys Cretensis and Dares Phrygius; it was one of the first printed in Bohemian, and was issued from the press at Pilsen in 1468.

Second period.

(2) The second period begins with the great name of Hus, whose Bohemian writings were edited by Erben in 1865–68. Hus developed his native language as Luther did German. He corrected the translation of the Bible, and improved Bohemian orthography. We have nine letters written by him while in prison at Constance. During the period of the Hussite wars there was abundance of political and religious pamphlets. Most of these productions, however, were of ephemeral interest. The travels of Marco Polo and Sir John Mandeville were translated into Bohemian. Peter Chelcicky, one of the leaders of the United Brethren, was a popular writer. He was a cobbler by trade, hence he was nicknamed "Kopyta," or the Shoe-Last. His works, written between 1430 and 1456, have a strongly marked democratic tone; among them may be especially mentioned his *Postils* and the *Net of Faith* (*Sit Viry*). In 1488 the complete Bible was printed in Bohemia, the first regular printing press at Prague having been set up the year before. In 1506 a Calixtine Bible appeared at Venice. The national literature made distinct progress under George Podĕbrad, a native king. Vavrinec z Brezové (1370–1455) wrote in Latin *Historia de Bello Hussitico*, of which there is an early Chekh translation. There is a satire in Latin by Jan Hasisteinsky z Lobkovic, entitled *Lament of St. Wenceslaus over the Morals of the Chekhs*. He was also a considerable traveller in the East. The Chekhs were fond of making pilgrimages to the Holy Land; Martin Kabatnik was a traveller of this kind. His *Peregrinations* were first printed in 1518. Works on law were written by Ctibor and Viktorin, and many translations from the classics appeared. Gregory Hruby z Jelene (called Gelenius) and his son Sigismund were very industrious in this way; the latter published at Basel in 1536 a curious dictionary, *Lexicon Symphonum*, an early attempt at comparative philology, in which he compares Greek, Latin, German, and Slavonic. We must find space for a mention of the writings of Dubravius (*c.* 1489–1553), bishop of Olmüts, although he used the Latin and not the Bohemian language. His work on fish-ponds and fish (*Libellus de Piscinis et Piscium qui in eis aluntur Natura*, 1547) is not altogether unknown to Englishmen owing to the citations in Izaak Walton, with whom the bishop was a great authority. His most important work, however, was his *History of Bohemia* in thirty-three books, from the earliest times to the coronation of Ferdinand I. at Prague in 1527, the termination of Bohemian independence. In 1533 appeared the first Chekh grammar, by Beneš Optat. Verse-writers abounded at this time, but no poet of eminence. Veleslavin (1545–1599) was an indefatigable worker, being, like Caxton, both printer and author. The Latin herbal of Andrew Matthiolus, physician to the archduke Ferdinand, was translated by Thaddeus Hajek. Some good works on law appeared, and there are quantities of sermons. Simon Lomnicky (b. 1560) wrote a great deal of poetry; he was the laureate of Rudolph II., and also wrote a triumphal song for the elector Frederick when chosen king of Bohemia by the Protestants. He was severely wounded at the battle of the White Mountain and spent the rest of his days in poverty; but there appears to be no truth in the story that he became a public beggar. The claims of Lomnicky to be considered a poet are but meagre; he writes little better than rhymed prose. There is some merit, however, in his comic pieces and satires. At this period flourished the chronicler Hajek, who appears to have been a priest, and who died in 1553. His work is interesting, but altogether uncritical, and he does not seem to have cared much about truth. He gives us all the old Chekh sagas, and fortunately uses the Chekh language. His book attained great popularity, and was translated into German. Indeed, it was almost the chief authority for Bohemian history till towards the close of the 18th century. The travels of Christopher Harant in the Holy Land are full of learning and of curious matter. A new edition was published in 1854. The author perished on the scaffold on the memorable 19th June, 1621, when Bohemia lay completely at the feet of the Hapsburg conqueror. Harant started for his journey in 1598, he and his companions being dressed as Franciscan friars. There is also the account by Wenceslaus Vratislav of Mitrovitz (1576–1635) of his three years' captivity at Constantinople,—a work full of picturesque incidents. The letters of Karl ze Žerotin (d. 1636), one of the Moravian Brethren, who was for some time in the service of Henry IV. of France, have been edited by Brandl. With the battle of the White Mountain in 1620 terminates what has been called the golden age of Chekh literature. In 1615 the diet had made a resolute effort to protect the national language. But now the country became Germanized, and books in Chekh were eagerly sought out and destroyed. In addition to its sufferings during the Thirty Years' War, Bohemia had the misfortune to lose many of its most valuable manuscripts, which were carried off by the conquerors. For nearly 200 years Bohemia ceased to be counted among the nationalities of Europe. Here and there a patriot labored in the interest of his country, such as the Jesuit Balbin or Balbinus (1621–1688), who was professor of rhetoric at Prague and author of *Epitome Rerum Bohemicarum* (1677) and also *Miscellanea Rerum Bohemicarum* (1680–81). His services to Bohemian literature were considerable, but his writings are in Latin. Many authors of repute were, however, at this time in exile, and of these no one has earned a greater renown than Jan Amos Komensky (frequently styled by the Latin form of his name, Comenius). This eminent man was born at Nivnitz near Hungarian Brod in Moravia and was the last bishop of the Moravian Brethren.[1] After the battle of the White Mountain he fled to Poland, which at that time had not altogether lost its spirit of toleration. Here he was joined by some Polish dissidents and formed the nucleus of a religious society. In 1631 he published his *Janua Linguarum Reserata*, in which he developed a new theory of learning languages. This work became very popular and has been repeatedly translated. He afterwards visited England and Sweden, and in 1659[2] gave to the world his *Orbis Pictus*, which also enjoyed great reputation as an educational work. He died at Amsterdam in 1670.[2] It would be impossible in a brief sketch like the present to give a detailed list of the writings of Komensky. Of his Bohemian works we may mention the prose poem *Labyrint Svĕta a Raj Srdce* (The Labyrinth of the World and Paradise of the Heart) and his *Informatorium Školy Mateřske*. He also translated the Psalms into Chekh. In 1656, on the destruction of the town of Leszno by fire, Komensky lost some of his most valuable works still in manuscript; we may especially regret his *Poklad Jazyka Českého* (Treasury of the Bohemian Language), upon which he had been engaged from 1612. During the latter part of the 17th century and the greater part of the 18th the language and literature of Bohemia steadily declined. A few scribblers appeared, such as Rosa, Pohl, and Šimek, but their names are hardly deserving of mention. But Gelasius Dobner and Martin Pelzel were valuable workers in the field of Bohemian history.

Modern period.

(3) The true study of the Slavonic languages may be said to have begun with Joseph Dobrovsky. In 1809 he published *Ausführliches Lehrgebäude der böhm. Sprache.* In 1822 appeared at Vienna his great work *Institutiones Linguæ Slavicæ Dialecti Veteris.* Dobrovsky died in 1829. The strange thing about him is that, in spite of all his labors, he had no faith in his native language and despaired of its revival. But, like Columbus, he was destined to accomplish greater results than he expected. Joseph Jungmann (1773–1847), another regenerator of the Chekh language, was author of the great dictionary and an esteemed translation of *Paradise Lost.* Besides these works he wrote a history of Bohemian literature. Kollar (1793–1852 and Čelakovsky (1799–1852) both earned a considerable reputation as poets,—the first by a series of sonnets called *Slavy Dcera* (The Daughter of Glory), under which title he celebrates the praises of all Slavonic lands and at the same time his love for the daughter of a German pastor; the second by his "Echo of Russian Songs" (*Ohlas Pisni Ruskych*) and the "Rose with a Hundred Leaves" (*Růže Stolista*). A good poetical style was now formed for the Bohemians, and a host of minor poets appeared for whose names we cannot find space. Karel Erben (1811–1870) has left some excellent ballads in his *Kytice* (Garland). His genius was kindled by the folk tales with which Bohemia abounds. He conferred a benefit upon Slavonic students by his interesting collec-

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[1] [For the renewed Moravian Episcopate see vol. xvi. p. 838.—Am. Ed.]

[2] [Prof. S. S. Laurie, of Edinburgh, in his *John Amos Comenius* (1884), pp. 64, 191, says he died 15th November, 1671, having given *Orbus Pictus* in 1657 to the world.—Am. Ed.]

tion of national tales previously alluded to; moreover, he was a sound scholar and an indefatigable antiquary. *Regesta diplomatica necnon epistolaria Bohemiæ et Moraviæ*, extending to 1253, and editions of Harant's *Journey to the Holy Land* and Nestor's *Chronicle* are monuments of his industry. A great impulse to Bohemian poetry was given by the discovery of *Libušin Soud* and of the *Kralodvorsky Rukopis* by Hanka. Vitezslav Halek (1835–1874) has left two volumes of poems, which were reprinted in 1879 under the editorship of Ferdinand Schütz. Halek presents a twofold appearance, first as the writer of a series of narrative pieces of a half dramatic character, reminding us of the *Idyls* of Tennyson, secondly as a lyrical poet. In his "Heirs of the White Mountain" (*Dedicové Bile Hory*) he has chosen a patriotic subject which must find its way to the heart of every Bohemian. He has been fortunate in having some of his poems wedded to the music of Dvořák. Jan Neruda (b. 1834), still living, has written "Flowers of the Churchyard" (*Hrbitovni Kviti*), published in 1858, and a volume of poems called "Cosmic Songs" (*Pisne Kosmicke*). According to some Bohemian critics the greatest of their modern lyric poets is Adolf Heyduk, born in 1836 and still living at Pisek. Much of his poetry has been inspired by the south of Europe. His "Forest Flowers" (*Lesni Kviti*) were gathered, as he tells us, while wandering amidst the delightful scenery of the Šumava or Böhmerwald. Heyduk, although a Slovak, has avoided the Slovakish dialect, which has been used by Holly, Sladković, and others. His patriotism is very conspicuous in *Cymbal and Guitar*. One of his most popular works is *Deduv Odkaz* (The Grandfather's Bequest), the grandfather being the genius of the country, who instructs the poet. Some very elegant verses, showing a true feeling for nature with feminine delicacy of expression, have been published by Mademoiselle Henrietta Pech, who writes under the name of "Eliška Krasnohorska. Her first volume was published in 1870 and entitled *Z Maje Žiti* (Life in May). Her "Poetical Pictures" (*Basnicke Kresby*) show great power of word painting. M. Josef Vaclav Sládek (b. 1845), who has published several volumes of original poems, besides translations from English and other languages, shows considerable lyrical power. The most voluminous, however, of the modern writers is Emil Bohus Frida (b. 1853), who uses the pseudonym of "Jaroslav Vrchlicky." He has been astonishingly active; among his principal productions may be mentioned the following,—*Mythy* (Myths), which he divides into two cycles; the miscellaneous collection "From the Depths" (*Z Hlubin*), which is inscribed to Vitezslav Halek, and seems to be inspired by the same scenery as kindled Halek's fancy; *Duch a Svet* (The Spirit and the World), fine lyrics, the motive of which has been supplied by Greek mythology. He has subsequently published *Dojmy a Rozmary* (Impressions and Fancies), and, besides other translations from various languages, a version of the *Divina Commedia* in the *terza rima* of the original. He is also the author of some plays which are much esteemed. especially *Drahomíra*. Dr. J. Durdik, J. J. Kolár, and L. Strupeznicky have attained celebrity in this branch of literature. Some good poetry has been written by Svatopluk Čech. Some critics rank him as the greatest poet of the modern school since the death of Halek. In addition to poetry he has also published three volumes of tales (*Povidky, Arabesky a Humoresky*), collected by him from his various contributions to magazines. Many of these show considerable humor. Another poet by no means to be passed over in this brief sketch (which only attempts to grasp the salient facts with regard to these authors), is M. Zeyer, who has published a series of epic pieces, called *Vyšehrad*, after the well-known Chekh stronghold or acropolis at Prague. The subjects are all taken from the Old Bohemian legends on Libuša, Vlasta, Lumír, etc. Zeyer has adopted the Slavonic metre as we find it in the Servian songs collected by Vuk Stephanovich. Besides these poems he has written a good historical novel entitled *Andrew Chernisheff*, which deals with the reign of Catherine II. of Russia. In 1880 appeared two other tales by the same writer, *Romance concerning the Faithful Friendship of Amisa and Amil*, and a strange book of Oriental tales styled *Baje Šošany* (Stories of Susannah). As with us, the social romance or novel of domestic life has latterly been much cultivated among the Chekhs. The legends and tales current among the peasantry have also been carefully collected, first by Bozěna Nemcova (1820–1862), whose *Slovenske Povesti* had a very great success. She was followed by Madame Mužak, authoress of some of the most popular of the modern Bohemian novels. Her "Country Romance" (*Veznicky Roman*) has been translated into French. Excellent pictures of rural life have also been given by Vaclaff Smilovsky (a *nom de plume* of Smilauer), who has written a great many novels, as the "Old Organist" (*Stary Varharnik*), *Martin Oliva*, etc., much in the style of Auerbach and Zschokke. Other writers of historical novels are M. Bohumil Cidlinsky and Vaclaff Vlćek. Madame Žofie Podlípska, sister of Madame Mužak, is known as a popular writer of social romances. For an account of the historical labors of Francis Palacky, see PALACKY. Among the pupils of the great historian the first place must be given to Vaclaff Vladivoj Tomek (b. 1818), now professor of Austrian history in the university of Prague, whose chief production is a history of that city, which he has carried to a fifth volume. In 1849 he published the first volume of a history of the university of Prague, which seems never to have been completed, and in 1880 a biography of the Bohemian hero Žižka. He appears throughout as a most accurate and painstaking writer. Vocel (1803–1871) is the author of a valuable work, "The Early Days of Bohemia" (*Pravěk Země České*), which we have quoted already when treating of Slavonic ethnology. Alois Šembera (1807–1882), whose literary activity extended over a long period, wrote voluminously on Bohemian history and literature. He was professor of the Bohemian language at the university of Vienna. In a work on the western Slavs (*O Západnich Slovanech*) he maintained that the Chekhs, Moravians, Slovaks, and Polabes were settled much earlier in the countries which they at present occupy than many historians have been willing to admit. As a critic, Professor Šembera is an iconoclast and has attacked many of the (supposed) early monuments of the Chekh language. Dr. Antonine Gindely, born at Prague in 1829, has proved himself to be a most conscientious and enthusiastic worker in the field of historical research. In order to collect materials for his publications he travelled in various parts of Bohemia, Poland, Germany, France, Belgium, Holland, and Spain. The results of this diligence have appeared in a collection of valuable historical works, such as the *History of the Bohemian Brethren*, *Rudolph II. and his Times*, and later a *History of the Bohemian Revolt of* 1618. The brothers Joseph and Hermenegild Jireček have won a reputation in Bohemian literature by many useful works. They have conjointly published a book in defence of the *Kralodvorsky Rukopis* which is well worthy the attention of those who wish to make themselves acquainted with the literature of this vexed question. Joseph is now occupied in editing in a cheap form some of the most interesting monuments of early Bohemian literature. In 1880 Hermenegild published a valuable *Collection of Slavonic Laws*, containing an almost complete series of the early codes of the Slavs in the original languages. Joseph Jireček is also author of a useful chrestomathy of Bohemian literature with biographical and critical notices. Joseph Constantine Jireček (son of Joseph, born in 1854), formerly a *privatdocent* of the university of Prague, has devoted himself to Bulgarian history and bibliography. In 1872 he published a *Bibliography of Modern Bulgarian Literature*, and has written a *History of Bulgaria*, of which a German translation has appeared. Joseph Emler and Karl Tieftrunk have been co-operators with Dr. Gindely in his "Old Monuments of Bohemian History" (*Stere Pamiti Dejin Českych*). The former has also edited the second volume of the *Regesta Bohemica* and since 1870 has been editor of the "Journal" (*Časopis*) of the Bohemian museum. Karl Tieftrunk has written several useful works, among them the *History of Bohemian Literature* from the earliest period to the present time, and the interesting monograph on the opposition of the Bohemian states to Ferdinand I. in 1547. The *History of Bohemian Literature* is very carefully written and gives in a short compass much valuable information. An elaborate work is now appearing in parts by F. Backovsky, entitled *Zevrubne Dejiny Českého Pisemnictvi Doby Nové* (A complete history of Modern Bohemian Literature) from the year 1774 to the present time. There is also a work by Jerábek, *Early Days of Romantic Poetry*. Many valuable contributions to Bohemian history have proceeded from the pen of Dr. Joseph Kalousek (b. 1838). Vincent Brandl and Beda Dudik have devoted particular attention to Moravian history and antiquities. The former, among other works, has edited the letters of Karl ze Žerotin, previously mentioned. Beda Dudik, a Benedictine monk and historiographer of Moravia, has published some valuable works on the history of that portion of the Bohemian kingdom and has also written a *History of Moravia*. Like the great work of Palacky, it was first written in German, but has since appeared in the Bohemian language. Extracts from the interesting diary of Žerotin have been edited by him in the *Mährische Geschichtsquellen*. Through his efforts twenty-one Bohemian manuscripts which had been carried away to Sweden at the time of the Thirty Years' War have been restored, and are now preserved in the state archives of Brünn. Among these is the *Legend of St. Catherine*, many words in which are said to explain difficult passages in the *Kralodvorsky Rukopis* and to furnish testimony to its authenticity. Jakub Maly (d. 1885) was the author of many important articles in the *Slovnik Naučny*, the Chekh *Conversations-Lexicon*, and of a popular history of the Bohemian people. He also wrote a grammar of Chekh for Englishmen, besides assisting in the translation of Shakespeare, which has been produced by the joint labors of many Bohemian scholars. In 1868 was published under the editorship of Erben the second volume of the *Vybor z Literatury České*, a very important work, containing specimens of the old Bohemian authors. The first volume had been edited by Schafarik, for an account of whose literary activity see SCHAFARIK. Valuable works on philology have been written by Martin Hattala, by birth a Slovak, who is now professor of Slavonic philology at the university of Prague. One of his most important productions is in Latin, *De Contiguarum Consonantium Imitatione in Linguis Slavicis*. He is a defender of the genuineness of the two celebrated manuscripts, the Zelenohorsky (*i.e.*, "that which contains the judgment of Libuša") and the Kralodvorsky. Among sound philologists are reckoned Drs. Gebauer and Geitler. The former has contributed some valuable papers to the *Archiv für slawische Philologie*, edited by Professor Jagić of St. Petersburg. The latter, born in 1847, is at present professor of Slavonic philology at the university of Agram. He commenced his studies at Prague under Alfred Ludwig, the translator of the *Vedas*, and Hattala, and at Vienna under Miklosich. Having begun with a dissertation in the *Časopis* on the present condition of comparative philology, he published in the same year a work on the Old Bulgarian language. In 1873 he made a tour in Russian and Prussian Lithuania, that, like Schleicher, he might study that interesting language from the mouths of the people. He afterwards published the results of his travels in his *Lithauische Studien*. He has since written a treatise on the Albanian alphabet (*Die Albanesischen und Slavischen Schriften*, Vienna, 1883). In this an attempt is made to connect the Glagolitic and Albanian alphabets. A valuable work was written by Antonin Matzenauer (b. 1823), entitled "Foreign Words in Slavonic Languages" (*Cizi Slova ve Slovanskych Řečech*). Excellent works on classical philology have been published by A. Kvićala and Vaniček. Natural science was successfully cultivated by Jan Svatopluk Presl (1791–1849), professor in the university of Prague, and Jan Ev. Purkyně (1787–1869), professor of physiology in the same university. As regards moral philosophy, the first part of Dr. J. Durdik's *History of Recent Philosophy* has just appeared, which extends from Kant to Herbart. Throughout the whole period of the resuscitation of Bohemian literature the society called the Matice Ceska has worked energetically, printing its excellent journal or *Časopis* four times a year, and also issuing some of the old Bohemian classic and meritorious works by modern authors. It was a great triumph for the Chekhs when a part of the instruction of the university was allowed to be carried on in the Bohemian language. A new magazine (*Slovansky Sbornik*) made its appearance at the beginning of 1884. The *Listy Philologické* (Philological Leaves) is still published. Recently a new literary journal (*The Athenæum*) has been started, which seems to be more or less modelled upon its English namesake.

Slovak.

Slovak.—This language or dialect is spoken in the northwestern corner of the kingdom of Hungary. It is generally considered to exhibit an earlier form of Chekh, and this is proved by many of its grammatical peculiarities being found in the older Chekh literature. One characteristic of the language is the use of diphthongs in cases where the other Slavonic tongues use simple vowels. For a long time the Slovaks employed Chekh in all their published writings. About the close of the 18th century a separatist movement began. The first Slovak grammar was published by Bernolak at Presburg in 1790. It was followed by those of Dianiška and Viktorin. There is a Slovak dictionary by Loos. The attempt to form a new literary language was to be deplored on many grounds, for both the Magyar and the German have to be resisted. For a short time a literary society existed among the Slovaks, which published useful books and a journal. The Magyars, however, suppressed it, because it was "contra integritatem patriæ," as we were told by one of their ecclesiastics. The Bohemian naturally resents the attempts at separation by the Slovak, and in 1846 the Chekh Literary Society issued a work entitled "Opinions in Favor of One Written Language for the Chekhs, Moravians, and Slovaks" (*Hlasove o potřebě Jednoty Spisovného Juzyka pro Čechy, Moravany, a Slovaky*). The Slovaks have produced a few poets of repute, such as Holly, Sladković, and Chalupka, but their literature is meagre.

Lusatian Wendish.

Lusatian Wendish.—This language is divided into two dialects, Upper and Lower, although even these are capable of subdivision. The word "Wend," as previously explained, is a purely German name and is never used by the Slavs themselves. The Lusatians are also sometimes called Serbs and Sorbs. They are the remnants of the powerful tribes which once occupied nearly the whole of North Germany. The Lusatians in the earlier period of their history were under the dominion of the Poles and afterwards of the Chekhs. In the early part of the 17th century the bulk of them had been annexed to the electorate of Saxony, with the exception of the small part about Kottbus, which had belonged to Brandenburg since 1445. In 1815, however, when the states of Europe were rearranged, in most instances with very small regard to the nationalities under their sway, many more of the Lusatians were handed over to Prussia; and, according to the statistics of Boudilovich, at the present time (1886) all the Lower Lusatians, amounting to 40,000, belong to Prussia, as well as 44,000 of the Upper Lusatians. Besides the two dialects specified there are other minor ones, to judge from an article in the Bohemian Literary Journal; but they are too minute to be specified here. The Upper Lusatian dialect shows most affinity with Chekh, especially in substituting *h* for *g*; the Lower more resembles Polish, and has the strong or barred *ł*, as in *łos*, "hair." The Upper dialect has been the most cultivated; some good grammars have been published by Seiler, Jordan, and Pfuhl, and there is a copious dictionary edited by Pfuhl in conjunction with others. The language is full of Germanisms and German words and cannot hold out long against the vigorous attempts at denationalization made by its Teutonic neighbors. There is a small Lower Lusatian dictionary by Zwahr, a posthumous work of very little merit. The Macíca Serbska, the literary society of the Sorbs, founded on the model of the Bohemian Society in 1847, publishes its journal twice a year, which contains interesting articles on folk-tales and folk-lore generally, with popular songs taken down from the mouths of the people.

Sorbish literature.

The first printed book in the Upper Sorbish language was the little catechism of Luther, published in 1597 by the pastor Worjech. This was not, however, the first time that any Lusatian or Sorbish words had been printed, for we find the names of plants in that language given in Franke's *Hortus Lusatiæ*, published in 1594. In 1706 Michael Brancel or Frencel published a translation of the New Testament into Sorbish; a little before, in 1689, a grammar had appeared by Zacharias Bierling entitled *Didascalia seu Orthographia Vandalica*. In 1693–96 Abraham Frencel, son of Michael, published a dictionary. In 1806 Möhn translated some extracts from Klopstock's *Messiah*. From 1837 a new impulse was given to Sorbish literature; newspapers were printed in the language and useful books translated into it. One poet has appeared among them, Andrew Seiler, a clergyman, who died in 1872. Lower Sorbish has always been much less developed than Upper. The first book printed in it was a collection of hymns and a catechism, by Albin Moller, in 1574. Chojnan, a pastor in Lubin, wrote the first grammar between 1649 and 1664; in the latter half of the same century Körner compiled a dictionary. At the commencement of the 18th century Bohumil (Gottlieb) Fabricius published his translation of the New Testament (first edition in 1709); at the end of the same century a version of the Old Testament by Frico appeared. A good collection of Sorbish songs has been edited by Haupt and Schmaler. According to an interesting article by Hornik in the second volume of the *Slavianski Sbornik*, a number of these Wends emigrated to America and settled in Bastrop county, Texas, where they have divine service performed in their own language, and publish some newspapers.

Polabish.

Polabish.—Of the Slavonic languages spoken in the north of Germany the Lusatian Wendish and Kashoubish are alone living. Of those which are extinct Polabish is the only one of which any memorials have come down to us, and these are but scanty. The language affords a parallel to Cornish, not only in the few fragments which remain, but also in the date of its decline and extinction. It is considered by Schleicher,[1] who has written an excellent grammar by piecing the scanty materials together, just as geologists restore an ichthyosaurus, to have more affinity to Polish than to Chekh, owing to the possession of nasals. This interesting language[2] expired in the first quarter of the 18th century in the eastern corner of the former kingdom of Hanover, principally in the circuit of Lüchow, which even at the present time is called Wendland. Between 1691 and 1786 certain vocabularies and dialogues in this language (including also a song) were taken down, and from them Schleicher has taken the materials for his grammar and the valuable little dictionary appended to it. Dr. Pfuhl printed these memorials in their entirety in 1863–64. The spelling is altogether phonetic, and, owing to the ignorance of the Slavonic peasant and his German interrogators, the former of German and the latter of Slavonic, there are some ludicrous blunders. The two most important of these documents are a German-Wendish dictionary, compiled at the end of the 17th century by Christopher Henning, by birth a Lusatian, and pastor of Wustrow near Lüchow. Divine service is said to have been held in that town in Wendish as late as 1751. Secondly, we have the Slavonic words and dialogues collected by a farmer named Johann Parum-Schultz. His manuscript is still in the possession of his descendants. There is a valuable monograph on the dialect of the Lüneburg Slavs by Biskupski. In the 15th century Slavonic had ceased to be spoken in the island of Rügen, and in the same century it could only be heard from peasants in the market-place of Leipsic, a town (as already stated) with a Slavonic name. What the Slavs, however, have lost in the West they have partly gained in the East, and few languages have a more magnificent prospect than Russian,—the dignity and strength of which fit it to be the tongue of an imperial people. (W. R. M.)

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[1] *Laut- und Formen-Lere der Polabischen Sprache*, St. Petersburg, 1871.

[2] To avoid confusion it must be remembered that the word "Polabish" is used somewhat carelessly by ethnologists to denote (1) the Slavonic tribes in north Germany generally, (2) the particular Slavonic tribe on the Elbe (Slav. *Laba*).

SŁAVYANSK, a town of Russia, in the government of Kharkoff, situated 158 miles by rail to the southeast of the town of Kharkoff, on the Torets river and close by several salt lakes. From these salt is extracted to the annual value of more than £10,000 [$48,600]; there are also several tallow-works in the place. The Słavyansk merchants carry on a brisk trade in salt, cattle, and tallow. The population (11,650 in 1870) reached 15,400 in 1883.

The ancient name of Słavyansk was Tor. The town, which is supposed to occupy the site of a former settlement of the Torks (Turks) who inhabited the steppes of the Don, was founded in 1676 by the Russians to protect the salt marshes. Having an open steppe behind it, this fort was often destroyed by the Tatars. Its salt trade became insignificant in the 18th century and has only revived during the last twenty years since coal was brought from Ekaterinoslaff.

SLEEP is a normal condition of the body, occurring periodically, in which there is a greater or less degree of unconsciousness due to inactivity of the nervous system and more especially of the brain and spinal cord. It may be regarded as the condition of rest of the nervous system during which there is a renewal of the energy that has been expended in the hours of wakefulness. For in the nervous system the general law holds good that periods of physiological rest must alternate with periods of physiological activity, and, as the nervous system is the dominating mechanism in the body, when it reposes, all the other systems enjoy the same condition to a greater or less extent. Rest alternates with work in all vital phenomena. After a muscle has contracted frequently at short intervals, a period of relaxation is necessary for the removal of waste products and the restitution of energy; the pulsating heart, apparently working without intermission, is in reality not doing so, as there are short intervals of relaxation between individual beats in which there is no expenditure of energy; the cells in a secreting gland do not always elaborate, but have periods when the protoplasm is comparatively at rest. Nervous action also involves physico-chemical changes of matter and the expenditure of energy. This is true even of the activity of the brain associated with sensation, perception, emotion, volition, and other psychical phenomena, and therefore the higher nervous centres require rest, during which they are protected from the stream of impressions flowing in from the sense-organs, and in which waste matters are removed and the cerebral material is recuperated for another time of wakeful activity.

Time of sleep.

The coincidence of the time of sleep with the occurrence of the great terrestrial phenomena that cause night is more apparent than real. The oscillations of vital activity are not correlated to the terrestrial revolutions as effect and cause, but the occurrence of sleep, in the majority of cases, on the advent of night is largely the result of habit. Whilst the darkness and stillness of night are favorable to sleep, the state of physiological repose is determined more by the condition of the body itself. Fatigue will normally cause sleep at any time of the twenty-four hours. Thus many of the lower animals habitually sleep during the day and prowl in search of food in the night; some hibernate during the winter season, passing into long periods of sleep during both day and night; and men whose vocations require them to work during the night find that they can maintain health and activity by sleeping the requisite time during the day.

Symptoms.

The approach of sleep is usually marked by a desire for sleep, or sleepiness, embracing an obscure and complicated group of sensations, resembling such bodily states of feeling as hunger, thirst, the necessity of breathing, etc. All of these bodily states, although on the whole ill defined, are referred with some precision to special organs. Thus hunger, although due to a general bodily want, is referred to the stomach, thirst to the fauces, and breathing to the chest; and in like manner the desire for sleep is referred chiefly to the region of the head and neck. There is a sensation of weight in the upper eyelids, intermittent spasm of the sub-hyoid muscles causing yawning, and drooping of the head. Along with these signs there is obscuration of the intelligence, depression both of general sensibility and of the special senses, and relaxation of the muscular system. The half-closed eyelids tend more and more to close; the inspirations become slower and deeper; the muscles supporting the lower jaw become relaxed, so that the mouth opens; the muscles of the back of the neck that tend to support the head also relax and the chin droops on the breast; and the limbs relax and tend to fall into a line with the body. At the same time the hesitating utterances of the sleepy man indicate vagueness of thought, and external objects gradually cease to make an impression on the senses. These are the chief phenomena of the advent of sleep. After it has supervened there are many gradations in its depth and character. In some cases the sleep may be so light that the individual is partially conscious of external impressions and of the disordered trains of thought and feeling that pass through his mind, constituting dreams, and these may be more or less vivid according to the degree of consciousness remaining. On the other hand, the sleep may be so profound as to abolish all psychical phenomena: there are no dreams, and when the sleeper awakes the time passed in this unconscious state is a blank. The first period of sleep is the most profound. After a variable period, usually from five to six hours of deep sleep, the faculties awaken, not simultaneously but often fitfully, so that there are transient periods of consciousness. This is the time of dreaming. As the period of waking approaches the sensibility becomes more acute, so that external impressions are faintly perceived. These impressions may influence and mould the flow of images in the mind of the sleeper, frequently altering the nature of his dreams or making them more vivid. The moment of waking is usually not instantaneous, but is preceded by an intermediate state of partial consciousness, in which there are feelings of a pleasant lassitude, a sense of repose, a luxurious abandonment of the body to any position in which it may happen to be, and a strange play of the mental faculties that has more of the character of an "intellectual mirage" than of consecutive thought.

Intensity.

The intensity of sleep has been measured by Kohlschütter by the intensity of the sound necessary to awaken the sleeper. This intensity increases rapidly during the first hour, then decreases, sometimes rapidly, sometimes slowly, during the next two or three hours, and then very slowly until the time of waking. This statement agrees generally with experience. As a rule the deeper the sleep the longer it lasts.

Physiological changes.

Various physiological changes have been observed during sleep, but much remains to be done in this direction. The pulse becomes less frequent; the respiratory movements are fewer in number and are almost wholly thoracic, not abdominal; all the secretions are reduced in quantity; the gastric and intestinal peristaltic movements are less rapid; the pupils of the eye are contracted and during profound sleep are not affected by light; and the eyeballs are rotated upwards. The pupils dilate slightly when strong sensory or auditory stimuli are applied, and they dilate the more the lighter the sleep; at the moment of waking they become widely dilated. Whilst muscular relaxation is general, there seems to be increased contraction of certain sphincter muscles, as the circular fibres of the iris and the fibres concerned in closing the eyelids.

Durham's observations.

The state of the circulation of the brain has been frequently investigated. The older view was that there was a degree of plethora or congestion of the vessels of the brain, as is the state of matters in coma, to which the state of sleep has a superficial resemblance. Coma, however, is not sleep, but a condition of inactivity of the cerebral matter owing to the accumulation of dark venous blood in its vessels. This has been actually observed in cases where it was possible to see the brain. During sleep the surface of the exposed brain has been observed to become pale and to shrink somewhat from the sides of the opening (Blumenbach). A careful experimental research was conducted by Arthur E. Durham in 1860, in which he trephined a portion of bone as large as a shilling from the parietal region of a dog, and, to obviate the effects of atmospheric pressure, inserted a watch glass into the aperture so that the surface of the brain could be seen. His results are summarized thus:

> "(1) Pressure of distended veins on the brain is not the cause of sleep, for during sleep the veins are not distended; and, when they are, symptoms and appearances arise which differ from those which characterize sleep. (2) During sleep the brain is in a comparatively bloodless condition, and the blood in the encephalic vessels is not only diminished in quantity, but moves with diminished rapidity. (3) The condition of the cerebral circulation during sleep is, from physical causes, that which is most favorable to the nutrition of the brain tissue; and, on the other hand, the condition which prevails during waking is associated with mental activity, because it is that which is most favorable to oxidation of the brain substance, and to various changes in its chemical constitution. (4) The blood which is derived from the brain during sleep is distributed to the alimentary and excretory organs. (5) Whatever increases the activity of the cerebral circulation tends to preserve wakefulness; and whatever decreases the activity of the cerebral circulation, and, at the same time, is not inconsistent with the general health of the body, tends to induce and favor sleep. Such circumstances may act primarily through the nervous or through the vascular system. Among those which act through the nervous system may be instanced the presence or absence of impressions upon the senses, and the presence or absence of exciting ideas. Among those which act through the vascular system may be mentioned unnaturally or naturally increased or decreased force or frequency of the heart's action."

Mosso's experiments.

Dr. William A. Hammond and Dr. Weir Mitchell have repeated and extended Durham's observations, with the same general results (1866), and more recently Ehrmann, Salathé (1877), François Franck (1877), and Mosso (1881), by more refined methods of observation, have arrived at the same general conclusions. Mosso in particular has applied with great success the graphic method of registration to the study of the movements of the brain and of the circulation during sleep. He made observations on three persons who had lost a portion of the cranial vault and in whom there was a soft pulsating cicatrix. They were a woman of thirty-seven years of age, a man of thirty-seven years, and a child of about twelve years. By special arrangements, Mosso took simultaneous tracings of the pulse at the wrist, of the beat of the heart, of the movements of the wall of the chest in respiration, and of the movements of the denuded brain. Further, by means of the plethysmograph,—an instrument of Mosso's own invention,—he obtained tracings showing changes in the volume of the hand and forearm; and he succeeded in showing that during sleep there is a diminished amount of blood in the brain, and at the same time an increased amount in the extremities. He showed further that there are frequent adjustments in the distribution of the blood, even during sleep. Thus a strong stimulus to the skin or to a sense organ—but not strong enough to awaken the sleeper—caused a contraction of the vessels of the forearm, an increase of blood pressure, and a determination of blood towards the brain; and, on the other hand, on suddenly awakening the sleeper, there was a contraction of the vessels of the brain, a general rise of pressure, and an accelerated flow of blood through the hemispheres of the brain. So sensitive is the whole organism in this respect, even during sleep, that a loudly spoken word, a sound, a touch, the action of light, or any moderate sensory impression modified the rhythm of respiration, determined a contraction of the vessels of the forearm, increased the general pressure of the blood, caused an increased flow to the brain, and quickened the frequency of the beats of the heart. These observations show how a physiological explanation can be suggested of the influence of external impressions in modifying the dreams of a sleeper. Further, Mosso found that during very profound sleep these oscillations disappear; the pulsatory movements are uniform and are not affected by sensory impressions, and probably this condition exists when there is the absolute unconsciousness of a "dead" sleep. By such methods as have been employed by Mosso, three movements of the brain have been observed,—(1) *pulsations*, corresponding to the beats of the heart; (2) *oscillations*, or longer waves, sometimes coinciding with the heart beats, or more generally consisting of longer festoons, carrying each a number of smaller waves, and believed to correspond generally to the respiratory movements; and (3) *undulations*, still longer and less marked elevations and depressions, first clearly observed by Mosso, and believed by him to indicate rhythmic contractions of the vessels of the pia mater and of the brain. This view is in keeping with the observations of Donders, Kussmaul, Tenner, and others on changes of calibre observed in the cerebral vessels, and with the experiments of many physiologists, showing that the vessels of the pia mater, like other vessels, are controlled by the vaso-motor system of nerves (see PHYSIOLOGY, "Nervous System"). It may therefore be considered certain that during sleep there is an anæmia or partially bloodless condition of the brain, and that the blood is drawn off to other organs, whilst at the same time this anæmic condition may be modified by changes in the circulation or in the respiratory mechanism caused by position, by sensory impressions, or by sudden changes in the state of repose of the muscles. The examination of the retina (which may be regarded as a cerebral outwork) by the ophthalmoscope during sleep also shows a comparatively bloodless condition. Such are the facts; the deficiency in the way of a theoretical explanation is that physiologists cannot satisfactorily account for the anæmic condition causing unconsciousness. Sudden hemorrhage from the brain and nerve-centres, or a sudden cessation of the supply of blood to the brain, as occurs in syncope (failure of the heart's action,—a faint), no doubt causes unconsciousness, but in these circumstances there is a tendency to convulsive spasm. Such spasm is usually absent in sleep, but sudden jerks of the limbs may sometimes be observed during the time when there is the confusion of ideas preceding the passage into sleep.

During sleep the amount of carbonic acid eliminated is very much reduced, indicating that molecular changes in the tissues do not occur to the same extent as in the waking state. This is also shown by the fact that less heat is produced. Helmholtz states that the amount of heat produced by a man weighing 67 kilogrammes (147.4 ℔) is about 40 calories per hour during sleep, as against 112 calories per hour while awake. This diminished production of heat may be largely accounted for by the quiet condition of the muscles of locomotion, but it also indicates diminished tissue changes throughout the body. In profound sleep the bodily temperature may fall from .6° to 2° Fahr. In consequence of diminished oxidation changes during sleep, it is not improbable that excess of nutrient matter may then be stored up in the form of fat, and that thus the proverb "He who sleeps dines" is based on a correct appreciation of the fact that sleep tends to produce plethora or obesity.

Theories as to cause of sleep.

Whilst it is easy to state that sleep is caused by fatigue of the nervous system, it is a more difficult matter to explain what the precise changes are that produce the state of unconsciousness. Various hypotheses have been advanced, but it cannot be said that any one is wholly satisfactory. Aware that the fatigue of muscle is associated with the accumulation of sarcolactic acid, Preyer surmised that the activity of nervous matter might be interfered with by the accumulation in the nerve-centres of some such acid, or of its soda salt (lactate of soda), but this view has not been supported by the results of experiment, as the injection into the blood of a dose of lactate of soda has not produced sleep. Pflüger has observed that frogs deprived for a considerable time of oxygen passed gradually into a state resembling profound sleep, and he has advanced the theory that there is no organ of the body so quickly affected by deprivation of oxygen as the brain. According to Pflüger, the phenomena of life depend on a dissociation of living matter, and in particular the activity of the cerebral substance connected with psychical states depends on dissociation changes in the gray matter. To excite the dissociation, however, oxygen is necessary. The oxygen unites with certain of the compounds set free by the dissociation, forming, amongst other substances, carbonic acid. If such matters as these that unite with oxygen are in sufficient amount to use up all the oxygen, the gray matter of the brain suffers from a deficiency of oxygen (or from its absence), and also from the accumulation of carbonic acid. According to such a theory, cerebral activity depends on cerebral respiration, and sleep is a kind of cerebral asphyxia. Some such condition is not improbable, but it must be stated that the evidence at present in support of it is meagre. Possibly in attempting to account for the phenomenon of sleep, too much importance has been attributed to the changes occurring in the brain, forgetting that not merely brain matter but every tissue of the body becomes exhausted by work, and that sleep may be partly due to phenomena occurring throughout the body and not in the brain alone. Some more comprehensive hypothesis than any yet advanced may be possible when the condition of all the functions during sleep has been more thoroughly investigated.

All the phenomena of sleep point to a diminished excitability of the cerebral nerve-centres and of the spinal cord. Contrary to what is often stated, there can be no doubt that reflex action is in partial abeyance and that the spinal cord is in a state of partial inactivity as well as the brain. The only nerve-centres that do not sleep are those absolutely essential to life, such as those connected with the heart, with respiratory movements, and with the distribution of blood by the vaso-motor arrangements; and Mosso's experiments indicate that even these have a certain amount of repose in profound sleep.

Sleeping in animals.

There is little doubt that all living beings require periods of repose alternating with periods of activity. Many plants close their flowers and bend their petioles at certain times of the day. These phenomena, called "the sleep of plants," depend apparently on changes in solar radiation, and there is no reason to believe that during the time of quiescence any reparative processes go on, as during the sleeping period of animals. Naturalists have observed many of the lower animals apparently in a state of sleep. Insects, crustaceans, fishes, reptiles, may all be observed occasionally to be almost motionless for considerable periods of time. The sleeping of birds is familiar to all, and in these there are anatomical arrangements by which the bird may, like the crane, sleep perched on one leg, or grasping a branch with both feet, like perching birds generally, without any muscular effort and consequently without fatigue.

Amount of sleep required by man.

The amount of sleep required by man varies according to age, sex, and habit. The popular notion that a child sleeps half its time, an adult one-third, whilst an old person may do little except eat and sleep is not far wrong. In early life the cerebral faculties appear to be easily exhausted and during the frequent and prolonged sleeps of infancy the brain rests and the vegetative changes connected with nutrition and growth go on actively. As life advances, less sleep is required, until in adult life a period of seven or eight hours is sufficient. As a rule, women require more sleep than men; but much depends on habit. Thus most women bear the loss of sleep in the first instance better than men, because they have been accustomed more to loss or irregularity of sleep. The effect of habit is well seen in nurses, both male and female, who will often be able to work for weeks continuously with snatches of sleep, not amounting to more than two or three hours daily. Sooner or later, however, even in these cases nature asserts her demands, and prolonged sleep is necessary to maintain health and vigor.

Insomnia.

Wakefulness during the time when one ought to be asleep is frequently a distressing condition, undermining the strength and incapacitating for active and efficient work. Insomnia or sleeplessness often afflicts those of active mental habits and lays the foundation of premature decay. From what has been stated as to the cause of sleep it is evident that whatever tends to augment unduly the circulation through the brain may cause wakefulness. Thus long-continued or excessive intellectual action, or any powerful emotion, may be injurious. Moderate intellectual work is favorable to sleep. The remedy in such cases is to avoid as far as possible the exciting causes or to counteract them by bodily exercise and attention to the general health. When sleeplessness overtakes a brain-worker it is a sure indication that less intellectual work must be done, and that he ought to betake himself, if possible, to out-of-door exercise in the pure air of the country. It is dangerous to persist, and still more to induce sleep artificially by drugs, as the overworked organ may become the seat of permanent disease or pernicious habits may be formed. The posture of the body in bed may influence sleep. Thus such positions as impede the flow of blood from the brain without affecting the supply of blood to it by the arteries may cause sleeplessness. Sometimes in cases of insomnia from excessive mental work there is the distressing condition that sleep disappears when the person lies down in bed, although before lying down he felt drowsy. In such a case resting with the head high may produce the desired result. Insomnia may also be caused by various functional diseases, whereby the amount of blood in the brain is increased. Thus in young females derangement of the menstrual functions may cause a hyperæsthesia or increased sensibility to such an extent that the sufferer cannot sleep, or, if sleep be obtained, it is so light as to be dispelled by weak sensory impressions that would fail to arouse a healthy person. Again, an irregular or deficient action of the heart may cause wakefulness, especially if associated with coldness of the extremities. In such cases the application of heat to the feet and attention to the digestive organs may produce refreshing sleep. Lastly, the excessive use of various drugs, such as alcohol, opium, belladonna, Indian hemp, tea, and coffee, may cause sleeplessness. In these cases a moderate dose usually acts as a hypnotic, whilst frequently repeated doses have the reverse effect. Thus sleeplessness is one of the most distressing symptoms of delirium tremens, and it occurs also in those in the habit of indulging in opium, morphia, chloral, or Indian hemp. The general correctives of sleeplessness are active work, a moderate amount of bodily exercise, freedom from worry and anxiety, the use of the warm bath in some cases to allay irritability before going to bed, and such a posture in bed as the individual has found in his own case to be favorable. Sometimes a light but nutritious meal about an hour before retiring may conduce to sleep, but as a rule late suppers are unfavorable. The use of drugs should be indulged in only with medical advice. It is not too much to say that the injudicious use of bromide of potassium, chloral, opium, morphia, and stimulants by literary persons to procure sleep has often been productive of sad results, such as shattered health, an incurable habit of self-indulgence, and even accidental death (see Hammond, *On Wakefulness*).

Hypnosia.

It is a matter of common observation not only that certain persons require more sleep than others but that they have less power of resisting its onset and of awaking. This condition may become morbid, constituting a veritable nervous disease, to which the name "maladie du sommeil" or *hypnosia* may be given. It may be described as invincible sleep, and it may continue for weeks and for months, terminating in convulsive seizures, and even death. A persistent drooping of the upper eyelid has been observed even during waking hours. Dr. W. Ogle has observed in such cases an engorgement of the cervical ganglia of the sympathetic; but this may have nothing to do with the condition. Cases of very prolonged sleep are not uncommon, especially amongst hysterical females, lasting four, seven, or ten days. On awaking the patient is exhausted and pale, with cold extremities, and not unfrequently, after a brief interval of waking, passes off into another lethargic sleep. Something similar to this may be seen in very aged persons towards the close of life.

Dreaming.

Dreams (cf. DREAM, vol. vii. p. 391 *sq.*) only occur when sleep is light, and they indicate that consciousness is still continued. The characteristic feature of dreaming is that the mind has no control over the groups of images that crowd upon it. These images are either revivals of old sensory impressions that have been stored up in the brain or they are the result of an untrammelled imagination. The will has lost the power of direction and control; ideas, often grotesque, always confused, rise apparently spontaneously, are vivid for an instant, and then disappear. Dreaming may be described as a kind of physiological delirium. A consideration of the state indicates that the cerebral hemispheres are partially active and that it is the inhibitory power that is deficient (see PHYSIOLOGY, "Nervous System"). A further explanation cannot be given in the present state of our knowledge of cerebral physiology, but some of the more evident conditions or laws of the dreaming state may be indicated. (1) The character of dreams is often determined by a predominant thought or train of ideas that has occupied the mind before going to sleep. Thus the events of the preceding day may produce a particular kind of dream, and not unfrequently when a person attempts on waking to unravel his dream he may find the connecting thread in an occurrence or in a conversation or in the thoughts suggested by a book on the previous day. It would thus seem that the memory of recent things (and physiologically there must be an organic basis for memory) may revivify old and apparently forgotten impressions. (2) In dreaming, the train of thought may be influenced by impressions made on the senses of the sleeper, sufficiently intense to produce this result, but not intense enough to awake him. Thus a sudden sensory impression, such as a loud sound, a current of cold air, a restrained position of one of the limbs, a word or sentence uttered by a familiar voice, may arouse a dream or turn the disordered throng of fancies in a new direction. In some instances, the dreamer is peculiarly susceptible to such external impressions, so that the same stimulus will always give rise to the same kind of dream. (3) It has frequently been observed that in dreaming there may be memories of old impressions, scenes, faces, words, that have long since faded from the recollection during waking hours, showing that many impressions that are supposed to be lost are only forgotten and require but the appropriate stimulus to cause them to start vividly into mental life. (4) In rare instances there may be consecutive thought in dreams, so that the dreamer may write verse, frame speeches, or even work out mathematical problems. Most persons have had experience of this strange kind of power and have regretted, in the partially conscious state before awaking, that they could not preserve some of the results, feeling assured that the sober reality of waking life would dispel the vision. (5) Dreams make only a feeble impression on the memory, so that on awaking what is at first vivid and distinct fades insensibly and rapidly away. This may be accounted for by the evanescent character of the mental "stuff" of dreams. In the waking state an act of attention is required to fix anything in the memory, and, as this is absent in dreaming, the impressions do not leave a permanent effect. For this reason also in dreams we have no memory of former dreams. (6) All have observed that there is no feeling of time or of space in dreams. We live in an ideal world. This probably arises from the absence of fixity of thought, so that there is no apparent connection between the successive pictures of the imagination. (7) In some dreams the activity of the cerebrum is such that the train of thoughts prompts to movement, and the sleeper may be heard muttering in his sleep or tossing the arms or making gestures. There are gradations between this condition of a "troubled" dream and that of true somnambulism.

Somnambulism.

Somnambulism.—Some persons rise during sleep, walk about, apparently unconscious of all external impressions, after a time return to bed, and when they are awake they have no recollection of any of these occurrences. Sometimes the actions performed are of a complicated character and bear some relation to the daily life of the sleeper. Thus a cook has been known to rise out of bed, carry a pitcher to a well in the garden, fill it, go back to the house, fill various vessels carefully and without spilling a drop of water, then return to bed, and have no recollection of what had transpired. Again, somnambulists have been observed to write letters or reports, execute drawings, and play upon musical instruments. Frequently they have gone along dangerous paths, executing delicate movements with precision. Four types of somnambulist may be noticed,—(1) those who speak without acting, a common variety often observed in children and not usually considered somnambulistic: (2) those who act without speaking, also well known and the most common type; (3) those who both act and speak, more exceptional; and (4) those who both act and speak and who have not merely the sense of touch active but also the senses of sight and hearing. The fourth class is the most extreme type and merges into the physiological condition of mesmerism or hypnotism. This peculiar condition has already been fully described under animal magnetism (see MAGNETISM, ANIMAL), and it is necessary here only to notice it in connection with the subject of sleep. Many observations indicate that, at all events in some cases, the somnambulist, engaged, for example, in writing, has a mental picture of the page before him and of the words he has written. He does not see what he really writes. This has been proved by causing persons to write on a sheet of paper lying on the top of other sheets. After he has been allowed to write a few sentences, the sheet was carefully withdrawn and he continued his writing on the next sheet, beginning on the new sheet at the corresponding point where he left off on the first one. Moreover, the somnambulist, by force of habit,

	Organic Life.	Consciousness.	Imaginative Faculties.	Co-ordinating Faculties.	Power of Movement and Sensibility.
Normal waking state	—	—	—	—	—
Sleep, 1st degree	—	—	—	—	
" 2d degree	—	—	—		
" 3d degree	—	—			
Deep sleep	—				
Waking, 1st degree	—	—			
" 2d degree (specially dreaming state)	—	—	—		
" 3d degree	—	—	—	—	
Complete waking	—	—	—	—	—
Dreaming state	—	—	—		
Ordinary somnambulism —(2) above	—		—	—	—
Profound somnambulism (perfect unconsciousness)	—				—
Somnambulistic dream (movements in a dream)	—		—		—

stroked t's and dotted i's at the exact places where the t's and i's would have been had he written continuously on one sheet, showing that what he was conscious of was not what was before him but the mental picture of what he had done.

The preceding table, modified from two such tables given by Ball and Chambord in their exhaustive article "Somnambulisme," in the *Dictionnaire Encyclopédique des Sciences Médicales*, shows the relation of the various intermediate conditions of sleeping and awaking, and of the dreaming and somnambulistic states. The horizontal stroke indicates the presence of the condition the name of which heads the column.

The somnambulist acts his dream. His condition is that of a vivid dream in which the cerebrum is so active as to influence centres usually concerned in voluntary movements. Under the dominant idea he executes the movements that this idea would naturally excite in the waking state. Many of his movements are in a sense purposive; his eyes may be shut, so that the movements are executed in the dark, or the eyes may be open so that there is a picture on the retina that may awaken no consciousness, and yet may, by reflex mechanisms, be the starting point of definite and deliberate movements. In many cases he does not hear, the auditory centres not responding; but in others suggestive words may alter the current of his dream and lead him to perform other actions than what he intended to do. On awaking, there is either no memory of what has taken place, or the dim recollection of a fading dream.

It is important to notice that there is scarcely any action of which a somnambulist may not be capable, and immoral acts from which the individual would shrink in waking hours may be performed with indifference. Considering the abrogation of self-control peculiar to the physiological condition, it is evident that no moral responsibility can be attached to such actions. In cases where somnambulistic propensities place a person in danger, an endeavor should be made to induce him to return to bed without awaking him; as a rude awakening may produce a serious shock to the nervous system. Inquiry should then be made into the exciting cause of the somnambulistic dream, such as a particular train of thought, over-excitement, the reading of special books, the recollection of an accident or of a crisis in the person's history, with the view of removing the cause if possible. It should never be forgotten that somnambulism, like chorea, hysteria, and epilepsy, is the expression of a general morbid predisposition, an indication of a nervous diathesis, requiring careful treatment so as to avoid more dangerous maladies.

See article, "Sommeil," in the *Dictionnaire Encyclopédique des Sciences Médicales*, where a full bibliography is given, and where also there is an account of the medico-legal questions connected with sleep and somnambulism; Macnish, *Physiology of Sleep;* Durham, "On the Physiology of Sleep," in Gay's *Hospital Reports*, 1860; Kohlschütter, "Die Mekanik des Schlafes," in *Z. f. ration. Med.*, vol. xxxiii., 1869; Pflüger, "Theorie des Schlafes," in *Pflüger's Archiv*, vol. x., 1875; Mosso, *Ueber den Kreislauf des Blutes im menschlichen Gehirn*, Leipsic, 1881. As to somnambulism, see the article on the subject, in the *Dictionnaire*, both for full details and a copious bibliography. (J. G. M.)

SLEIDANUS, JOHN (*c.* 1506–1556), the annalist of the Reformation, was born at Schleiden (now a small village in the Olefflthal, about 42 miles southwest of Cologne) in 1506 or 1508. Passing from the village school, he studied at Liége, Cologne (?), Louvain (where he became tutor to the son of Count Manderscheid of Schleiden), Paris, and Orleans (where he studied law). In 1536 he became secretary to Cardinal du Bellay, minister of Francis I., and spent five years with him and with his brother, Cardinal Guillaume du Bellay. The Cardinals Du Bellay belonged to that party among the French nobility who desired on political grounds an alliance between the German Protestants and Francis against the emperor Charles V., and who employed the leaders of the Strasburg citizens as intermediaries. Sleidanus, whilst among the humanists of Liége, had adopted Protestant opinions, had learned to distrust the Romanist policy of Charles V., and was himself a strong supporter on religious and political grounds of the plans of the brothers Du Bellay. Their confidence in him was such that he was sent (1540) to watch the conduct of the French ambassador at Hagenau, and this brought him into personal relation with the German Protestant leaders. Next year Du Bellay sent him to confer with the heads of the Schmalkaldic League, when he found his patron's ideas unacceptable. Philip of Hesse and the elector of Saxony would make no alliance with a foreign power against the emperor, and distrusted Francis personally because of his persecution of French Protestants. It is possible that this news made Du Bellay feel that he had no further need for his secretary, for we find Sleidanus leading a wandering life for two years, and finally making Strasburg his home, although he still kept up a political correspondence with France. Sleidanus had been accustomed to copy all documents bearing upon the Reformation to which he had access, and Bucer, who had seen his collection, proposed to Philip of Hesse to appoint him historian of the Reformation, giving him a salary and access to all necessary documents. After some delay the heads of the Schmalkaldic League agreed to Bucer's proposal, and Sleidanus began his great work and finished the first volume in 1545. In that year he was again recalled to diplomacy, and went to England in a French embassy to Henry VIII. While there he diligently collected materials for his history. On his return to Strasburg he was sent by that city as one of its representatives to the diets of Frankfort and Worms; and thence he proceeded to Marburg to explore the archives of Philip of Hesse. The Schmalkald War interfered with this work, and also prevented the payment of Sleidanus, who in his difficulties applied to England for aid, and at Cranmer's intercession received a yearly pension (not long continued) from Edward VI. In 1551 Sleidanus went to the council of Trent as representative from Strasburg, charged also with full powers to act for the imperial cities, Esslingen, Ravensburg, Reutlingen, Biberach, and Lindau. On his return his friends got him appointed professor of law in Strasburg, and he was once more able to give his whole attention to his great work, which he finished for the press in 1554. But want of money, the death of his wife—whom he had married in 1546 on his return from the diet of Frankfort—and other misfortunes, compelled him to delay printing. The book at length appeared,—*Commentariorum de statu religionis et reipublicæ, Carolo V. Cæsare, Libri XXVI.* (translated into English by John Daws in 1560 and by G. Bohum in 1689). But the troubles of Sleidanus were not ended. The work was too impartial to please any one, and even the gentle Melanchthon was unable to praise it. It remains, notwithstanding, the most valuable contemporary history of the times of the Reformation, and contains the largest collection of important documents. The author died at Strasburg in October, 1556, in poverty, and inconsolable since the death of his wife.

See H. Baumgarten, *Ueber Sleidanus Leben und Briefwechsel* (1878), and *Sleidans Briefwechsel* (1881).

SLIGO, a maritime county in the northwest of Ireland, in the province of Connaught, is situated between 53° 54′ and 54° 28′ N. lat. and between 8° 10′ and 9° 10′ W. long., and is bounded N. by the Atlantic, E. by Leitrim, S.E. by Roscommon, and S. and W. by Mayo. The total area is 451,129 acres, or nearly 705 square miles. Its greatest length from north to south, between Mullaghmore Head and Lough Gara, is 38 miles and its greatest breadth from east to west is 41.

The coast-line is very irregular and in some places rises into grand escarpments and terraces. The principal inlets are Killala Bay and Sligo Bay, the latter subdivided into Brown Bay, Drumcliffe Bay, and Ballysadare Bay. Near the coast are the islets of Inishmurray, Coney, and Oyster. Though Sligo cannot be compared for scenery with the western parts of Mayo, it is in many places charmingly picturesque, being well wooded and possessing several fine lakes and rivers, as well as some ranges of hills which from their situation and grouping have a very striking effect. In the north are the limestone elevations of Benbulbin (1722 feet) and Knocknarea (1078), contrasting finely with the adjacent rugged gneiss mountains, among which are King's Mountain (1965 feet) and Gullogherboy (1430). In the west are the ranges of the Slieve Gamph and Ox Mountains, 1300 and 1600 feet respectively. The Curlew Mountains (nearly 900 feet high) separate Sligo from Roscommon. The principal rivers are the Moy, forming for a part of its course the boundary with Mayo, and flowing southwestwards and then northwards into Killala Bay; the Easky, flowing northwards from Lough Easky; the Ballysadare, with its branches the Owenmore, Owenbeg, and Arrow or Unshin; and the Garvogue, flowing from Lough Gill. Except the finely situated Lough Gill (3130 acres) extending into Leitrim, Lough Arrow (3010), and Lough Gara (3683), none of the lakes have so large an area as 400 acres.

The Carboniferous Mountain Limestone forms the basis of a great part of the county, and includes the Lower Limestone calp or black shale series and the Upper Limestone, which rises occasionally into a lofty tableland. There is a small tract of Yellow Limestone in the extreme north, as also on the north and northeast of Lough Gara, whence it extends into Mayo. The Old Red Sandstone appears in two masses near Lough Arrow. A small tract of granite enters the county on the southwest, coming from between Lough Conn and Foxford in Mayo, giving place to a broad belt of trap porphyry bounded by a narrow fringe of Old Red Sandstone, which stretches in a northeasterly direction along the line of the Ox Mountains to Ballysadare Bay. Iron is abundant, especially in the neighborhood of the Ox Mountains, but from want of fuel is not worked. Pure copper is found in the beds of some of the rivers, and sulphate of copper and iron pyrites occur in some places.

Agriculture.—There is considerable variety both in the character of the soil and in the agricultural advancement in different parts of the county. In some parts it is a light sandy loam resting on a freestone bottom, and in the lower districts a rich and deep mould prevails resting on a substratum of limestone. Owing to the moistness of the climate cattle feeding is found to be the most remunerative method of farming. Out of a total of 451,429 acres 231,753 or 51.3 per cent. in 1884 were under grass, 86,365 under crops, 38,431 bog and marsh, 70,599 barren mountain land, 7577 woods and plantations, and 417 fallow, the remaining 15,987 acres being under water, roads, fences, etc. The total number of holdings was 15,352, there being 752 under 1 acre, 1443 between 1 and 5 acres each in extent, 5834 between 5 and 15, 4592 between 15 and 30, 1520 between 30 and 50, and 1211 of 100 acres and upwards. The total area under corn crops in 1884 was 24,324 acres, while in 1875 it was 30,810; under green crops 25,897, in 1875 30,491; under meadow and clover 36,120, in 1875 32,396; and under flax 24, in 1875 175,—the total area under tillage having decreased between 1875 and 1884 from 93,872 to 86,365 acres. Of the corn crops in 1884 oats occupied 23,055 acres, and green crops and potatoes 19,835. The number of horses between 1875 and 1884 increased from 7244 to 8292, of asses from 7588 to 8471; cattle decreased from 97,658 to 89,458, sheep from 65,857 to 64,324; pigs, again, increased from 19,726 to 26,996, goats from 3081 to 4745, and poultry from 277,113 to 305,509. According to the landowners' return Sligo was divided among 856 proprietors, possessing 448,397 acres at an annual value of £210,382 [$1,022,456.52], or about 9s. 4½d. [$2.28] per acre. The principal proprietors were Colonel E. H. Cooper, 34,120 acres; Sir Robert Gore Booth, 31,774; Charles W. O'Hara, 21,070; W. R. O. Gore, 21,019; Owen Wynne, 12,982; Colonel King-Harman, 12,629; Hon. Evelyn Ashley, 12,426; and William Phibbs, 10,507.

Manufactures and other Industries.—Coarse woollens and linens are manufactured for home consumption, and there are tanneries, distilleries, and breweries in the principal towns. A considerable general trade is carried on at the ports of Ballina (on the Moy) and Sligo. The fisheries on the coast are valuable, and there are important salmon fisheries at the mouths of the rivers.

Administration and Population.—The county is divided into 6 baronies, and contains 37 parishes and 4 parts of parishes, and 1292 townlands. The county has three poor-law unions—Dromore West, Sligo, and Tobercurry—with parts of the unions of Ballina and Boyle (Roscommon). It is in the Connaught circuit, and assizes are held at Sligo and quarter sessions at Ballymote, Easky, and Sligo. It is in the Dublin military district, and there are barracks at Sligo. For parliamentary representation the county has since 1885 formed two divisions (North and South), each returning a member. Between 1841 and 1851 the population decreased from 180,886 to 128,515 or 29 per cent., and by 1881 it had decreased to 111,578 (55,144 males, 56,434 females), or 38.3 per cent. since 1841. In 1881 the number of persons who could read and write was 52,602, who could read only 15,574, who could neither read nor write 43,402. There were 2326 who could speak Irish only, while 24,263 could speak Irish and English. There were 10 superior schools with 266 pupils, of whom 142 were Catholics and 124 Protestants, and 211 primary schools with 13,714 pupils, of whom 12,070 were Catholics and 1644 Protestants. The principal towns are Sligo (population 10,808 in 1881), Ballina (1442 in Sligo and 4318 in Mayo), Ballymote (1145), and Tobercurry (1081).

History and Antiquities.—In the time of Ptolemy the district was inhabited by the *Nagnatæ*, the capital *Nagnata* being somewhere near the site of the present town of Sligo. Afterwards it was possessed by a branch of the O'Connors, called O'Connor Sligo. On the landing of Henry II. it gradually fell into the power of the De Burgos. The district formed part of Connaught, which, in the reign of Elizabeth, was divided into seven counties. On the lands of Carrowmore, between Sligo and Ballysadare, there is a remarkable collection of Druidical remains, consisting of cairns, a circle, cromlechs, and pillar stones. At Drumcliffe is the only round tower now remaining in the county, and a beautiful Celtic cross 13 feet in height. The principal monastic ruins are the abbey of St. Fechan at Ballysadare, with an ancient church displaying some curious architecture of the 11th or 12th century; the remarkable group of buildings on Inishmurray; and the abbey of Sligo, noticed under the town below. There are a considerable number of old castles, but none of special interest.

SLIGO, the chief town of the above county and an important seaport, is finely situated at the mouth of the Garvogue, near Lough Gill, 137 miles northwest of Dublin by rail. The town is rather irregularly built and has a decayed appearance, which somewhat belies its actual prosperity. Formerly it was fortified by a castle and walls, but of these there are now no remains. The abbey, founded in 1252 by Maurice Fitzgerald, lord-justice, is one of the finest monastic ruins in Ireland. It was partly destroyed by fire in 1414 and again in 1642. Within recent years measures have been taken to preserve it. Three sides of the cloister of the quadrangle still remain, and the lofty quadrangular tower at the junction of the nave and chancel is entire. The eastern window, still very perfect, is of the date of the original structure. The principal modern buildings are the new Catholic cathedral, in the Norman style with a finely sculptured doorway, the town-hall (1865–66), the county court-house, the custom-house, the lunatic asylum, and the barracks. The quays are commodious, and steamers ply to and fro between Sligo and Glasgow, Liverpool, and Londonderry,—the principal exports being cattle, fowls, eggs, and butter, and the imports coal, iron, timber, and provisions. The port is under the control of harbor commissioners. There is an important butter-market, and maize, flour, and corn mills. The population in 1861 was 10,693, and in 1881 it was 10,808.

A castle was built at Sligo by Maurice Fitzgerald in 1242, which in 1270 was taken and destroyed by O'Donnell; in 1310 it was rebuilt by Richard, earl of Ulster, and was again partly destroyed in 1369 and 1394. Early in the reign of James I. the town received a market and two annual fairs; in 1613 it was incorporated and received the privileges of a borough; and in 1621 it received a charter of the staple. In 1641 it was besieged by the Parliamentary forces under Sir Charles Coote, but was afterwards evacuated, and occupied by the Royalists till the termination of the war. In 1688 it declared in favor of James II., and, after being captured by the Enniskilleners, was retaken by General Sarsfield, but ultimately surrendered to the earl of Granard. The borough was disfranchised in 1870.

SLIVEN, SLIVNO, SELIMNIA, ISLEMNIYE or ISLIMYE, an important town of East Roumelia, situated at the southern base of the Balkans, 750 feet above the sea, where several mountain streams flow south to the Tunja, a tributary of the Maritza. The luxuriant foliage of its trees and the general picturesqueness of its appearance gain in effect by the contrast which they present with the bare gneiss and porphyry summits that rise immediately to the north. On the south it is surrounded by orchards, gardens and extensive mulberry plantations. Besides a large number of mosques, the public buildings comprise a synagogue and four Christian churches; but there is nothing of much architectural interest in the town. A Government factory for the manufacture of military clothing was established in 1834; there is a good silk industry; and Sliven red wine is famous. The population (Turks, Bulgarians, Armenians, Greeks, Jews, and Gypsies) was 22,000 in 1872.

Sliven, the Stlifanos of the Byzantine writers, owes a good deal of its importance to its strategical position on one of the trans-Balkan highways to Adrianople and the south. In early times, when it was a subject of dispute between Byzantium and Bulgaria, it generally followed the fate of Aidos and Mesembria (Misivri). After its capture by the Turks (1388) it was one of the "voinik" towns which remained exempt from taxes and were allowed to elect their own voivode; but those privileges were lost in the 16th century. On 12th August, 1829, Sliven was occupied by the Russian army under Rüdiger and Gortchakoff.

SLOANE, Sir Hans (1660–1753), a celebrated collector and successful physician, was born on 16th April, 1660, at Killileagh in county Down, Ireland, where his father had settled at the head of a Scotch colony sent over by James I. He had as a youth a strong turn for collecting objects of natural history and other curiosities. This led him to the study of medicine, which he went to London to pursue, directing his attention assiduously to botany, materia medica and pharmacy. His collecting propensities made him useful to the more philosophically minded Ray and Boyle, and procured him their patronage. After four years in London he travelled through France, spending some time at Paris and Montpellier, and taking his M.D. degree at the university of Orange. He returned to London with a considerable collection of plants and other curiosities, of which the former were sent to Ray and utilized by him for his *History of Plants*. Sloane was quickly elected into the Royal Society, and at the same time he had the good fortune to attract the notice of Sydenham, who took a fancy to him and gave him valuable introductions to practice. In 1687 he became fellow of the College of Physicians, and took the opportunity of proceeding to Jamaica the same year as physician in the suite of the duke of Albemarle. The duke died soon after landing, and Sloane's visit lasted only fifteen months; but during that time he got together about 800 new species of plants, the island being at the time virgin ground to the botanist. Of these he published an elaborate catalogue in Latin; and at a later date (1707–25) he made the experiences of his visit the subject of two sumptuous folio volumes. His merits as a collector were sufficient to give him a high place in the scientific circles of the time. He became secretary to the Royal Society in 1693, and edited its *Transactions* for twenty years. His practice as a physician among the upper classes was large and lucrative; he is said to have inspired the members of the court and aristocracy with the "greatest confidence in his prescriptions." In the pamphlets written concerning Dr. Cockburn's sale of a secret remedy for dysentery and other fluxes, it was stated for the defence that Sloane himself did not disdain the same kind of professional conduct; and there is some color given to that charge by the fact that his only medical piece, an *Account of a Medicine for Soreness, Weakness and other Distempers of the Eyes* (London, 1745) was not given to the world until its author was in his eighty-fifth year, and had retired from practice.

On the accession of George I. Sloane was made physician-general to the army, and in 1716 was created a baronet, being the first medical practitioner to receive an hereditary title. In 1719 he became president of the College of Physicians, and held the office sixteen years. In 1727 he succeeded Sir Isaac Newton in the presidential chair of the Royal Society; he retired from it at the age of eighty, "much against the inclination of that respectable body, who chose Martin Folkes to succeed him, and in a public assembly thanked him for the great and eminent services which he had rendered them." Sloane's memory survives more by his judicious investments than by anything that he contributed to the subject-matter of natural science or even of his own profession; his name is absolutely unknown in the history of medicine, and his services to botany were such as, in the nature of things, would be soon forgotten. But his purchase of the manor of Chelsea has perpetuated his memory in the name of a "place," a street, and a square. His great stroke as a collector was to acquire (by bequest, conditional on paying off certain debts) in 1701 the cabinet of William Courten, who had made collecting the business of his life. When Sloane retired from active work in 1741 his library and cabinet of curiosities, which he took with him from Bloomsbury to his house in Chelsea, had grown to be very extensive and of unique value. On his death on 11th January, 1753, he bequeathed his books, manuscripts, prints, drawings, pictures, medals, coins, seals, cameos, and other curiosities to the nation, on condition that parliament should pay to his executors £20,000 [$97,200], which was a good deal less than the value of the collection. The bequest was accepted on those terms by an Act passed the same year, and the collection, together with George II.'s royal library, etc., was opened to the public at Bloomsbury as the British Museum in 1759. Among his other acts of benevolence or munificence may be mentioned his gift to the Apothecaries' Company of the freehold of the botanical or physic garden, which they had rented from the Chelsea estate since 1673, also his help in starting the foundling hospital. Sloane is described as having been a man of considerable presence and of courtly address.

See Weld, *History of the Royal Society*, i. 450 (London, 1848); and Munk, *Roll of the College of Physicians*, 2d ed., i. 466 (London, 1878).

SLODTZ, René Michel or Michel Ange (1715–1764), French sculptor, was born at Paris on 29th September, 1715. He passed seventeen years of his life at Rome, where he was chosen to execute a statue of St. Bruno, one of the best modern works of the class in St. Peter's. He was also the sculptor of the tomb of Marquis Capponi in St. John of the Florentines. Other works of his are to be seen at the church of St. Louis of France and at Santa Maria della Scala. After his return to France, Slodtz, in conjunction with his brothers Sebastian and Paul, produced many decorative works in the churches of Paris, and, though much has been destroyed, his most considerable achievement—the tomb of Languet de Gergy in St. Sulpice—exists at the present day. He died at Paris on 26th October, 1764.

Slodtz had been, like his brothers, a member of the Academy of Painting and Sculpture, and many particulars of his life are preserved in a memoir written by Cochin, and also in a letter from the same to the *Gazette Littéraire*, which was reproduced by Castilhon in the *Nécrologe* of 1766. Slodtz's father (1655–1726) was also a sculptor, born at Antwerp; he became a pupil of Girardon and worked mostly under him at Versailles and the Tuileries.

See C. N. Cochin, *Mém. inéd.*, Paris, 1881; Barbet de Jouy, *Sculpture moderne du Louvre*, Paris, 1856; Dussieux, *Artistes Français à l'Étranger*, Paris, 1852.

SŁONIM, a district town of Russia, in the government of Grodno, 105 miles southeast of Grodno and 20 from the railway from Moscow to Warsaw, on the high craggy banks of the Schara. It derives its importance from this river, which is navigable and enters the system of the Oginski Canal connecting the Niemen with the Dnieper. Corn, tar, and especially timber are exported annually to a large amount, which in 1882 reached the value of £20,700 [$100,602]. The population was 21,110 in 1883.

Slonim is a very old town, being mentioned in 1040, when Yaroslaff defeated the Lithuanians in its neighborhood and compelled them to acknowledge his rule. In 1241 the Mongols, under Batyi, pillaged it and burned its wooden fort. Owing to its position between Galician Russia and Lithuania, it often changed hands until it was conquered by the Lithuanians in the 14th century. From 1631 to 1685 it was the seat of the Lithuanian *seim* and became a flourishing city. In the 18th century, under the hetman Oginski, a canal was dug to connect the Schara with the Dnieper. Oginski embellished the city and founded there a printing-office. Russia annexed the town in 1795.

SLOTH. The general characters by which the family *Bradypodidæ* are distinguished from the rest of the order *Edentata* have been given in the article MAMMALIA (vol. xv. p. 387). The sloths, as the animals of this family are called on account of the habitual sluggishness of their movements, are the most strictly arboreal of all mammals, living entirely among the branches of trees, usually hanging under them, with their backs downwards, and clinging to them with the simple hook-like organs to which the terminations of all their limbs are reduced. When they are obliged from any cause to descend to the ground, which they rarely, if ever, do voluntarily, their limbs, owing to their unequal length and the peculiar conformation of the feet—which allows the animals to rest only on the outer edge—are most inefficient for terrestrial progression, and the sloths crawl along a level surface with considerable difficulty. Though generally slow and inactive, even when in their natural haunts, they can on occasions travel with considerable rapidity along the branches, and, as they do not leap, like most other arboreal creatures, they avail themselves of the swaying of the boughs by the wind to pass from tree to tree. They feed entirely on leaves and young shoots and fruits, which they gather in their mouth, the fore-limbs aiding in dragging boughs within reach, but not being used as hands, as they are by monkeys, squirrels, etc. When sleeping they roll themselves up in a ball, and, owing to the dry shaggy character of their hair, are very inconspicuous among the mosses and lichens with which the trees of their native forests abound; and the concealment thus afforded is heightened in some species by the peculiar greenish tint of the outer covering,—very uncommon in mammals. This is not due to the color of the hair itself, but to the presence upon its surface of an alga, the lodgment of which is facilitated by the fluted or rough surface of the exterior of the hair, and the growth of which is promoted by the dampness of the atmosphere in the gloomy tropical forests, as it soon disappears from the hair of animals kept in captivity in England. Sloths are nocturnal, silent, inoffensive, and solitary animals, and produce usually but one young at birth. They appear to show an almost reptilian tenacity of life, surviving the most severe injuries and large doses of poisons, and exhibiting longer persistence of irritability of muscular tissue after death than other mammals.

Two-toed sloth (*Cholœpus hoffmanni*).

The sloths were all included in the Linnean genus *Bradypus*, but Illiger very properly separated the species with but two claws on the fore-feet, under the name of *Cholœpus*, leaving *Bradypus* for those with three.

Genus *Bradypus*.—Three-toed sloths. Teeth usually $\frac{5}{4}$ on each side; no tooth projecting greatly beyond the others; the first in the upper jaw much smaller than any of the others; the first in the lower jaw broad and compressed; the grinding surfaces of all much cupped. Vertebræ: C 9, D and L 20 (of which 15 to 17 bear ribs), S 6, C 11. All the known species present the remarkable peculiarity of possessing nine cervical vertebræ, *i.e.*, nine vertebræ in front of the one which bears the first thoracic rib (or first rib connected with the sternum, and corresponding in its general relations with the first rib of other mammals); but the ninth, and sometimes the eighth, bears a pair of short movable ribs. The arms or fore-limbs are considerably longer than the hind legs. The bones of the fore-arm are complete, free, and capable of pronation and supination. The hand is long, very narrow, habitually curved, and terminates in three pointed curved claws, in close apposition with each other; they are, in fact, incapable of being divaricated, so that the hand is reduced to the condition of a triple hook, fit only for the function of suspension from the boughs of trees. The foot closely resembles the hand in its general structure and mode of use. The sole is habitually turned inwards and cannot be applied to the ground in walking. The tongue is short and soft, and the stomach large and complex, bearing some resemblance to that of the ruminating animals. The windpipe or trachea has the remarkable peculiarity among mammals—not unfrequent among birds and reptiles—of being folded on itself before it reaches the lungs. The mammæ are two and pectoral in position.

"Ai" is the common name given in books to the three-toed sloths. They were all comprised by Linnæus under the species *Bradypus tridactylus*. More recently Dr. Gray has described as many as eleven, ranged in two genera, *Bradypus* and *Arctopithecus*; but the distinctions which he assigns both to species and to genera do not bear close examination. Some are covered uniformly with a gray or grayish-brown coat; others have a dark collar of elongated hairs around the shoulders (*B. torquatus*); some have the hair of the face very much shorter than that of the rest of the head and neck; and others have a remarkable-looking patch of soft short hair on the back between the shoulders, consisting when best marked of a median stripe of glossy black, bordered on each side by bright orange, yellow, or white. There are also structural differences in the skulls, as in the amount of inflation of the pterygoid bones, which indicate real differences of species; but the materials in our museums are not yet sufficient to correlate these with external characters and geographical distribution. The habits of all are apparently alike. They are natives of Guiana, Brazil, and Peru, and one if not two species (*B. infuscatus* and *B. castaneiceps*) extend north of the Isthmus of Panama as far as Nicaragua. Of the former of these Dr. Seeman says that, though generally silent, a specimen in captivity uttered a shrill sound like a monkey when forcibly pulled away from the tree to which it was holding.[1]

Genus *Cholœpus*.—Teeth $\frac{5}{4}$; the most anterior in both jaws separated by an interval from the others, very large, caniniform, wearing to a sharp, bevelled edge against the opposing tooth, the upper shutting in front of the lower when the mouth is closed, unlike the true canines of heterodont mammals. Vertebræ: C 6 or 7, D 23–24, L 3, S 7–8, C 4–6. One species (*C. didactylus*) has the ordinary number of vertebræ in the neck; but an otherwise closely allied form (*C. hoffmanni*) has but six. The tail is very rudimentary. The hand generally resembles that of *Bradypus*; but there are only two functional digits, with claws,—those answering to the second and third of the typical pentadactyle manus. The structure of the hind limb generally resembles that of *Bradypus*, the appellation "two-toed" referring only to the anterior limb, for in the foot the three middle toes are functionally developed and of nearly equal size. *C. didactylus*, which has been longest known, is commonly called by the native name of *Unau*. It inhabits the forests of Brazil. *C. hoffmanni* has a more northern geographical range, extending from Ecuador through Panama to Costa Rica. Its voice, which is seldom heard, is like the bleat of a sheep, and if the animal is seized it snorts violently. Both species are very variable in external coloration. (W. H. F.)

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[1] Godman and Salvin's *Biologia Centrali-Americana*, p. 184.

SLOUGH, an urban sanitary district of Buckinghamshire, England, is situated on the Great Western Railway, 18½ miles west of London and 2 north of Windsor. Within recent years it has largely increased, and it contains a number of good shops and villas. It is supplied with water from artesian wells. The parish church of St. Mary, erected 1837, has been recently enlarged. Among other public buildings are the British orphan asylum, the Eton union workhouse, and the reading-room and literary institute. Sir William Herschel, the astronomer, resided at Slough, and there constructed his telescope. The population of the urban sanitary district, which embraces parts of the parishes of Stoke Poges and Upton-cum-Chalvey, in 1871 was 4509, and in 1881 (area, 401 acres) it was 5095.

SLOVAKS. See SLAVS.

SLOVENES. See SLAVS.

SLUG. See SNAIL.

SLUTSK, a district town of Russia, in the government of Minsk, situated on the Slutcha river (tributary of the Pripet), 123 miles south of Minsk. This old town is mentioned in the 12th century as a dependency of Kieff, and, like other towns of the region, was devastated by the Tatars, and later suffered in the wars between Russia and Poland. It is now merely a large village, whose inhabitants are chiefly engaged in agriculture, with a little trade in corn, timber, and wooden wares. The immense marshy and woody tracts of the Polyesie (see MINSK) surround it on all sides, the Slutcha being its chief means of communication. Its population remains almost stationary and was 19,000 in 1883.

SMALLPOX, or VARIOLA (*varus*, "a pimple"), an acute infectious disease characterized by fever and by the appearance on the surface of the body of an eruption, which, after passing through various stages, dries up, leaving more or less distinct cicatrices. Few diseases have been so destructive to human life as smallpox, and it has ever been regarded with horror alike from its fatality, its loathsome accompaniments and disfiguring effects, and from the fact that no age and condition of life are exempt from liability to its occurrence. Although in most civilized countries its ravages have been greatly limited by the protection afforded by vaccination, yet epidemic outbreaks are far from uncommon, affecting especially those who are unprotected, or whose protection has become weakened by lapse of time.

Much obscurity surrounds the early history of smallpox. It appears to have been imported into Europe from Asia, where it had been known and recognized from remote antiquity. The earliest accounts of its existence reach back to the middle and end of the 6th century, when it was described by Procopius and Gregory of Tours as occurring in epidemic form in Arabia, Egypt, and the south of Europe. In one of the narratives of the expedition of the Abyssinians against Mecca (*c.* 550) the usual miraculous details are combined with a notice of smallpox breaking out among the invaders.[1] Not a few authorities, however, regard these accounts as referring not to smallpox but to plague. The most reliable statements as to the early existence of the disease are found in Rhazes (see vol. xv. p. 815), by whom its symptoms were clearly described, its pathology explained by a humoral or fermentation theory, and directions given for its treatment. During the period of the crusades smallpox appears to have spread extensively through Europe, and hospitals for its treatment were erected in many countries. But at this period and for centuries afterwards the references to the subject include in all likelihood other diseases, since no precise distinction appears to have been made between the different forms of eruptive fever until a comparatively recent date. Smallpox was known in England as early as the 13th century, and had probably existed there before. It appears to have been introduced into America shortly after the discovery of that continent, and there, as in Europe and throughout the known world, destructive epidemics were of frequent occurrence during succeeding centuries.

Contagion.

The only known factor in the origin of smallpox is contagion,—this malady being probably the most contagious of all diseases. Its outbreak in epidemic form in a locality may frequently be traced to the introduction of a single case from a distance. The most direct means of communicating smallpox is inoculation (see below). By far the most common cause of conveyance of the disease, however, is contact with the persons or the immediate surroundings of those already affected. The atmosphere around a smallpox patient is charged with the products of the disease, which likewise cling tenaciously to clothing, furniture, etc. The disease is probably communicable from its earliest manifestations onwards to its close, but it is generally held that the most infectious period extends from the appearance of the eruption till the drying up of the pustules. Smallpox may also readily be communicated by the bodies of those who have died from its effects. No age is exempt from susceptibility to smallpox. Infants are occasionally born with the eruption or its marks upon their bodies, proving that they had undergone the disease *in utero*. Dark-skinned races are said to suffer more readily and severely than whites. One attack of smallpox as a rule confers immunity from any recurrence, but there are numerous exceptions to this rule. Over-crowding and all insanitary surroundings favor the spread of smallpox where it has broken out; but the most influential condition of all is the amount of protection afforded to a community by previous attacks and, especially in the present day by vaccination. Such protection, although for a time most effectual, tends to become exhausted, unless renewed. Hence in a large population there is always likely to be an increasing number of individuals who have become susceptible to smallpox. This probably explains its occasional and even apparently periodic epidemic outbreaks in large centres, and the well-known fact that the most severe cases occur at the commencement,—those least protected being necessarily more liable to be first and most seriously attacked.

Symptoms.

While the symptoms of smallpox are essentially the same in character in all cases, they are variously modified according to the form which the disease may assume, there being certain well-marked varieties of this as of most other infectious maladies. The following description applies to an average case. After the reception into the system of the smallpox contagion the onset of the symptoms is preceded by a period of incubation, during which the patient may or may not complain. This period is believed to be from about ten to fourteen days. In cases of direct inoculation of the virus it is considerably shorter. The invasion of the symptoms is sudden and severe, in the form of a rigor followed by fever (the *primary fever*), in which the temperature rises to 103° to 104° Fahr. or higher notwithstanding that perspiration may be going on. A quick pulse is present, together with thirst and constipation, while intense headache accompanied with vomiting and pain in the back is among the most characteristic of the initial symptoms. Occasionally the disease is ushered in by convulsions. Some authorities hold that the more violent the invasion the more severe the attack is likely to prove. These symptoms continue with greater or less intensity throughout two entire days, and during their course there may occasionally be noticed on various parts of the body, especially on the lower part of the abdomen and inner sides of the thighs, a diffuse redness accompanied by slight spots of extravasation (*petechiæ*), the appearance somewhat resembling that of scarlet fever. These "prodromal rashes," as they are termed, appear to be more frequent in some epidemics than in others, and they do not seem to have any special significance. They are probably more frequently seen in cases of the mildest form of smallpox (varioloid), referred to below. On the third day the characteristic eruption begins to make its appearance. It is almost always first seen on the face, particularly about the forehead and roots of the hair, in the form of a general redness; but upon this surface there may be felt by the finger numerous elevated points more or less thickly set together. The eruption, which is accompanied by heat and itching, spreads over the face, trunk, and extremities in the course of a few hours,—continuing, however, to come out more abundantly for one or two days. It is always most marked on the exposed parts; but in such a case as that now described the individual "pocks" are separated from each other (discrete). On the second or third day after its appearance the eruption undergoes a change,—the pocks becoming vesicles filled with a clear fluid. These vesicles attain to about the size of a pea, and in their centre there is a slight depression, giving the characteristic umbilicated appearance to the pock. The clear contents of these vesicles gradually become turbid, and by the eighth or ninth day they are changed into pustules containing yellow matter, while at the same time they increase still further in size and lose the central depression. Accompanying this change there are great surrounding inflammation and swelling of the skin, which, where the eruption is thickly set, produce much disfigurement and render the features unrecognizable, while the affected parts emit an offensive odor, particularly if, as often happens, the pustules break. The eruption is present not only on the skin but on mucous membranes, that of the mouth and throat being affected at an early period; and the swelling produced here is not only a source of great discomfort but even of danger from the obstruction thus occasioned in the upper portion of the air-passages. The voice is hoarse and a copious flow of saliva comes from the mouth. The mucous membrane of the nostrils is similarly affected, while that of the eyes may also be involved, to the danger of permanent impairment of sight. The febrile symptoms which ushered in the disease undergo marked abatement on the appearance of the eruption on the third day, but on the eighth or ninth, when the vesicles become converted into pustules, there is a return of the fever (*secondary* or *suppurative fever*), often to a severe extent, and not unfrequently accompanied by prominent nervous phenomena, such as great restlessness, delirium, or coma. On the eleventh or twelfth day the pustules show signs of drying up (desiccation), and along with this the febrile symptoms decline. Great itching of the skin attends this stage. The scabs produced by the dried pustules gradually fall off and a reddish-brown spot remains, which, according to the depth of skin involved in the disease, leaves a permanent white depressed scar,—this "pitting" so characteristic of smallpox being specially marked on the face. Convalescence in this form of the disease is as a rule uninterrupted.

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[1] See Nöldeke, *Geschichte der Perser . . . aus Tabari* (Leyden, 1879), p. 218. Nöldeke thinks that this notice may be taken from genuine historical tradition, and seems to find an allusion to it in an old poem.

Varieties.

There are certain varieties of smallpox depending upon the form it assumes or the intensity of the symptoms. *Confluent smallpox* (*variola confluens*), while essentially the same in its general characters as the form already described, differs from it in the much greater severity of all the symptoms even from the onset, and particularly in regard to the eruption, which, instead of showing itself in isolated pocks, appears in large patches run together, giving a blistered aspect to the affected skin. This confluent condition is almost entirely confined to the face, and produces shocking disfigurement, while subsequently deep scars remain and the hair may be lost. The mucous membranes suffer in a similar degree of severity, and dangerous complications may arise from the presence of the disease in the mouth, throat, and eyes. Both the primary and secondary fevers are extremely severe. The mortality is very high, and it is generally estimated that at least 50 per cent. of such cases prove fatal, either from the violence of the disease or from one or other of the numerous complications which are specially apt to attend upon it. Convalescence is apt to be slow and interrupted. Another variety is that in which the eruption assumes the *hemorrhagic* form owing to bleeding taking place into the pocks after their formation. This is apt to be accompanied with hemorrhages from various mucous surfaces (particularly in the cases of females), occasionally to a dangerous degree and with symptoms of great prostration. Many of such cases prove fatal. A still more serious form is that termed *malignant smallpox*, in which, as in the malignant forms of other infectious diseases (see MEASLES and SCARLET FEVER), the patient is from the onset overwhelmed with the poison and quickly succumbs,—the rash scarcely, if at all, appearing or showing the hemorrhagic or purpuric character. Such cases are, however, comparatively rare. The term *varioloid* or *modified smallpox* is applied to cases occurring in persons constitutionally but little susceptible to the disease, or in whom the protective influence of vaccination or a previous attack of smallpox still to some extent exists. Cases of this mild kind are of very common occurrence where vaccination has been systematically carried out. As compared with an average case of the unmodified disease as above described, this form is very marked, the differences extending to all the phenomena of the disease. (1) As regards its onset, the initial fever is much milder and the premonitory symptoms altogether less in severity. (2) As regards the eruption, the number of pocks is smaller, often only a few and mostly upon the body. They not unfrequently abort before reaching the stage of suppuration; but should they proceed to this stage the secondary fever is extremely slight or even absent. There is little or no pitting. (3) As regards complications and injurious results, these are rarely seen and the risk to life is insignificant.

Attendant circumstances.

Various circumstances affect the mortality in ordinary smallpox and increase the dangers attendant upon it. The character of the epidemic has an important influence. In some outbreaks the type of the disease is much more severe than in others, and the mortality consequently greater. Smallpox is most fatal at the extremes of life, except in the case of vaccinated infants, in whom there is immunity from the disease. Again, any ordinary case with discrete eruption is serious, and a case of confluent or even semi-confluent character is much more grave, while the hemorrhagic variety is frequently and the malignant always fatal. Numerous and often dangerous complications, although liable to arise in all cases, are more apt to occur in the severer forms, and in general at or after the supervention of the secondary fever. The most important are inflammatory affections of the respiratory organs, such as bronchitis, pleurisy, or pneumonia, diphtheritic conditions of the throat, and swelling of the mucous membrane of the larynx and trachea. Destructive ulceration affecting the eyes or ears are well-known and formidable dangers, while various affections of the skin, in the form of erysipelas, abscess, or carbuncles, are of not infrequent occurrence. Persons of enfeebled health, and those whose constitutions are impaired by intemperance, readily succumb to attacks of smallpox, even of comparatively mild character, as do also pregnant women, to whom this disease is peculiarly dangerous.

Vaccination.

The most important of all the conditions tending to affect the mortality from smallpox, alike in the individual and the community, is the protection afforded by VACCINATION (*q.v.*). During the first decade of life, if vaccination has been fully and successfully accomplished in infancy, the risk of death from smallpox is *nil;* but, should the disease be caught—which is improbable—it will in all likelihood show itself in the mild form of varioloid. As regards revaccination, it has been found in all smallpox hospitals that the attendants and nurses escape the disease when revaccinated. In the experience of the late Dr. Waller Lewis in the case of an average of 10,504 persons permanently employed in the General Post Office, London, all of whom had to be revaccinated on admission, it was proved that in the ten years 1870–79 not a single fatal case of smallpox occurred, and only ten mild cases were seen during a period embracing two epidemics.

Treatment.

Treatment.—The treatment of smallpox is conducted upon the same general principles as that for the other infectious diseases (see CHOLERA, DIPHTHERIA, MEASLES, SCARLET FEVER). The establishment of smallpox hospitals separated as far as possible from populous localities, and the prompt removal of cases of the disease where practicable, as well as the diligent prosecution of vaccination and revaccination, are among the first requirements. The plan introduced into several large towns of compulsory notification of infectious diseases has much to recommend it. The special treatment applicable to a person suffering from smallpox includes in the first place the providing competent nurses, who, together with all others in the neighborhood of the patient, should be duly protected by recent vaccination. The patient should lie on a soft bed in a well-ventilated but somewhat darkened room and be fed with the lighter forms of nutriment, such as milk, soups, etc. The skin should be sponged occasionally with tepid water and the mouth and throat washed with a solution of chlorate of potash, Condy's fluid, or other safe disinfectant. In a severe case, with evidence of much prostration, stimulants may be advantageously employed. The patient should be always carefully watched, and special vigilance is called for where delirium exists. This symptom may sometimes be lessened by sedatives, such as opium, the bromides, or chloral. With the view of preventing pitting many applications have been proposed, but probably the best are cold or tepid compresses of light weight kept constantly applied over the face and eyes. The water out of which these are wrung may be a weak solution of carbolic or boracic acid. When the pustules have dried up the itching this produces may be much relieved by the application of oil or vaseline. Complications are to be dealt with as they arise and the severer forms of the disease treated in reference to the special symptoms presented. In cases where the eruption is tardy of appearing and the attack threatens to assume the malignant form, the writer has seen marked benefit attend the use of the wet pack. Disinfectants should be abundantly employed in the room and its vicinity, and all clothing, etc., in contact with the patient should be burned.

Inoculation.

Inoculation.—Previous to the introduction of vaccination the method of preventive treatment by what was known as inoculation had been employed. This consisted in introducing into the system—in a similar way to the method now commonly employed in vaccination—the smallpox virus from a mild case with the view of reproducing the disease also in a mild form in the person inoculated, and thus affording him protection from further attack. This plan had apparently been resorted to by Eastern nations from an early period in the history of the disease. It was known to be extensively practiced in Turkey in the beginning of the 18th century, when, chiefly through the letters of Lady Mary Wortley Montagu, it became known and was speedily adopted in England. There is no doubt, both from the statistics of the Smallpox and Inoculation Hospital, London, and from the testimony of physicians throughout the country, that this practice made a marked impression upon the fatality of the disease, and was itself attended with extremely little risk to life. The objections to it, however, were great, for, although usually conveying the smallpox in a mild form, it not unfrequently took effect severely, and, while death might be averted, the disfiguring results of the disease remained. Further, each inoculated person upon whom the operation took effect became for the time being a possible source of infection to others, and in point of fact the practice tended to spread the disease and so to increase the general mortality. Although inoculation continued to be practiced for a number of years subsequently to Jenner's great discovery, it gradually became displaced by that vastly superior and safer preventive. In 1840 an Act of Parliament was passed rendering smallpox inoculation unlawful in England. (J. O. A.)

SMART, CHRISTOPHER (1722–1771), English poet, was born at Shipbourne in Kent on 11th April, 1722. The discovery that Smart was anything more than an unfortunate Bohemian of letters who wrote much uninteresting verse of second-rate 18th-century quality is quite recent. After one or another of his superseded translations or ineffective exercises in heroics had in turn been assigned the place of honor as his representative literary work, his real masterpiece was discerned in a poem which, except for a reprint issued in 1819, had been singularly overlooked, and even omitted from the collected editions of his poetry. The history of this poem, *A Song to David*, is somewhat remarkable. It was written in the saner moments of confinement for a fit of insanity, and was, it is said, on not unimpeachable authority perhaps, indented with an iron nail or a key on the wall of the cell in default of other means of writing. The real facts of the case would seem to be that the unfortunate poet inscribed one or two stanzas in the manner asserted, and that he either dictated or was given the materials wherewith to write the rest of the poem. There is no internal evidence of any morbid origin, however, for the poem is full of a healthy and virile energy. As a boy he was delicate and precocious, with a facile gift of verse, which already won him a certain notoriety, of not the best effect haply, at Durham school, whither he had been sent on leaving a preparatory school at Maidstone. During a holiday visit to Raby castle his boyish gifts attracted the interest of the duchess of Cleveland, who made him an allowance of £40 [$194.40] a year, which was continued until her death, and which possibly served further to weaken his self-reliance. At Cambridge, where he was entered at Pembroke Hall in 1739, he led a rather dissipated life, getting heavily into debt, and, while he easily excelled in certain congenial branches of study, he paid little attention to the usual college routine. In spite of his irregularities, he was made a fellow of his college in 1745, and at a later date won the newly instituted Seaton prize for an English poem,—the subject each year being one of "the attributes of the Supreme Being." Smart gained this prize five times in all. Resorting then to London and marrying there a daughter-in-law of Newbery, the publisher, the poet attempted to make a living by literary hack-work and journalism, but sank gradually into difficulties through his improvident and dissipated habits, so that his wife and children were at last obliged to leave him. His misfortunes seem to have culminated in the fit of insanity associated with *A Song to David*, which was published in 1763, and in 1771 Smart died from the effects of poverty and disease.

Amid all his miseries Smart must have been fairly industrious if his journalistic work was at all proportionate to his more substantial literary productions. Of all that he wrote, however, *A Song to David* will alone bear the test of time. Unlike in its simple forceful treatment and impressive directness of expression, as has been said, to anything else in 18th-century poetry, the poem on analysis is found to depend for its unique effect also upon a certain ingenuity of construction, and the novel way in which David's ideal qualities are enlarged upon. This will be more readily understood on reference to the following verse, the first twelve words of which become in turn the key-notes, so to speak, of the twelve succeeding verses:

> "Great, valiant, pious, good, and clean,
> Sublime, contemplative, serene,
> Strong, constant, pleasant, wise!
> Bright effluence of exceeding grace;
> Best man!—the swiftness, and the race,
> The peril, and the prize."

The last line is characteristic of another peculiarity in *A Song to David*, the effective use of alliteration to complete the initial energy of the stanza in many instances. But in the poem throughout is revealed a poetic quality which eludes critical analysis and gives its writer an exceptional interest hardly maintained by his other works.

A Song to David is found in somewhat shortened form in Ward's *English Poets*, vol. iii., and Smart's other poems are given in Anderson's *British Poets* (1794), vol. xi., which contains also a full account of his life.

SMEATON, John (1724–1792), English civil engineer, the son of an attorney, was born at Austhorpe Lodge, near Leeds, on 8th June, 1724. He received a good education at the grammar-school of Leeds, displaying a special proficiency in geometry and arithmetic. At a very early age he evinced a great liking for the use of mechanical tools, and in his fourteenth or fifteenth year contrived to make a turning-lathe. On leaving school in his sixteenth year he was employed in his father's office, but, after attending for some months in 1742 the courts at Westminster Hall, he earnestly requested to be allowed to follow some mechanical profession. He became apprentice to a philosophical instrument maker, and in 1750 set up in business on his own account. Besides improving various mathematical instruments used in navigation and astronomy, he carried on several experiments in regard to other mechanical appliances, amongst the most important being a series on which he founded a paper—for which he received the Copley medal of the Royal Society in 1759—entitled *An Experimental Inquiry concerning the Native Powers of Water and Wind to turn Mills and other Machines depending on a Circular Motion.* In 1754 he made a tour of the Low Countries to study the great canal works of foreign engineers. Already by his papers read before the Royal Society and his intercourse with scientific men his abilities as an engineer had become well known, and in 1756 application was made to him to reconstruct the Eddystone lighthouse, which had been burnt down in December of the previous year (see LIGHTHOUSE, vol. xiv. pp. 620–621). Smeaton now began to be much consulted in regard to all kinds of important engineering projects, including river navigation, the drainage of fens, the designing of harbors, and the repair and construction of bridges, owing to the thorough engineering skill he displayed in every operation he undertook. In judging of his achievements it ought to be remembered that he was the precursor of the great modern engineers. James Watt said of him, "His example and precepts have made us all engineers." He combined in a remarkable degree theoretical with practical skill, much of his success being due to the fact that, as Stevenson states, "he was an incessant experimenter." A considerable portion of his time was also devoted to astronomical studies and observations, on which he read various papers before the Royal Society. In order to prepare an account of the various works on which he had been engaged as an engineer, Smeaton resolved to retire from his profession, but he only lived to complete in 1791 his *Narrative of the Building of Eddystone Lighthouse.* He died at Austhorpe, 28th October, 1792, and was buried in the old parish church of Whitkirk.

See *A Short Narrative of the Genius, Life, and Works of the late Mr. John Smeaton*, 1793; and Smiles, *Lives of the Engineers*.

SMELL is a sensation excited by the contact with the olfactory region of certain substances, usually in a gaseous condition and necessarily in a state of fine subdivision. The sense is widely distributed throughout the animal kingdom. The lower animals, especially those breathing in water, become cognizant of the presence of odoriferous matter near them without touch, vision, or hearing, and we suppose that they do so by some sense of taste or smell, or a combination of both. In such cases smell has been appropriately termed "taste at a distance," by which is meant that particles of matter may be diffused through the water so as to come into contact with the terminal organ and give rise to a sensation such as would have been excited had the matter from which the particles emanated come directly into contact with the nerve-endings. It is therefore of no great importance whether such sensations in humble aquatic organisms are termed taste or smell. In the higher air-breathing animals, however, the senses are differentiated; that of taste is found at the entrance of the alimentary canal, whilst that of smell guards the opening of the respiratory tract. This view assists in the interpretation of various structures met with in the lower forms which have been fairly regarded by naturalists as olfactory organs.

Comparative View of Olfactory Organs.—In various *Medusæ* pit-like depressions, lined with ciliated epithelium, on the dorsal side of the excavation in which the "marginal" bodies are found, have been called olfactory regions. In many *Arthropoda* the sense of smell is located in delicate tubular structures, or conical projections, found on the antennæ and connected with nerves. Similar organs are met with in *Crustacea*. In *Cyclops* (*Copepoda*), *Isopoda*, and *Thoracostraca* olfactory hairs are present as delicate appendages of the anterior antennæ, chiefly in the male sex. In *Schizopoda* the anterior antennæ have a comb-like prominence bearing a great number of olfactory hairs. *Insecta* have olfactory organs largely developed, usually in the form of hairs, cones, or knobs on the antennæ, and connected with gangliated nerve-endings. Olfactory organs are also met with in *Mollusca*; in *Lamellibranchiata* they appear as hairs on the margin of the mantle; in aquatic *Gasteropoda* as tufts of hairs scattered over the surface of the body and specially aggregated in those parts where tactile sensibility is highly developed; in terrestrial *Gasteropoda* the antennæ have on their end plates a number of club-shaped cells with rods, which are held to be olfactory, and recently in the same class Sprengel has shown that an organ "which was supposed to be a rudimentary gill, and is innervated from the supra-intestinal ganglion," has an olfactory function. In *Ascidians* the olfactory region is believed to be a depression on the wall of the pharynx, situated in front of the ganglion, and lined with ciliated epithelium.

In *Fishes* the olfactory organs consist of a membrane (the pituitary membrane) lining one or two pits, to which the olfactory or first pair of cranial nerves are distributed. This highly vascular membrane is usually thrown into numerous folds, so as to admit of an extensive surface being packed into small space, and it is covered by ciliated epithelium. In the lowest vertebrate, *Amphioxus*, the olfactory organ is a simple unsymmetrical pit at the anterior end of the nervous system. In the hag fishes (*Myxinidæ*) the olfactory pit has a posterior opening which pierces the palate and can be closed by a valvular apparatus. In the lampreys (*Petromyzon*) the flask-shaped nasal sac opens on the top of the head, and from this a tube descends which expands into a blind sac towards the base of the skull. In all other fishes the olfactory organs are double and have no communication with the mouth. In osseous fishes the olfactory capsules or sacs are covered with skin which is usually pierced by two openings for each sac. Some, such as the wrasses, have a single nasal opening; and where there are two the anterior can be closed by a valve. The olfactory region may be extensive owing to the pituitary membrane being thrown into plaits or folds, and it may be divided into two portions, one quite smooth and the other plicated. The smooth portion, probably acting as a reservoir, may be large, extending down to the palate, as in the mackerel, or to the back part of the palate, as in the wolf-fish (Owen). The nasal cavities exist below the snout in sharks, near the angles of the mouth in the rays, and beneath the fore part of the head, behind the base of the rostrum, in the saw-fish. In such fishes the olfactory organ is guarded by valves, containing cartilaginous plates moved by muscles, and we may, therefore, conclude with Owen, "that these fishes scent as well as smell, *i.e.*, actively search for odoriferous impressions by rapidly changing the current of water through the olfactory sac."

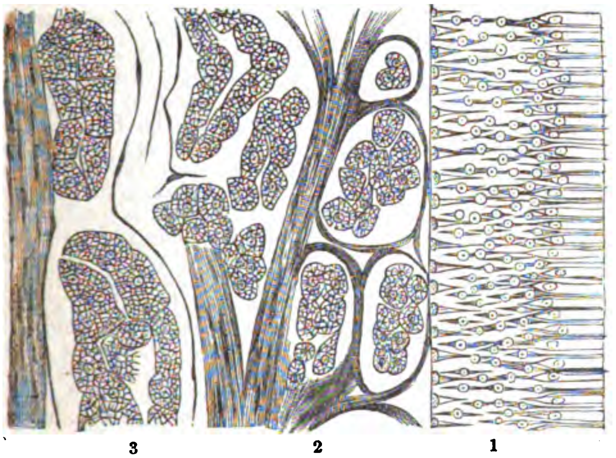
The olfactory organs of *Amphibia* are always paired cavities, opening internally either anteriorly within the lips or further back, as in the batrachians and salamandrines. In the *Perennibranchiates* (Siren, Proteus, Axolotl) there are no outward signs of olfactory organs, and the thick upper lip must be raised to bring the plicated sac with its two remote orifices into view (Owen). In the *Tritonidæ* (newts) and *Salamandrinæ* (salamanders) the olfactory membrane is smooth and lines an oval bag having an external nostril, guarded by a valvular fold of skin, and a palatal opening. Frogs and toads (*Batrachia*) have also an external nostril with a flap of skin, and the palatal opening is wide and near the fore part of the mouth. The skulls of extinct saurians of marine habits (*Ichthyosaurus* and *Plesiosaurus*) show that the external nostrils opened near the orbits at a distance from the muzzle. In snakes (*Ophidia*) the external nostrils are double, and the internal nostril is single and in the median line. In water snakes the external orifices can be closed by valves.

In *Chelonia* (turtles, tortoises) and in *Crocodilia* the external nasal opening is single and near the end of the snout; but in *Chelonia* the nostrils are really distinct, although their external apertures coincide. In the turtle the nasal cavity is large and contains a twisted shell-like cartilage, so as to give extent of surface to the darkly pigmented and highly vascular pituitary membrane. In the crocodiles and alligators the nostrils can be closed by a valvular lobe, and in the gavials (*Rhamphostoma gangeticum* and *Rhynchosuchus schlegelii*) the integument can be raised round the nostril in the form of a tube so as to bring the orifice to the surface of the water without exposing the other parts of the head (Owen). In all *Crocodilia* the nasal cavity is of great length, commencing at the fore part of the muzzle and ending beneath the occiput by a single aperture, and the surface of this long olfactory meatus is increased by the meatus communicating with large cells or sinuses. In snakes and lizards a second olfactory organ is found embedded between the turbinals and the vomer and is known as "Jacobson's organ." It has the form of a cup or depression round a cartilaginous papilla and is supplied by a nerve which arises from the end of the olfactory lobe.

The olfactory organs of *Birds* are somewhat similar to those of the cold-blooded reptiles and amphibians in that "the external nostrils are simple perforations, having no movable cartilages or muscles provided for dilating or contracting their apertures, as in mammalia" (Owen). The extent of the olfactory surface is increased by projections and folds of turbinated bones and not by large accessory cavities. With the exception of the apteryx and dinornis, the olfactory nerve passes out of the skull by a single foramen. The external nostrils are, in the majority of birds, placed at the sides of the upper mandible; but in some cases, as in the toucans, they are found at the base of the bill, and in the apteryx they open at the extremity of the long upper mandible. In herons the apertures are so small as scarcely to admit the point of a pin; and in the pelicans they are wanting, and odors get access to the olfactory organ from the palate. The *Rasores* (scratching birds) have the nostrils defended by a scale, and the crows (*Corvidæ*) have a bunch of stiff feathers for the same purpose. The septum or partition between the nostrils is usually complete and is formed of bone and cartilage. The outer wall of each nasal passage is furnished with three turbinal or twisted shell-like bones, of which the middle is the largest, thus affording a considerable extent of olfactory surface. In most birds there are two posterior nasal apertures communicating with the palate; but in some, as in the cormorant and gannet, the passages unite and there is only one opening. In birds the upper part of the nasal passage is more especially devoted to the sense of smell, whilst the lower part may be regarded as the beginning of the respiratory tract. This is indicated by the arrangement of the nerves, the olfactory nerve being distributed to the membrane covering the septum and the superior and middle turbinated bones, whilst the lower portion and lower turbinals are supplied by the fifth nerve,—a nerve of general sensibility. The upper turbinals reach their greatest development in the apteryx, where they are attached, according to Owen, to the whole outer part of the prefrontals. This bird has amongst birds the largest olfactory nerves in proportion to its size, and it would appear to be guided by the sense of smell to the worms that form its food. A contrast as regards the anatomical arrangements for the olfactory sense is well seen on comparing the turkey with the vulture. In the turkey the olfactory nerve is small, about one-fifth the size of that in the vulture, and is distributed over a small middle turbinal, there being no extension over a superior turbinal. The vulture, on the other hand, has a large nerve and the olfactory region is extensive, owing to the largely developed superior turbinal bone. There can be no doubt that the carrion-eating vulture is guided from great distances to its food by the sense of smell, although it will be assisted by its powerful sense of vision.

The sense of smell reaches its highest development in *Mammalia*. The anatomical surface is enormously extended in many cases, not only by the complication of the ethmoidal labyrinth, but also by the nasal passages communicating with spaces of the neighboring cranial and facial bones. The olfactory nerves also are very numerous and arise from a special encephalic centre. They pass out of the skull by numerous holes in the cribriform or sieve-like plate of the prefrontal bone, which, on account of this peculiarity, is called the ethmoid bone. These nerves ramify on the olfactory membrane, covering the upper or ethmo-turbinal bones. The cavity containing the organ of smell is bounded by the prefrontal, vomerine, nasal, sphenoid, pterygoid, palatine, maxillary, and premaxillary bones, and it is usually in connection with air-cavities or sinuses in many or all of the bones of the skull. The median partition by which the two nostrils are formed consists of bone and cartilage and is built up by processes of the prefrontals, the vomer, and by the ridges of the nasals, palatines, maxillaries, and premaxillaries with which the vomer articulates. Each passage thus formed is the beginning of the respiratory tract, and is continued forwards into a more or less mobile part called a nose, snout or proboscis, whilst posteriorly it communicates with the upper part of the pharynx, into which opens the windpipe. On the outer wall there are three turbinal bones—superior, middle, and inferior—dividing partially the nasal cavity into three meatuses or passages. The superior meatus is between the superior and middle turbinated bones, the middle meatus between the middle and inferior turbinated bones, and the inferior meatus between the inferior turbinated bones and the floor of the nose (see ANATOMY, vol. i. p. 721, Fig. 7; also vol. i. pl. XIX. Fig. 2). Many of the lower mammals have in addition a process from the frontal and nasal bones, sometimes called the superior spongy bone, which is not the same as the superior turbinated, as described in the anatomy of the human being. The extent of olfactory surface is enormously increased by numerous plicæ or processes of bone which to a great extent mask the comparatively simple arrangement above described. In *Ornithorhynchus* there is a single olfactory nerve escaping through an aperture in the prefrontal bone; in *Echidna*, the other member of the *Monotremata*, there are numerous olfactory nerves and a large development of ethmo-turbinals. In many *Marsupials* the sense of smell is largely developed, and in some (*Osphranter*) the turbinated bones are so large as to cause a lateral bulging of the nasal cavity, forming a marked feature of the skull. In *Rodents* the ethmo-turbinals may be subdivided into lamellæ so as to increase the olfactory surface; such is the case in the common hare. In the porcupine the sinuses developed from the olfactory cavity are of large size, forming a spongy mass surrounding the cavity of the skull in which the anterior portion of the brain lies. In *Insectivora* the olfactory surface is very large. Thus in the mole the ethmo-turbinal has not fewer than eight lamellæ or plates and the external nose is developed into a snout capable of considerable movement. Such a snout is very large and mobile in the elephant shrews. Armadillos and ant-eaters (*Edentata*) have a strong sense of smell. Thus in *Dasypus* the nasal portion of the skull is about equal in volume to all the rest, and in *Chlamydophorus* (dwarf armadillo) the frontals are raised "into a pair of domes" by sinuses in them communicating with the large olfactory cavity. In most armadillos the external nose is strengthened by small bones. The air sinuses in the sloth extend upwards into the frontals and downwards into the sphenoid bone. No *Cetaceans* have olfactory organs, except the baleen or whalebone whales, and thus are devoid of the sense of smell. In the manatee (*Sirenia*) the nasal openings are placed far forwards and have movable cartilages, and the bony walls of the nasal passages are not extensive in proportion to the size of the rest of the skull. The elephants (*Proboscidea*) have the part of the nasal cavity concerned in smell contracted and narrow, but the cavity is prolonged into the trunk, at the end of which are the nostrils; the nasal cavity communicates with sinuses permeating every bone of the cranium. The tapirs have a shorter but very mobile proboscis, and the development of the nasal passages is extensive. The horse has the power of dilating and contracting each nostril, and the cribriform plates transmit very numerous olfactory nerves from the olfactory bulbs, which are large in proportion to the size of the rest of the brain. The *Suidæ* (swine) have a large and complex olfactory region; the accessory sinuses or spaces attain a great development; the nose is prolonged and truncate, the cartilages forming a complete tube, which is a continuation of the bony nostrils, and these tubes open on a naked disk. In the ox and sheep the olfactory region is large, but not so large as in the horse. The external, glandular, and moist part of the nose is a linear tract running from the mid-furrow of the upper lip to the oblique nostril in the sheep, and this portion passes through many gradations in size, as seen in the roebuck, fallow-deer, red-deer, and the ox. The *Carnivora* have the ethmo-turbinal and maxillo-turbinal regions even more largely developed than in *Herbivora*, and the latter portion reaches its maximum in the seals, where "these turbinals seem to block up the entry of the nasal respiratory passages, and must warm the air in arctic latitudes as well as arrest every indication from the effluvia of alimentary substances or prey" (Owen). In *Quadrumana* the nasal chamber becomes shorter and gains in depth, but not proportionally. In the platyrhine monkeys the cartilage forming the septum becomes flattened anteriorly, pushing the nostrils outwards. In the catarrhines this flattening is much less, so that the nostrils are approximated. In both groups the nostrils are not terminal. In *Man* the chief characteristic is the prominence of the fore part of the chambers, with the nostrils on the lower surface, and the nose is supported by eleven pieces of cartilage, of which one is medial, the others lateral, in five pairs. The size and form of the septal or medial cartilage mainly determine the shape and prominence of the nose. It is least developed but thickest in the Negro and Papuan races. (For a description of the muscles of the nose in man, see ANATOMY, vol. i. p. 734).

The interior of the nose is divided physiologically into two portions,—(1) the upper (*regio olfactoria*), which embraces the upper part of the septum, the upper turbinated bone, and a portion of the middle turbinated bone; and (2) the lower portion of the cavity (*regio respiratoria*). The olfactory region proper has a thicker mucous membrane than the respiratory; it is covered by a single layer of epithelial cells, often branched at their lower ends and containing a yellow or brownish-red pigment; and it contains peculiar tubular glands named "Bowman's glands." The respiratory portion contains ordinary serous glands. In the olfactory region also are the terminal organs of smell. These are long narrow cells passing to the surface between the columnar epithelium covering the surface. (See ANATOMY, vol. i. p. 777, Fig. 76.) The body of the cell is spindle-shaped and it sends up to the surface a delicate rod-like filament, whilst the deeper part is continuous with varicose nerve-filaments, the ends of the olfactory nerve. In the frog the free end terminates in fine hairs.



Longitudinal section through the olfactory membrane of guinea-pig. × about 400. 1, Olfactory epithelium on free surface; 2, plexus of olfactory nerve-fibres; 3, pouches of serous glands containing epithelial cells. From Klein's *Atlas of Histology*.

Physical Causes of Smell.—Electrical or thermal stimuli do not usually give rise to olfactory sensations. Althaus states that electrical stimulation caused a sensation of the smell of phosphorus. To excite smell it is usually supposed that substances must be present in the atmosphere in a state of fine subdivision, or existing as vapors or gases. The fineness of the particles is remarkable, because if the air conveying an odor be filtered through a tube packed with cotton-wool and inserted into the nose a smell is still discernible. This proceeding completely removes from the air organisms less than the $\frac{1}{100000}$th of an inch in diameter which are the causes of putrefaction and fermentation. A grain or two of musk will scent an apartment for years and at the end of the time no appreciable loss of weight can be detected. Substances exciting smell are no doubt usually gases or vapors. Only a few tentative efforts have been made to connect the sense with the chemical constitution of the substance. One of the most important of these is in an *Essay on Smell*, by Dr. William Ramsay, of University College, Bristol. The following gases have no smell: hydrogen, oxygen, nitrogen, water gas, marsh gas, olefiant gas, carbon monoxide, hydrochloric acid, formic acid vapor, nitrous oxide, and ammonia. (It is necessary, of course, to distinguish between the sensation of smell and the irritant action of such a gas as ammonia). The gases exciting smell are chlorine, bromine, iodine, the compounds of the first two with oxygen and water, nitric peroxide, vapors of phosphorus and sulphur, arsenic, antimony, sulphurous acid, carbonic acid, almost all the volatile compounds of carbon except those already mentioned, some compounds of selenium and tellurium, the compounds of chlorine, bromine, and iodine with the above-named elements, and some metals. Chlorine, bromine, iodine, sulphur, selenium, and tellurium, which are volatile and give off vapor at ordinary temperatures, have each a characteristic smell. Ramsay points out that as a general rule substances having a low molecular weight have either no smell or simply cause irritation of the nostrils. He also shows that in the carbon compounds increase of specific gravity as a gas is associated to a certain point with a sensation of smell. Take the marsh gas or methane series commonly called the paraffins. The first two have no smell; ethane (fifteen times as heavy as hydrogen) has a faint smell; and it is not till butane (thirty times heavier than hydrogen) that a distinct sensation of smell is noticed. Again, a similar relation exists among the alcohols. Methyl alcohol has no smell. Ethyl, or ordinary alcohol free from ethers and water, has a faint smell; "and the odor rapidly becomes more marked as we rise in the series, till the limit of volatility is reached, and we arrive at solids with such a low vapor tension that they give off no appreciable amount of vapor at the ordinary temperature." Acids gain in odor with increase in density in the form of gas. Thus formic acid is devoid of smell; acetic acid has a characteristic smell; and the higher acids of the series—propionic, butyric, valerianic—increase in odor. It would appear also that "the character of a smell is a property of the element or group which enters into the body producing the smell, and tends to make it generic." Many compounds of chlorine, hydrogen, compounds of sulphur, selenium, and tellurium, the paraffins, the alcohols, the acids, the nitrites, the amines, the pyridine series, the benzene group, have each a characteristic odor. Ramsay has advanced the theory that the sense of smell "is excited by vibrations of a lower period than those which give rise to the sense of light or heat," and he points out a series of important facts in support of this view. He states that to produce the sensation of smell a substance must have a molecular weight at least fifteen times that of hydrogen. For instance, the specific gravity of marsh gas is eight (no smell), of ethane fifteen (faint smell), of propane twenty-two (distinct smell). Again, prussic acid has a specific gravity of fifteen, and many persons fail to detect its odor. Further, Ramsay supposes that smell may be excited by vibrations, and suggests that the period of vibration of the lighter molecules is too rapid to affect the sense; at last a number of vibrations is reached capable of exciting the sense organ; and beyond an upper limit the sense is again lost. Graham pointed out that odorous substances are in general readily oxidized.[1] Tyndall showed that many odorous vapors have a considerable power of absorbing heat. Taking the absorptive capacity of the air as unity, the following absorptions were observed in the respective cases:

Name of Perfume.	Absorption per 100.	Name of Perfume.	Absorption per 100.
Patchouli	30	Lavender	60
Sandal-wood	32	Lemon	65
Geranium	33	Portugal	67
Oil of cloves	33.5	Thyme	68
Otto of roses	36.5	Rosemary	74
Bergamot	44	Oil of laurel	80
Neroli	47	Cassia	109

In comparison with the air introduced in the experiments the weight of the odors must be almost infinitely small. "Still we find that the least energetic in the list produces thirty times the effect of the air, whilst the most energetic produces 109 times the same effect."[2]

Venturi, B. Prévost, and Liégeois have studied the well-known movements of odoriferous particles, such as camphor, succinic acid, etc., when placed on the surface of water, and they have suggested that all odoriferous substances in a state of fine subdivision may move in a similar way on the moist surface of the olfactory membrane, and thus mechanically irritate the nerve endings. This explanation is too coarse; but it is well known that the odors of flowers are most distinctly perceived in the morning, or after a shower, when the atmosphere contains a considerable amount of aqueous vapor. It would appear also that the odors of animal effluvia are of a higher specific gravity than the air, and do not readily diffuse,—a fact which may account for the pointer and bloodhound keeping their noses to the ground. Such smells are very persistent and are apparently difficult to remove from any surface to which they have become attached. The smell of a corpse may haunt a living person for days, notwithstanding copious ablutions and change of clothes.[3]

Special Physiology of Smell.—It is necessary that the air containing the odor be driven forcibly against the membrane. Thus the nostrils may be filled with eau de Cologne, or with air impregnated with sulphuretted hydrogen, and still no odor is experienced if the person does not breathe. When a sniff is made the air within the nasal passages is rarefied, and, as the air rushes in to equilibrate the pressure, it is forcibly propelled against the olfactory surface. The olfactory surface must be moist; if it is dry, or is covered with too thick a layer of mucus (as in catarrh), the sense is much weakened or lost. The first moment of contact is the most acute and the sense quickly becomes blunted. The first scent of a flower is the strongest and sweetest; and after a few minutes' exposure the intensity of even a fetid odor may not be perceived. This fact may be accounted for on the supposition that the olfactory membrane becomes quickly coated with a thin layer of matter, and that the most intense effect is produced when the odoriferous substances are applied to a clean surface. The intensity of smell depends on (1) the area of olfactory surface affected, and (2) the degree of concentration of the odoriferous matter. It is said that musk to the amount of the two-millionth of a milligramme, and one part of sulphuretted hydrogen in 1,000,000 parts of air, may be perceived. If the two nostrils are filled with different odorous substances, there is no mixture of the odors, but we smell sometimes the one and sometimes the other (Valentin). Morphia, mixed with sugar and taken as snuff, paralyzes the olfactory apparatus, while strychnine makes it more sensitive (Lichtenfels and Fröhlich).

The delicacy of the sense is much greater in many of the lower animals than in man, and it is highly probable that the dog or cat obtain information by means of this sense which a human being cannot get. Odors may excite in the minds of many animals vivid impressions, and they have probably a memory of smells which the human being does not possess. Even in man the sense may be greatly improved by exercising it. A boy, James Mitchell, was born blind, deaf, and dumb, and chiefly depended on smell for keeping up a connection with the outer world. He readily observed the presence of a stranger in the room and he formed his opinions of persons apparently from their characteristic smells. In some rare cases, the sense of smell is congenitally absent in human beings, and it may be much injured by the practice of snuffing or by diseases of the nose affecting the olfactory membrane. Subjective impressions of smells, like spectral illusions or sounds in the ears, are occasionally, but rarely observed in the insane. Finally, it may be observed that the sense of odor gives information as to the characters of food and drink and as to the purity of the air. In the lower animals, also, the sense is associated with the sexual functions.

See art. "Olfaction" by François Franck, in *Dictionnaire Encyclopédique des Sciences Médicales*, 2d series, where a full historical bibliography is given; Hermann's *Handbuch der Physiologie: d. Sinnesorgane: Zweiter Theil, Geruchsinne*, by Prof. V. Vintschgau, p. 226; Owen's *Comp. Anatomy and Physiol. of Vertebrates*; Bain, *op. cit.*, p. 147; Grant Allen's *Physiological Æsthetics*, p. 77; Ramsay, *Nature*, vol. xxvi. p. 187; and for James Mitchell's case, see Dugald Stewart's *Works*, vol. iv. p. 300. (J. G. M.)

SMELT. See SALMONIDÆ, vol. xxi. p. 236.

SMETHWICK, an urban sanitary district of Staffordshire, England, on the borders of Worcestershire and Warwickshire, is situated on the Birmingham, Dudley, and Wolverhampton Canal, and on branches of the London and North-Western and the Great Western Railway lines, 3 miles west from Birmingham, of which the town of Smethwick is a suburb. It possesses a public hall and a free library and reading-room. Within the limits of the district is the Soho foundry originated by James Watt; and since its origin numerous other industries have been concentrated in the suburb, the more important being the manufacture of glass, chemicals, hydraulic jacks, patent nuts and bolts, and patent tubes. Many of the works are of great extent. The population of the urban sanitary district in 1871 was 17,158, and in 1881 (area, 1882 acres) it had increased to 25,084.

SMIRKE, ROBERT (1752–1845), subject painter, was born at Wigton near Carlisle in 1752. In his thirteenth year he was apprenticed in London with an heraldic painter, and at the age of twenty he began to study in the schools of the Royal Academy, to whose exhibition he contributed in 1786 a Narcissus and a Sabrina, which were followed by many works, usually small in size, illustrative of the English poets, especially Thomson. In 1791 Smirke was elected an associate of the Royal Academy, and two years later a full member. In 1814 he was nominated keeper to the Academy, but the king refused to sanction the appointment on account of the artist's pronounced revolutionary opinions. He was engaged upon the Shakespeare gallery, for which he painted Katharina and Petruchio, Prince Henry and Falstaff, and other subjects. He also executed many clever and popular book-illustrations. His works, which are frequently of a humorous character, are pleasing and graceful, accomplished in draftsmanship and handled with considerable spirit. He died in London on the 5th of January, 1845.

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[1] Bain, *Senses and Intellect*, 3d ed., p. 152.

[2] Tyndall, *Contributions to Molecular Physics in Domain of Radiant Heat*, p. 99.

[3] Liégeois, *Archiv de Physiol.*, 1868.

SMITH, ADAM (1723–1790), the greatest of political economists, was the only child of Adam Smith, comptroller of the customs at Kirkcaldy, in Fifeshire, Scotland, and of Margaret Douglas, daughter of Mr. Douglas of Strathendry, near Leslie. He was born at Kirkcaldy on 5th June, 1723, some months after the death of his father. Of a weak constitution, he required and received during his early years the most tender care of an affectionate mother, which he repaid in after life by every attention which filial gratitude could dictate. When he was three years old he was taken on a visit to his uncle at Strathendry, and when playing alone at the door of the house was carried off by a party of "tinkers." Fortunately he was at once missed, and the vagrants pursued and overtaken in Leslie wood. He received his early education in the school of Kirkcaldy under David Miller, amongst whose pupils were many who were afterwards distinguished men. Smith showed as a boy great fondness for books and remarkable powers of memory; and his friendly and generous disposition made him popular amongst his schoolfellows. He was sent in 1737 to the university of Glasgow, where he attended the lectures of Dr. Hutcheson; and in 1740 he went to Baliol College, Oxford, as exhibitioner on Snell's foundation, with a view to his taking orders in the English Church. He remained at that university for seven years. At Glasgow his favorite studies had been mathematics and natural philosophy; but at Oxford he appears to have devoted himself almost entirely to moral and political science and to the cultivation of the ancient and modern languages. He also labored to improve his English style by the practice of translation, particularly from the French. He was not impressed with a favorable opinion of the system of education then pursued at Oxford. After his return to Kirkcaldy he resided there two years with his mother, continuing his studies; he had relinquished the idea of entering the ecclesiastical profession, but had not yet adopted any other plan for his future life. In 1748 he removed to Edinburgh, and there, under the patronage of Lord Kames, gave lectures on rhetoric and belles-lettres. About this time commenced his acquaintance with David Hume, which afterwards ripened into an intimate friendship, founded on mutual esteem; his relations with that great thinker must have powerfully influenced the formation of his opinions. In 1751 he was elected professor of logic at Glasgow, and in the following year was transferred to the chair of moral philosophy in the same university, which had become vacant by the death of Thomas Craigie, the successor of Hutcheson. This position he occupied for nearly twelve years, which he long afterwards declared to have been "by far the most useful, and therefore by far the happiest and most honorable period of his life." He was highly esteemed by his colleagues, of whom, on his side, he speaks as "very excellent men." His course of lectures, as Professor Millar informs us, was divided into four parts—(1) natural theology; (2) ethics; (3) a treatment of that branch of morality which relates to justice, a subject which he handled historically after the manner of Montesquieu, "endeavoring to trace the gradual progress of jurisprudence, both public and private, from the rudest to the most refined ages, and to point out the effects of those arts which contribute to subsistence and to the accumulation of property in producing corresponding improvements or alterations in law and government;" (4) a study of those political regulations which are founded, not upon the principles of justice, but that of expediency, and which are calculated to increase the riches, the power, and the prosperity of a state. Under this view he considered the political institutions relating to commerce, to finances, to ecclesiastical and military establishments He first appeared as an author by contributing two articles to the *Edinburgh Review* (an earlier journal than the present, which was commenced in 1755, but of which only two numbers[1] were published),—one on Johnson's *Dictionary* and the other a letter to the editors on the state of literature in the different countries of Europe. In 1759 appeared his *Theory of Moral Sentiments*, embodying the second portion of his university course, to which was added in the 2d edition an appendix with the title "Considerations concerning the first Formation of Languages." After the publication of this work his ethical doctrines occupied less space in his lectures, and a larger development was given to the subjects of jurisprudence and political economy. Stewart gives us to understand that he had already, as early as 1752, adopted the liberal views of commercial policy which he afterwards preached with so much effect; and this we should have been inclined to believe independently from the fact that such views were propounded in that year in the *Political Discourses* of his friend Hume. His residence at Glasgow brought him into personal relations with many intelligent men from whose practical experience he could derive information on mercantile questions; and, on the other hand, we are told, his reasonings convinced several eminent merchants of that city of the soundness of the principles of free trade, which were at variance with their previous opinions.

In 1762 the senatus academicus of Glasgow conferred on him the honorary degree of doctor of laws. In 1763 he was invited to take charge of the young duke of Buccleuch on his travels. He accepted the proposal, and resigned his professorship. He went abroad with his pupil in March, 1764; they remained only a few days at Paris and then settled at Toulouse, then the seat of a parliament, where they spent eighteen months in the best society of the place, afterwards making a tour in the south of France and passing two months at Geneva. Returning to Paris about Christmas of 1765, they remained there till the October of the following year. The period was one of intellectual and social ferment, and Smith was brought into relation with the most eminent persons of the time. He lived in the society of Quesnay, Turgot, D'Alembert, Morellet, Helvétius, Marmontel, and the duke de la Rochefoucault. It was the regard he entertained for the young nobleman[2] last named that dictated the omission in the later editions of his *Moral Sentiments* of the name of the celebrated ancestor of the duke, whom he had associated with Mandeville as author of one of the "licentious systems" reviewed in the seventh part of that work. Smith was without doubt much influenced by his contact with the members of the physiocratic school, especially with its chief, though Dupont de Nemours probably goes too far in speaking of Smith and himself as having been "condisciples chez M. Quesnay." Smith afterwards described Quesnay as a man "of the greatest modesty and simplicity," and declared his system of political economy to be, "with all its imperfections, the nearest approximation to truth that had yet been published on the principles of that science." In October, 1766, tutor and pupil returned home, and they ever afterwards retained strong feelings of mutual esteem. For the next ten years Smith lived with his mother at Kirkcaldy, only paying occasional visits to Edinburgh and London; he was engaged in close study during most of this time, but unbent his mind in familiar intercourse with a few friends. He describes himself to Hume during this period as being extremely happy, comfortable and contented. He was now occupied on his *Inquiry into the Nature and Causes of the Wealth of Nations*, which there is some reason for believing he had begun at Toulouse. That great work appeared in 1776.[1] After its publication, and only a few months before his own death, Hume wrote to congratulate his friend—"*Euge! belle!* dear Mr. Smith, I am much pleased with your performance, and the perusal of it has taken me from a state of great anxiety. It was a work of so much expectation by yourself, by your friends and by the public that I trembled for its appearance; but am now much relieved. Not but that the reading of it requires so much attention, and the public is disposed to give so little, that I shall still doubt for some time of its being at first very popular. But it has depth, and solidity, and acuteness, and is so much illustrated by curious facts that it must at last take the public attention. Smith attended Hume affectionately during a part of his last illness, and soon after the death of the philosopher there was published, along with his autobiography, a letter from Smith to Strahan, in which he gave an account of the closing scenes of his friend's life, and expressed warm admiration for his character. This letter excited some rancor among the theologians, and Dr. George Horne, afterwards bishop of Norwich, published in 1777, by way of comment on it, *A Letter to Adam Smith on the Life, Death and Philosophy of his Friend David Hume, by one of the people called Christians*. But Smith took no notice of this effusion.[2] He was also attacked by Archbishop Magee, for the omission in subsequent editions of a passage of the *Moral Sentiments* which that prelate had cited with high commendation as among the ablest illustrations of the doctrine of the atonement. Smith had omitted the paragraph in question on the ground that it was unnecessary and misplaced; but Magee suspected him of having been influenced by deeper reasons.

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[1] These two numbers were reprinted in 1818. Smith's letter to the editors is specially interesting for its account of the *Encyclopédie* and its criticism of Rousseau's pictures of savage life.

[2] The duke undertook a translation of the *Theory of Moral Sentiments*, but the Abbé Blavet's version appeared (1774) before his was completed and he then relinquished the design. An earlier French translation had been published (1764) under the title *Métaphysique de l'Âme;* and there is a later one—the best—by the marquis de Condorcet (1798, 2d ed. 1830.)

The greater part of the two years which followed the publication of the *Wealth of Nations* Smith spent in London, enjoying the society of the most eminent persons of the day, amongst whom were Gibbon, Burke, Reynolds and Beauclerk. In 1778 he was appointed, through the influence of the duke of Buccleuch, one of the commissioners of customs in Scotland, and in consequence of this fixed his residence at Edinburgh. His mother, now in extreme old age, lived with him, as did also his cousin, Miss Jane Douglas, who assisted him in the care of his aged parent and superintended his household. Much of his now ample income is believed to have been spent in secret charities, and he kept a simple though hospitable table, at which, "without the formality of an invitation, he was always happy to receive his friends." "His Sunday suppers," says M'Culloch, "were long celebrated at Edinburgh." One of his favorite places of resort in these years was a club of which Dr. Hutton, Dr. Black, Dr. Adam Ferguson, John Clerk, the naval tactician, Robert Adam, the architect, as well as Smith himself, were original members, and to which Dugald Stewart, Professor Playfair and other eminent men were afterwards admitted. Another source of enjoyment was the small but excellent library he possessed; it is still preserved in his family. Professor Nicholson has had access to it, and was struck by the varied nature of the collection, and especially by the large number of books of travel and poetry which it contained. In 1787 he was elected lord rector of the university of Glasgow, an honor which he received with "heartfelt joy." If we can believe a note in Wilberforce's *Correspondence*, he visited London in the spring of the same year, and was introduced by Dundas[3] to Pitt, Wilberforce and others. From the death of his mother in 1784, and that of Miss Douglas in 1788, his health and strength gradually declined, and after a tedious and painful illness he died on 17th July, 1790.

Before his decease Smith directed that all his manuscripts except a few selected essays should be destroyed, and they were accordingly committed to the flames. Of the pieces preserved by his desire the most valuable is his tract on the history of astronomy, which he himself described as a "fragment of a great work"; it was doubtless a portion of the "connected history of the liberal sciences and elegant arts" which, we are told, he had projected in early life. Among the papers destroyed were probably, as Stewart suggests, the lectures on natural religion and jurisprudence which formed part of his course at Glasgow, and also the lectures on rhetoric which he delivered at Edinburgh in 1748. To the latter Blair seems to refer when, in his work on *Rhetoric and Belles-Lettres* (1783), he acknowledges his obligations to a manuscript treatise on rhetoric by Smith, part of which its author had shown to him many years before, and which he hoped Smith would give to the public. It was probably the lectures on jurisprudence which Smith had in view when, some time before his death expressing regret that he "had done so little," he added, "I meant to have done more, and there are materials in my papers of which I could have made a great deal." He had promised at the end of his *Theory of Moral Sentiments* a treatise on the general principles of jurisprudence from the historical point of view, which would doubtless have been a development of his university lectures on that subject.

In person Smith was of about the middle size, well made and stout, though not corpulent. His features are said to be well represented in the medallion by Tassie engraved in M'Culloch's edition of the *Wealth of Nations*. His discourses as professor were almost entirely extemporary, and, as he was always interested in his subject, he never failed to interest his hearers. He was sometimes, Millar tells us, embarrassed and spoke with hesitation at the outset; but "as he advanced the matter seemed to crowd upon him, his manner became warm and animated, and his expression easy and fluent." In society, except amongst intimate friends, he spoke but seldom, and was rather disposed to enjoy in silence the gayety of those around him. He often seemed altogether occupied with his own thoughts, or might even have been supposed, from his looks and gestures, to be "in the fervor of composition." "He was the most absent man in company," says Alexander Carlyle, "that I ever saw, moving his lips and talking to himself and smiling in the midst of large companies." When called on to give his opinion of the matter under discussion he was apt to do so too much in the manner of a lecture. Easy and flowing as is the style of his books, yet to the end he wrote slowly and with difficulty; he did not usually himself take pen in hand, but dictated to an amanuensis, whilst he walked up and down his apartment. In character he was sincere and earnest, in manner apparently cold, but capable of strong feelings, whether of personal affection or of moral indignation. His frequent acts of beneficence were marked by delicacy no less than by liberality. He was a model of filial love and duty, and took to the last the warmest interest in all that concerned the welfare of his friends.

As a moral philosopher Smith cannot be said to have won much acceptance for his fundamental doctrine. This doctrine is that all our moral sentiments arise from sympathy, that is, from the principle of our nature "which leads us to enter into the situations of other men and to partake with them in the passions which those situations have a tendency to excite." Our direct sympathy with the agent in the circumstances in which he is placed gives rise, according to this view, to our notion of the propriety of his action, whilst our indirect sympathy with those whom his actions have benefited or injured give rise to our notions of merit and demerit in the agent himself. It seems justly alleged against this system by Dr. Thomas Brown that "the moral sentiments, the origin of which it ascribes to our secondary feelings of mere sympathy, are assumed as previously existing in the original emotions with which the secondary feelings are said to be in unison." A second objection urged, perhaps with less justice, against the theory is that it fails to account for the authoritative character which is felt to be inherent in our sense of right and wrong—for what Butler calls the "supremacy of conscience." But those who most strongly dissent from Smith's general doctrine are warm in their admiration of the eloquence of his style—sometimes, however, faulty on the side of redundancy—and the felicity of his illustrations. In all its minor details, says Brown, "the work may be considered as presenting a model of philosophic beauty," and it is universally admitted that the author has thrown much light on many delicate and subtle phenomena of our moral nature. The minute observation and the rare ingenuity which he shows in dealing with the finer traits of character and the less obvious indications of feeling remind us of the similar qualities exhibited in a different field in the *Wealth of Nations*.

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[1] Mr. J. E. T. Rogers published in the *Academy*, 28th February, 1885, a letter of Smith to William Pulteney, written in 1772, from which he thinks it probable that the work lay "unrevised and unaltered" in the author's desk for four years. A similar conclusion seems to follow from a letter of Hume in Burton's *Life*, ii. p. 461.

[2] A story was told by Sir Walter Scott, and is also related in the *Edinburgh Review*, of an "unfortunate recontre," arising out of the publication of the same letter, between Smith and Dr. Johnson, during the visit of the latter to Glasgow. The same story is given in a note in Wilberforce's *Correspondence*, the scene being somewhat vaguely laid in "Scotland." But it is impossible that it should be true: for Johnson made his tour in 1773, whilst Hume's death did not take place till 1776. Smith seems not to have met Johnson in Scotland at all. It appears, however, from Boswell's *Life*, under date of 29th April, 1778, that Johnson had on one occasion quarrelled with Smith and treated him rudely at Strahan's house, apparently in London; but, as Robertson met Johnson "for the first time" immediately after that incident, and as we know that Robertson met him in Scotland, it follows that the "uulucky altercation" at Strahan's must have occurred before the Scotch tour, and could have had nothing to do with the letter on Hume's death.

[3] An interesting letter of Smith to Dundas (1st November, 1779), on free trade for Ireland, is printed in the *Eng. Hist. Review*, No.2.

It is on the latter work that Smith's fame mainly rests. Under POLITICAL ECONOMY (vol. xix. pp. 378-83) will be found a detailed analysis of the economic scheme contained in it, and an examination of its spirit and tendency as a contribution to the philosophy of society. We have there sufficiently exposed the exaggeration which represents Smith as the creator of political economy. But the *Wealth of Nations*. is, without doubt, the greatest existing book on that department of knowledge, the only attempt to replace and so antiquate it—that of John Stuart Mill—having, notwithstanding its partial usefulness, on the whole decidedly failed. Buckle, however goes too far when he pronounces it "the most important book ever written," just as he similarly exceeds due measure when he makes its author superior as a philosopher to Hume. Mackintosh more justly said of it that it stands on a level with the treatise *De Jure Belli et Pacis*, the *Essay on the Human Understanding*, and the *Spirit of Laws*, in the respect that these four works are severally the most conspicuous landmarks in the progress of the sciences with which they deal. And, when he added that the *Wealth of Nations* was "perhaps the only book which produced an immediate, general, and irrevocable change in some of the most important parts of the legislation of all civilized states," he scarcely spoke too strongly if we understand him as referring to its influence as an agent of demolition. It certainly operated powerfully through the harmony of its critical side with the tendencies of the half-century which followed its publication to the assertion of personal freedom and "natural rights." It discredited the economic policy of the past, and promoted the overthrow of institutions which had come down from earlier times, but were unsuited to modern society. As a theoretic treatment of social economy, and therefore as a guide to social reconstruction and practice in the future, it is provisional, not definitive. But here too it has rendered eminent service: it has established many truths and dissipated many obstinate prejudices; it has raised the views of all thinking men on national wealth to a higher level; and, when the study of its subject comes to be systematized on the basis of a general social philosophy more complete and durable than Smith's, no contribution to that final construction will be found so valuable as his.

Buckle has the idea that the two principal works of Smith, the *Theory of Moral Sentiments* and the *Wealth of Nations*, are mutually complementary parts of one great scheme, in which human nature is intended to be dealt with as a whole,—the former exhibiting the operation of the benevolent feelings, the latter of what, by a singular nomenclature, inadmissible since Butler wrote, he calls "the passion of selfishness." In each division the motor contemplated is regarded as acting singly, without any interference of the opposite principle. This appears to be an artificial and misleading notion. Neither in the plan of Smith's university course nor in the well-known passage at the end of his *Moral Sentiments* is there any indication of his having conceived such a bipartite scheme. The object of the *Wealth of Nations* is surely in no sense psychological, as is that of the *Moral Sentiments*. The purpose of the work is to exhibit social phenomena, not to demonstrate their source in the mental constitution of the individual. And Buckle seems to have fallen into the error of confounding "sympathy" with benevolence, or at least of regarding their spheres as coextensive. It is only in his ethical treatise that Smith carries back the pursuit of wealth to its ultimate motive; and, when he does so, instead of tracing it to a selfish principle, which is to be placed in contrast with sympathy, he expressly declares it to have its origin in "a regard to the sentiments of mankind"; in other words he makes it a consequence of the desire of sympathy.

In relation to Smith's personality, which is at present our principal object, it may be observed that his moral features are exhibited in an interesting way in his great work. The most marked characteristics thus reflected are his strong sympathy with the working classes, his contempt for vulgar politics, and his hatred of the spirit of monopoly,—the last manifesting itself especially in his suspicion of the public conduct of merchants and manufacturers. The first of these sentiments breaks out in several places, as in the discussion of the laws of settlement and in the remarks on combinations, and notably in the often-quoted passage where he says: "It is but equity that those who feed, clothe, and lodge the whole body of the people should have such a share of the produce of their own labor as to be themselves tolerably well fed, clothed and lodged." He has no respect for that "insidious and crafty animal, vulgarly called a statesman or politician," and complains that the "sneaking arts of underling tradesmen" are erected into political maxims for the conduct of a great empire. "All for ourselves and nothing for other people seems in every age of the world to have been the vile maxim of the masters of mankind." The project of shutting out every other nation from a share in the benefits of our colonial trade he brands as an "invidious and malignant" one. He never tires of condemning the "mean rapacity," the "monopolizing spirit," the "impertinent jealousy," the "interested sophistry" of the capitalistic class. "Our merchants and manufacturers," he says—and the remark is not yet out of date—"complain much of the effect of high wages in raising the price, and thereby lessening the sale, of their goods both at home and abroad; they say nothing concerning the bad effects of high profits; they are silent with respect to the pernicious effects of their own gains; they complain only of those of other people." "Their interest is never exactly the same with that of the public; they have generally an interest to deceive and even to oppress the public; and they accordingly have upon many occasions both deceived and oppressed it." This class he regarded, in fact, as corrupting by its selfishness the policy of the European nations and in particular of England, and as constituting the strength of the opposition, which he feared would be insuperable, to a system of commercial freedom. The general impression of its author which the book leaves behind it is that of a large, healthy and generous nature, earnest in insisting on fair play for all and prompt to denounce with contemptuous vehemence anything which wore the appearance of injustice.

Our principal authority for the biography of Smith is Dugald Stewart's *Account of his Life and Writings*, originally read (1793) before the Royal Society of Edinburgh, and afterwards prefixed to Smith's *Essays on Philosophical Subjects*, as edited by Black and Hutton. Additional particulars are given in Brougham's *Men of Letters and Science*, Burton's *Life of Hume*, and Alexander Carlyle's *Autobiography*; and some characteristic anecdotes of him will be found in *Memoirs of the Life and Works of Sir John Sinclair* (1837). For comments on his *Theory of Moral Sentiments*, see, besides Stewart, as cited above, Dr. T. Brown's *Philosophy of the Human Mind*, lects. 80 and 81; Sir J. Mackintosh's *Dissertation on the Progress of Ethical Philosophy*; J. A. Farrer's *Adam Smith* (1881) in the series entitled *English Philosophers*; and the art. ETHICS in the present work. On the *Wealth of Nations*, the student may consult the prefaces to M'Culloch's, Rogers's and Nicholson's editions of that work; Rogers's *Historical Gleanings* (1869): the art. "Smith" in Coquelin and Guillaumin's *Dictionnaire de l'Economie Politique*; Bagehot's *Economic Studies* (1880); and Cossa's *Guide to the Study of Political Economy* (Eng. trans., 1880), chap. v., where the author has enumerated the most important memoirs by foreign writers on Smith as an economist. (J. K. I.)

SMITH, ALBERT (1816-1860), an instance of the journalistic rather than the truly literary type of writer, was one of the most popular men of his time; a favorite humorist in the vein of humor then in vogue, but now already rather out of date; a leading contributor to *Punch*; the author of successful books of light social satire; and, not least, the exponent of "Mont Blanc" in a pre-scientific popular entertainment descriptive of that famous mountain. He was born at Chertsey, Surrey, on 24th May, 1816, and was educated to follow his father's profession of a surgeon. Having, in the course of his medical studies, been to the Hôtel Dieu, Paris, his first literary effort was an account of his life there, which appeared in the *Mirror*. From this time he gradually relinquished his medical work for the more congenial occupation of light literature. He was associated with *Punch* from its beginning, and was also a regular contributor to *Bentley's*

Miscellany, in whose pages his first and best book, *The Adventures of Mr. Ledbury*, first appeared. His other books were *A History of Evening Parties*, *Christopher Tadpole*, issued in monthly parts, *Pottleton's Legacy*, and, as a series of so-called natural histories, *The Gent*, *The Ballet Girl*, *The Idler upon Town*, and *The Flirt*. Albert Smith also wrote extravaganzas and adapted some of Charles Dickens's stories for the stage. He conducted too for a time a magazine called *The Man in the Moon*, which was discontinued in 1849. In 1851 he visited the Alps and ascended Mont Blanc, and the year after produced the descriptive entertainment before referred to. "China," a similar entertainment, was afterwards produced, but less successfully. Smith married in 1859 a daughter of Keeley, the comedian. He died at Fulham, Middlesex, on 23d May, 1860, from an attack of apoplexy.

SMITH, ALEXANDER (1830–1867), was the most prominent representative of the so-called "spasmodic" school of poetry, whose peculiarities first gained for it a hasty reputation, and then, having suffered under closer critical examination, it almost as speedily dropped out of mind again. Smith has never yet, perhaps, had his true position assigned to him. His first book, *A Life Drama and other Poems* (1853). which made his name, was a work of real promise. Although deficient in dramatic grasp of subject, in restraint of expression, in metrical quality, and although showing too obviously the influence of Keats and Tennyson in certain exaggerations of epithet and phrase, the book yet contains evidence of a poetic faculty which might, under more fortunate conditions, have developed into genuine power. Alexander Smith was one of those writers who require the critical safeguards of the schools to chasten their somewhat importunate energies; and for want of these academic restrictions he wasted his powers in discursive experiments of not much abiding value. Born at Kilmarnock, on the last day of 1830, he received the usual schooling common at that time; and, his parents being too poor to send him to college, he was placed in a linen factory to follow his father's trade of a pattern designer. His literary proclivities, however, soon showed themselves, and from time to time his early poems appeared in the *Glasgow Citizen*, in whose editor, James Hedderwick, he found a sympathizing and appreciative friend. His poems, having attracted the attention also of the Rev. George Gilfillan, found through him an opening in the London *Citizen*. *A Life Drama and other Poems*, published in 1853, speedily ran through several editions, and gained Smith the appointment of secretary to Edinburgh university in 1854. In the same year Sydney Dobell, whose name is now familiarly associated with Smith's, came to Edinburgh, and an acquaintanceship at once sprang up between the two, which resulted in their collaboration in a book of *War Sonnets*, inspired by the Crimean War, which was published in 1855. The volumes of verse issued independently by Alexander Smith in the ensuing years did not receive much attention; their author then turned himself to prose, after publishing *City Poems* in 1857, and *Edwin of Deira*, a Northumbrian epic poem, in 1861. His first prose work was *Dreamthorpe*, 1863; it was followed in 1865 by *A Summer in Skye*, which contains his best prose writing, and is full of a quiet charm and true sympathy with nature. His last work was an experiment in fiction, *Alfred Hagart's Household* (1866), which ran first through *Good Words*. In this the same faults of construction, conjoined with the same incidental grace of description that show themselves in his larger poems, are repeated. The strain produced by his literary and other work began to tell towards the end of 1866, and his death followed on 5th January, 1867.

A memoir of Smith by P. P. Alexander is prefixed to a volume of remains, entitled *Last Leaves*, in which will be found a fairly complete account of his life and writings.

SMITH, COLVIN (1795–1875), portrait painter, was born at Brechin, Scotland, in 1795. He studied in London in the schools of the Royal Academy and worked in Nolleken's studio. He then proceeded to Italy, where he executed some fine copies from Titian; and at Antwerp he made studies from the works of Rubens. Returning to Scotland in 1827, he settled in Edinburgh, occupying the house and studio which had formerly belonged to Raeburn. Soon he attained a wide practice as a portrait painter, and among his sitters were Lord Jeffrey, Henry Mackenzie, author of *The Man of Feeling*, and many of the most celebrated Scotsmen of the time. His portrait of Sir Walter Scott was so popular that he executed some twenty replicas of it, for seven of which he received fresh sittings. His works are distinguished by excellent draftsmanship, by directness and simplicity of treatment, and by well-marked individuality. He died in Edinburgh on 21st July, 1875.

SMITH, HENRY JOHN STEPHEN (1826–1883), mathematician, was born in Dublin on 2d November, 1826, and was the fourth child of his parents. When Henry Smith was just two years old his father died, whereupon his mother left Ireland for England. Mrs. Smith taught her children herself, and until Henry was over eleven he was under her exclusive care and teaching; after that he was educated by private tutors till he went to Rugby in 1841. Whilst under the first of these tutors, in nine months he read all Thucydides, Sophocles, and Sallust, twelve books of Tacitus, the greater part of Horace, Juvenal, Perseus, and several plays of Æschylus and Euripides. He also got up six books of Euclid and some algebra, besides reading a considerable quantity of Hebrew, and learning the *Odes* of Horace by heart. On the death of his elder brother in September, 1843, Henry Smith left Rugby, and in the end of 1844 gained a scholarship at Balliol College, Oxford. He won the Ireland scholarship in 1848, and obtained a first class in both the classical and the mathematical schools in 1849. He gained the senior mathematical scholarship in 1851. He was elected fellow of Balliol in 1850 and Savilian professor of geometry in 1861, and in 1874 was appointed keeper of the university museum. He was elected F.R.S. in 1861, and was an LL.D. of Cambridge and Dublin. He served on various royal commissions, and from 1877 was the chairman of the managing body of the meteorological office. He died at Oxford on 9th February, 1883.

After taking his degree he wavered between classics and mathematics, but finally chose the latter. After publishing a few short papers relating to theory of numbers and to geometry, he devoted himself to a thorough examination of the writings of Gauss, Lejeune-Dirichlet, Kummer, etc., on the theory of numbers. The main results of these researches, which occupied him from 1854 to 1864, are contained in his *Report on the Theory of Numbers*, which appeared in the British Association volumes from 1859 to 1865. This report contains not only a complete account of all that had been done on this vast and intricate subject, but also original contributions of his own. Some of the most important results of his discoveries were communicated to the Royal Society in two memoirs upon Systems of Linear Indeterminate Equations and Congruences, and upon the Orders and Genera of Ternary Quadratic Forms (*Phil. Trans.*, 1861 and 1867). He did not, however, confine himself to the consideration of forms involving only three indeterminates, but succeeded in establishing the principles on which the extension to the general case of *n* indeterminates depends, and obtained the general formulæ, thus effecting what is probably the greatest advance made in the subject since the publication of Gauss's *Disquisitiones Arithmeticæ*. A brief abstract of Smith's methods and results appeared in the *Proc. Roy. Soc.* for 1864 and 1868. In the second of these notices he gives the general formulæ without demonstrations. As corollaries to the general formulæ he adds the formulæ relating to the representation of a number as a sum of five squares and also of seven squares. This class of representation ceases when the number of squares exceeds eight. The cases of two, four, and six squares had been given by Jacobi and that of three squares by Eisenstein, who had also given without demonstration some of the results for five squares. Fourteen years later the French Academy, in ignorance of Smith's work, set the demonstration and completion of Eisenstein's theorems for five squares as the subject of their "Grand Prix des Sciences Mathématiques." Smith, at the request of a member of the commission by which the prize was proposed, undertook in 1882 to write out the demonstration of his general theorems so far as was required to prove the results for the special case of five squares. A month after his death, in March, 1883, the prize of 3000 [$579] francs was awarded to him. The fact that a question of which Smith had given the solution in 1867, as a corollary from general formulæ governing the whole class of investigations to which it belonged, should have been set by the French Academy as the subject of their great prize, shows how far in advance of his contemporaries his early researches had carried him. Many of the propositions contained in his dissertation are general; but the demonstrations are not supplied for the case of seven squares. He was also the author of important papers in which he extended to complex quadratic forms many of Gauss's investigations relating to real quadratic forms. After 1864 he devoted himself chiefly to elliptic functions, and numerous papers on this subject were published by him in the *Proc. Lond. Math. Soc.*, and elsewhere. At the time of his death he was engaged upon a memoir on the *Theta and Omega Functions*, which he left nearly complete. In 1868 he was awarded the Steiner prize of the Berlin Academy for a geometrical memoir, *Sur quelques problèmes cubiques et biquadratiques*. He also wrote the introduction to the collected edition of Clifford's *Mathematical Papers* (1882). The three subjects to which Smith's writings relate are theory of numbers, elliptic functions, and modern geometry; but in all that he wrote an "arithmetical" mode of thought is apparent, his methods and processes being arithmetical as distinguished from algebraic. He had the most intense admiration of Gauss. He was president of the mathematical and physical section of the British Association at Bradford in 1873, and of the London Mathematical Society in 1874–76. A memorial edition of his collected mathematical works is being (1887) printed by the Oxford university press.

An article in the *Spectator* of 17th February, 1883, written by Lord Justice Bowen, gives perhaps the best idea of Smith's extraordinary personal qualities and influence, his sound judgment, perfect temper, gentle and Lælian wisdom, sweetness of character, delicate gayety of spirit, and brilliant conversational power, which made him one of the most accomplished and attractive ornaments of any educated company in which he moved.

For further details relating to Henry Smith, reference should be made to the *Fortnightly Review* for May, 1883, and to the "Monthly Notices" of the Roy. Ast. Soc., vol. xliv.

SMITH, JAMES (1775–1839) and **HORACE** (1779–1849), sons of an eminent and prosperous London solicitor, were born, the former on 10th February, 1775, and the latter on 31st December, 1779, both in London. They were joint authors of the *Rejected Addresses*, described by Horace as "one of the luckiest hits in literature." The occasion of this happy *jeu d'esprit* was the rebuilding of Drury Lane theatre in 1812, after a fire in which it had been burnt down. The managers had offered a prize of £50 [$243] for an address to be recited at the reopening in October. Six weeks before that date the happy thought occurred to the brothers Smith of feigning that the most popular poets of the time had been among the competitors and issuing a volume of unsuccessful addresses in parody of their various styles. They divided the task between them, James taking Wordsworth, Southey, Coleridge, and Crabbe, while Byron, Moore, Scott, and Bowles were assigned to Horace.[1] The parodists were ready with their small volume by October, but they had some difficulty in getting a publisher, although the success of their clever imitations once published was such that seven editions were called for within three months. The *Rejected Addresses* are the most widely popular parodies ever published in England, and have taken quite a classical rank in that kind of literature. The brothers fairly divided the honors: the elder brother's Wordsworth is evenly balanced by the younger's Scott, and both had a hand in Byron. A striking feature in the parodies is the absence of malice; none of the caricatured bards took offence, while the imitation is so clever that both Byron and Scott are recorded to have said in effect that they could hardly believe they had not written the addresses ascribed to them.

After this brilliant success James, the elder brother, determined, as he said, "to leave off a winner" and follow Warburton's advice to Anstey: "Young man, you have written a highly successful work; never put pen to paper again." He was tempted occasionally to transgress this self-denying ordinance, and made another hit in writing *Country Cousins*, *A Trip to Paris*, *A Trip to America*, and other lively skits for Charles Mathews, earning from the comedian the praise of being "the only man who can write clever nonsense." His social reputation as a wit stood high. He was reputed one of the best of conversers in an age when the art was studied, and it was remarked that he held his own without falling into the great error of wits,—sarcasm. But for all his good nature he did not wholly escape the Charybdis of great talkers,—the charge of being something of a bore. In his old age the irreverent *Fraser's* put him in its gallery of living portraits as a gouty and elderly but painstaking joker. He died in London on 26th December, 1839.

Horace Smith was less timorously careful of his poetical reputation than his elder brother, whom he survived, and, after making a fortune as a stockbroker, followed in the wake of Scott and wrote about a score of historical novels,—*Brambletye House*, *Tor Hill*, *Reuben Apsley*, *Zillah*, *The New Forest*, *Walter Colyton*, etc. His sketches of eccentric character are brilliant and amusing; but he was more of an essayist than a story-teller. He began in 1826, when Scott, still retaining his hold on the public, had made success impossible for imitators with less wealth of historical substance and inferior command of stirring incident. As he went on he encountered such competitors as Bulwer Lytton, Disraeli, Marryat, and Dickens. Still Horace Smith established a fair reputation, and some of his novels may still be found in the smoking-rooms of country houses. He was also a frequent contributor to the *New Monthly Magazine* under the editorship of Campbell. Three volumes of *Gaieties and Gravities*, published in 1826, contain many witty essays both in prose and in verse, but the only single piece that has taken a permanent place is the "Address to the Mummy in Belzoni's Exhibition." There is more of earnest in this than is generally found in his jesting. In private life Horace Smith was not less popular than his brother, though less ambitious of renown as a talker. It was of him that Shelley said: "Is it not odd that the only truly generous person I ever knew who had money enough to be generous with should be a stockbroker? He writes poetry and pastoral dramas and yet knows how to make money, and does make it, and is still generous." Horace Smith died at Tunbridge Wells on 12th July, 1849.

SMITH, JOHN (1580–1631), usually distinguished as Captain John Smith, some time president of the English colony in Virginia, was the elder son of George Smith, a well-to-do tenant-farmer on the estate of Lord Willoughby d'Eresby at Willoughby near Alford in Lincolnshire. The life of this Virginian hero falls conveniently into five periods.

The first of these, 1580–1596, that of his early youth, is thus described by himself in his *Travels*: "He was born [1580] in Willoughby in Lincolnshire and was a scholar in the two free schools of Alford and Louth. His parents, dying [April, 1596] when he was thirteen [or rather fifteen] years of age, left him a competent means, which he, not being capable to manage, little regarded. His mind being even then set upon brave adventures, he sold his satchel, books, and all he had, intending secretly to get to sea, but that his father's death stayed him. But now the guardians of his estate more regarding it than him, he had liberty enough, though no means, to get beyond the sea. About the age of fifteen years, he was bound an apprentice to Master Thomas Sendall of [King's] Lynn, the greatest merchant of all those parts; but, because he would not presently send him to sea, he never saw his master in eight years after."

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[1] The particulars of the authorship are given in the 18th edition (1820), and in the memoir of his brother by Horace prefixed to a collection of fugitive pieces (1840). James contributed the first stanza to the imitation of Byron, but otherwise they worked independently.

The second period, 1596–1604, is that of his adventures in Europe, Asia, and Africa. He first went to Orleans in attendance on the second son of Lord Willoughby. Thence he returned to Paris, and so by Rouen to Havre, where, his money being spent, he began to learn the life of a soldier under Henry IV. of France. On the conclusion of the peace with the League he went with Captain Joseph Duxbury to Holland and served there some time, probably with the English troops in Dutch pay. By this time he had gained a wide experience in the art of war, not merely as an infantry officer, but also in those more technical studies which are now followed by the Royal Engineers. At length he sailed from Enkhuisen to Scotland, and on the voyage had a narrow escape from shipwreck upon Holy Island near Berwick. After some stay in Scotland he returned home to Willoughby, "where, within a short time being glutted with too much company, wherein he took small delight, he retired himself into a little woody pasture, a good way from any town, environed with many hundred acres of other woods. Here by a fair brook he built a pavilion of boughs, where only in his clothes he lay. His study was Machiavelli's *Art of War* and Marcus Aurelius; his exercise a good horse with his lance and ring; his food was thought to be more of venison than anything else; what [else] he wanted his man brought him. The country wondering at such a hermit, his friends persuaded one Signior Theadora Polaloga, rider to Henry, earl of Lincoln, an excellent horseman and a noble Italian gentleman, to insinuate [himself] into his woodish acquaintances, whose languages and good discourse and exercise of riding drew Smith to stay with him at Tattersall. . . . Thus, when France and the Netherlands had taught him to ride a horse and use his arms, with such rudiments of war as his tender years, in those martial schools, could attain unto, he was desirous to see more of the world, and try his fortune against the Turks, both lamenting and repenting to have seen so many Christians slaughter one another."

Next came his wanderings through France from Picardy to Marseilles. There he took ship for Italy in a vessel full of pilgrims going to Rome. These, cursing him for a heretic, and swearing they would have no fair weather so long as he was on board, threw him, like another Jonah, into the sea. He was able to get to a little uninhabited island, from which he was taken off the next morning by a Breton ship of 200 tons going to Alexandria, the captain of which, named La Roche, treated him as a friend. In this ship he visited Egypt and the Levant. On its way back the Breton ship fought a Venetian argosy of 400 tons and captured it. Reaching Antibes (Var) later on, Captain La Roche put Smith ashore with 500 sequins [$1134], who then proceeded to see Italy as he had already seen France. Passing through Tuscany he came to Rome, where he saw Pope Clement VIII. at mass, and called on Father R. Parsons. Wandering on to Naples and back to Rome, thence through Tuscany and Venice, he came to Gratz in Styria. There he received information about the Turks who were then swarming through Hungary, and, passing on to Vienna, entered the emperor's service.

In this Turkish war the years 1601 and 1602 soon passed away; many desperate adventures did he go through, and one in particular covered him with great honor. At Regal (Stuhlweissenburg), in the presence of two armies, as the champion of the Christians, he fought on horseback and killed three Turkish champions in succession. On 18th November, 1602, at the battle of Rothenthurm, a pass in Transylvania, where the Christians fought desperately against an overpowering force of Crim Tatars, Smith was left wounded on the field of battle. His rich dress saved him, for it showed that he would be worth a ransom. As soon as his wounds were cured he was sold for a slave and then marched to Constantinople, where he was presented to Charatza Tragabigzanda, who fell in love with him. Fearing lest her mother should sell him, she sent him to her brother Timor, pasha of Nalbrits, on the Don, in Tartary. "To her unkind brother this kind lady wrote so much for his good usage that he half suspected as much as she intended; for she told him, he should there but sojourn to learn the language, and what it was to be a Turk, till time made her master of herself. But the Timor, her brother, diverted all this to the worst of cruelty. For, within an hour after his arrival, he caused his 'drubman' to strip him naked, and shave his head and beard so bare as his hand. A great ring of iron, with a long stalk bowed like a sickle, was riveted about his neck, and a coat [put on him] made of ulgry's hair, guarded about with a piece of an undressed skin. There were many more Christian slaves, and nearly a hundred *forsados* of Turks and Moors, and he being the last was the slave of slaves to them all." While at Nalbrits the English captain kept his eyes open, and his account of the Crim Tatars is careful and accurate. "So long he lived in this miserable estate, as he became a thresher at a grange in a great field, more than a league from the Timor's house. The pasha, as he oft used to visit his granges, visited him, and took occasion so to beat, spurn, and revile him, that forgetting all reason Smith beat out the Timor's brains with his threshing bat, for they have no flails, and, seeing his estate could be no worse than it was, clothed himself in the Timor's clothes, hid his body under the straw, filled his knapsack with corn, shut the doors, mounted his horse, and ran into the desert at all adventure." For eighteen or nineteen days he rode for very life until he reached a Muscovite outpost on the river Don; here his irons were taken off him, and the Lady Callamata largely supplied all his wants. Thence he passed, attracting all the sympathy of an escaped Christian slave, through Muscovy, Hungary, and Austria until he reached Leipsic in December, 1603. There he met his old master, Prince Sigismund, who, in memory of his gallant fight at Regal, gave him a grant of arms and 500 ducats [$1134] of gold. Thence he wandered on, sightseeing, through Germany, France, and Spain, until he came to Saffi, from which seaport he made an excursion to the city of Morocco and back.

While at Saffi he was blown out to sea on board Captain Merham's ship, and had to go as far as the Canaries. There Merham fought two Spanish ships at once and beat them off. Smith came home to England with him, having a thousand ducats in his purse [$2268].

The third period, 1605–1609, is that of Captain Smith's experiences in Virginia. Throwing himself into the colonizing projects which were then coming to the front, he first intended to have gone out to the colony on the Oyapok in South America; but, Captain Ley dying, and the reinforcement miscarrying, "the rest escaped as they could." Hence Smith did not leave England on this account. But he went heartily into the Virginian project with Captain Bartholomew Gosnold and others. He states that what he got in his travels he spent in colonizing. "When I went first to these desperate designs, it cost me many a forgotten pound to hire men to go, and procrastination caused more to run away than went. I have spared neither pains or money according to my ability, first to procure His Majesty's letters patents, and a company here, to be the means to raise a company to go with me to Virginia, which beginning here and there cost me nearly five years' [1604–1609] work, and more than five hundred pounds of my own estate, besides all the dangers, miseries, and incumbrances I endured gratis." Two colonizing associations were formed,—the London Company for South Virginia and the Western Company for North Virginia. Smith was one of the founders of the London Company. The colonies which Sir W. Raleigh had established at Roanoke and other islands off the American coast had all perished, mainly for want of a good harbor, so that really nothing at all was known of the Virginian coastline when the first expedition left London on 19th December, 1606; and therefore the attempt was bound to fail unless a convenient harbor should be found. The expedition consisted of three ships (the "Susan Constant," 100 tons, Captain C. Newport; the "God Speed," 40 tons, Captain B. Gosnold; and a pinnace of 20 tons, Captain J. Ratcliffe), with about 140 colonists and 40 sailors. They made first for the West Indies, reaching Dominica on 24th March, 1607. At Nevis, their next stopping place, a gallows was erected to hang Captain Smith on the false charge of conspiracy; but he escaped, and, though afterwards the lives of all the men who plotted against him were at his mercy, he spared them. Sailing northwards from the West Indies, not knowing where they were, the expedition was most fortunately, in a gale, blown into the mouth of Chesapeake Bay, discovering land on 26th April, 1607. Anchoring, they found the James river, and, having explored it, fixed upon a site for their capital in the district of the chief or weroance of Paspaheh, its chief recommendation being that there were 6 fathoms of water so near to the shore that the ships could be tied to the trees. Orders had been sent out for the government of the colony in a box, which was opened on 26th April, 1607. Captains B. Gosnold, E. M. Wingfield, C. Newport, J. Smith, J. Ratcliffe, J. Martin, and G. Kendall were named to be the council to elect an annual president, who, with the council, should govern. Wingfield was, on 13th May, elected the first president; and the next day they landed at James Town and commenced the settlement.

All this while Smith was under restraint, for thirteen weeks in all. His enemies would have sent him home, out of a sham commiseration for him; but he challenged their charges, and so established his innocency that Wingfield was adjudged to give him £200 [$972] as damages. After this, on 20th June, 1607, Smith was admitted to the council.

As in going to America in those days the great difficulty was want of water, so in those colonizing efforts the paramount danger was from want of food. "There were never Englishmen left in a foreign country in such misery as we were in this new discovered Virginia. We watched every three nights [every third night], lying on the bare cold ground, what weather soever came, and warded all the next day, which brought our men to be most feeble wretches. Our food was but a small can of barley sodden in water to five men a day. Our drink, cold water taken out of the river, which was, at a flood, very salt, at a low tide, full of slime and filth, which was the destruction of many of our men." So great was the mortality that out of 105 colonists living on the 22d June, 1607, 67 died by the following 8th January. The country they had settled in was sparsely populated by many small tribes of Indians, who owned as their paramount chief, Powhatan, who then lived at Werowocomoco, a village on the Pamunkey river, about 12 miles by land from James Town. Various boat expeditions left James Town, to buy food in exchange for copper. They generally had to fight the Indians first, to coerce them to trade, but afterwards paid a fair price for what they bought.

On 10th December, 1607, Captain Smith, of whom it is said "the Spaniard never more greedily desired gold than he victail," with nine men in the barge, left James Town to get more corn, and also to explore the upper waters of the Chickahominy. They got the barge up as far as Apocant. Seven men were left in it, with orders to keep in midstream. They disobeyed, went into the village, and one of them, George Cassen, was caught; the other six, barely escaping to the barge, brought it back to James Town. It so happened that Opecanchanough (the brother of Powhatan, whom he succeeded in 1618, and who carried out the great massacre of the English on Good Friday, 1622) was in that neighborhood with two or three hundred Indians on a hunting expedition. He ascertained from Cassen where Smith was, who, ignorant of all this, had, with Jehu Robinson and Thomas Emery, gone in a canoe 20 miles farther up the river. The Indians killed Robinson and Emery while they were sleeping by the camp fire, and went after Smith, who was away getting food. They surprised him, and, though he bravely defended himself, he had at last to surrender. He then set his wits to confound them with his superior knowledge, and succeeded. Opecanchanough led him about the country for a wonder, and finally, about 5th January, 1608, brought him to Powhatan at Werowocomoco. "Having feasted him after their best barbarous manner they could, a long consultation was held; but the conclusion was two great stones were brought before Powhatan; then as many as could laid hands on Smith, dragged him to them, and thereon laid his head. And, being ready with their clubs to beat out his brains, Pocahontas, the king's dearest daughter, when no entreaty could prevail, got his head in her arms and laid her own upon his to save him from death. Whereat the emperor was contented Smith should live, to make him hatchets, and her bells, beads, and copper; for they thought him as well of all occupations [handicrafts] as themselves."

The truth of this story was never doubted till 1866, when the eminent antiquary, Dr. Charles Deane of Cambridge, Mass., in reprinting Smith's first book, the *True Relation* of 1609, pointed out that it contains no reference to this hairbreadth escape. Since then many American historians and scholars have concluded that it never happened at all; and, in order to be consistent, they have tried to prove that Smith was a blustering braggadocio, which is the very last thing that could in truth be said of him. The rescue of a captive doomed to death by a woman is not such an unheard-of thing in Indian stories. If the truth of this deliverance be denied, how then did Smith come back to James Town loaded with presents, when the other three men were killed, George Cassen in particular, in a most horrible manner? And how is it, supposing Smith's account to be false, that Pocahontas afterwards frequently came to James Town, and was next to Smith himself the salvation of the colony? The fact is, nobody doubted the story in Smith's lifetime, and he had enemies enough.[1]

Space fails to describe how splendidly Smith worked after his deliverance for the good of the colony, how he explored Chesapeake Bay and its influents, how (when all others had failed) the presidency was forced on him on 10th September, 1608; how he tried to seize Powhatan at Werowocomoco on 12th January, 1609, but he fled to Orapakes, 40 miles farther off; how with only eighteen men he cowed Opecanchanough in his own house at Pamunkey, in spite of the hundreds of Indians that were there, and made him sell corn; how well he administered the colony all through the spring and summer of 1609.

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[1] Pocahontas never visited James Town after Smith went to England in October, 1609, until she was brought there a state prisoner in April, 1613, by Captain S. Argall, who had obtained possession of her by treachery on the Potomac river. The colony, while treating her well, used her as a means to secure peace with the Indians. In the meantime, believing Smith to be dead, she fell in love with an English gentleman, John Rolfe, apparently at that time a widower. They were married about 1st April, 1614. Subsequently she embraced Christianity. Sir T. Dale, with Rolfe and his wife, landed at Plymouth on 12th June, 1616. Before she reached London, Smith petitioned Queen Anne on her behalf; and it is in this petition of June, 1616, that the account of his deliverance by the Indian girl first appears. After a pleasant sojourn of about seven months, being well received both by the court and the people, Pocahontas with her husband embarked for Virginia in the *George*, Captain S. Argall (her old captor), but she died off Gravesend about February, 1617.

Meanwhile the establishment of this forlorn hope in Virginia had stirred up a general interest in England, so that the London Company were able in June, 1609, to send out 9 ships with 500 colonists. Smith had now got the Indians into splendid order; but from the arrival on 11th August of the newcomers his authority came to an end. They refused to acknowledge him, and robbed and injured the Indians, who attacked them in turn. Smith did his best to smooth matters, while the rioters were plotting to shoot him in his bed. In the meantime he was away up the river. On his return, "sleeping in his boat, accidentally one fired his powder bag, which tore his flesh from his body and thighs, 9 or 10 inches square, in a most pitiful manner; but to quench the tormenting fire frying him in his clothes he leaped overboard into the deep river, where, ere they could recover him he was nearly drowned." Thus disabled, he was sent home on 4th October, 1609, and never set foot in Virginia again. Nemesis overtook the rioters the winter after he left, which is known in Virginian story as "the starving time." Out of 490 persons in the colony in October, 1609, all but 60 died by the following March.

The rest of Smith's life can only be briefly touched upon. The third period, 1610–1617, was chiefly spent in discovering Nusconcus, Canada, and Pemaquid in North Virginia, to which, at his solicitation, Prince Charles gave the name of New England. His first object was to fish for cod and barter for furs, his next, to discover the coast-line with the view to settlement. Two attempts, in 1615 and 1617, to settle at Capawuck failed, but through no fault of his. It was in connection with these projects that the Western Company for North Virginia gave him the title of admiral of New England. We cannot better conclude this sketch of his active operations than in his own words printed in 1631. "Having been a slave to the Turks; prisoner among the most barbarous savages; after my deliverance commonly discovering and ranging those large rivers and unknown nations with such a handful of ignorant companions that the wiser sort often gave me up for lost; always in mutinies, wants, and miseries; blown up with gunpowder; a long time a prisoner among the French pirates, from whom escaping in a little boat by myself, and adrift all such a stormy winter night, when their ships were split, more than £100,000 [$486,000] lost which they had taken at sea, and most of them drowned upon the Isle of Rhé—not far from whence I was driven on shore, in my little boat, etc. And many a score of the worst winter months have [I] lived in the fields; yet to have lived near thirty-seven years [1593–1630] in the midst of wars, pestilence, and famine, by which many a hundred thousand have died about me, and scarce five living of them that went first with me to Virginia, and yet to see the fruits of my labors thus well begin to prosper (though I have but my labor for my pains), have I not much reason, both privately and publicly to acknowledge it, and give God thanks?"

The last period, 1618–1631, of Smith's life was chiefly devoted to authorship. In 1618 he applied (in vain) to Lord Bacon to be numbered among his servants. In 1619 he offered to lead out the pilgrim fathers to North Virginia; but they would not have him, he being a Protestant and they Puritans. The London Virginia Company became bankrupt for £200,000 [$972,000] in 1624. A list of his publications will be found at the end of this article. Thus having done much, endured much, and written much, while still contemplating a *History of the Sea*, Captain John Smith died on 21st June, 1631, and was buried in St. Sepulchre's Church, London.

Two of the sixty survivors of "the starving time," Richard Pots and William Phettiplace, thus nobly expressed in print, so early as 1612, their estimate of Smith: "What shall I say? but thus we lost him [4th October, 1609] that in all his proceedings made justice his first guide and experience his second; ever hating baseness, sloth, pride, and indignity more than any dangers; that never allowed more for himself than his souldiers with him; that upon no danger would send them where he would not lead them himself; that would never see us want what he either had, or could by any means get us; that would rather want than borrow or starve than not pay; that loved actions more than words, and hated falsehood and cozenage than death; whose adventures were our lives, and whose loss our deaths."

A fairly complete bibliography will be found in Professor Edward Arber's reprint of Smith's *Works*, Birmingham, 1884, 8vo. The order of their first appearance is, *A True Relation*, etc., 1608 (first attributed to a gentleman of the colony, next to Th. Watson, and finally to Captain Smith); *A Map of Virginia*, ed. by W[illiam] S[immonds], Oxford, 1612; *A Description of New England*, 1616; *New England's Trials*, 1620; *New England's Trials*, 2d ed., 1622; *The General History of Virginia, New England, and the Summer Isles*, 1624; *An Accidence for all Young Seamen*, 1626; the same work recast and enlarged as *A Sea Grammar*, 1627, both works continuing on sale for years, side by side; *The True Travels*, etc., 1630; *Advertisements for the Unexperienced Planters*, etc., 1631. Of some of the smaller texts limited 4to editions have been published in the United States by Dr. C. Deane, J. Carter Brown, and others.[1] (E. A.)

SMITH, John Raphael (1752–1812), English painter and mezzotint engraver, a son of Thomas Smith of Derby, the landscape painter, was born in 1752. He was apprenticed to a linen draper in Derby, and afterwards pursued the same business in London, adding, however, to his income by the production of miniatures. He then turned to engraving, and executed his plate of the Public Ledger, which had great popularity, and was followed by his mezzotints of Edwin the Minstrel (a portrait of Thomas Haden), after Wright of Derby, and Mercury Inventing the Lyre, after Barry. He reproduced some forty of the works of Reynolds, some of these plates ranking among the masterpieces of the art of mezzotint, and he was appointed engraver to the Prince of Wales. Adding to his artistic pursuits an extensive connection as a printdealer and publisher he would soon have acquired wealth had it not been for his dissipated habits. He was passionately attached to field-sports, pugilism, and the stage, and was a boon companion of George Morland, whose figure-pieces he excellently mezzotinted. He executed many original portraits in chalks, and painted subject-pictures such as the Unsuspecting Maid, Inattention, and the Moralist, exhibiting in the Royal Academy from 1779 to 1790. Upon the decline of his business as a printseller he made a tour as an itinerant portrait painter through the northern and midland counties of England, producing much hasty and indifferent work, and settled in Doncaster, where he died on 2d March, 1812.

As a mezzotint engraver Smith occupies the very first rank. His prints are delicate, excellent in drawing, and finely expressive of color. His small full-lengths in crayons and his portraits of Fox, Horne Tooke, Sir Francis Burdett, and the group of the duke of Devonshire and family support his claims as a successful draftsman and painter. He was possessed of a very thorough knowledge of the principles and history of art, and was a brilliant conversationalist.

SMITH, Joseph. See Mormons.

SMITH, Sydney (1771–1845), one of the founders of the *Edinburgh Review*, and one of the wittiest talkers and political writers of his generation, was the son of an English country gentleman, and was born at Woodford in Essex on 3d June, 1771. His father, a man of restless ingenuity and activity, "very clever, odd by nature, but still more odd by design," who bought, altered, spoiled, and sold about nineteen different estates in England, had talent and eccentricity enough to be the father of such a wit as Sydney Smith on the strictest principles of heredity; but Sydney was wont himself to attribute not a little of his constitutional gayety to an infusion of French blood, his maternal grandfather being a French Protestant refugee of the name of Ollier, who could not speak a word of English. Sydney was the second of a family of four brothers and one sister, all remarkable for their talents. While two of the brothers, "Bobus" and Cecil, were sent to Eton, Sydney was sent with the youngest to Winchester, where he rose to be captain of the school, and with his brother so distinguished himself that their schoolfellows signed a round-robin "refusing to try for the college prizes if the Smiths were allowed to contend for them any more, as they always gained them." From Winchester Sydney went to New College, Oxford, and in due course became a fellow of his college. It was his wish then to read for the bar, but his father would add nothing to his fellowship, and he was reluctantly compelled to enter the church, and became a curate in a small village in the midst of Salisbury Plain. From this dreary incumbency he was relieved after two years, and conducted to the scene of the foundation of the *Edinburgh Review* by a combination of accidents. The squire of the parish invited the new curate to dine, was astonished and charmed to find such a man in such a place, and engaged him after a time as tutor to his eldest son. "It was arranged," he afterwards said, "that I and his son should proceed to the university of Weimar. We set out, but before reaching our destination Germany was disturbed by war, and in stress of politics we put into Edinburgh." This was in 1797. In Edinburgh, as everywhere else, Smith made numerous friends, whose cordiality was in no way abated by his constant quizzing of the national foibles and peculiarities; and among those friends were the future Edinburgh Reviewers. It was towards the end of his five years' residence in Edinburgh, in the elevated residence of the then Mr. Jeffrey, "in the eighth or ninth story or flat in a house in Buccleuch Place," that Sydney Smith proposed the setting up of a review as an organ for the opinions and a vehicle for the ambition of the young malcontents with things as they were. "I was appointed editor," he says in the preface to the collection of his contributions, "and remained long enough in Edinburgh to edit the first number [October, 1802] of the *Edinburgh Review*. The motto I proposed for the *Review* was 'Tenui musam meditamur avena'—'We cultivate literature on a little oatmeal.' But this was too near the truth to be admitted, and so we took our present grave motto from Publius Syrus, of whom none of us had, I am sure, ever read a single line." He continued to write for the *Review* for the next quarter of a century, and his brilliant articles were a main element in its success. They represent the very perfection of journalism. They were not merely the most readable, the most entertaining: the solidity of substance and the seriousness of purpose were quite as indisputable as the brilliancy of the execution. The writer seemed to tackle the gravest of political and social questions in the highest of spirits, yet he never lost sight of his aim in purposeless buffoonery; and, however heartily the reader might be made to laugh, the laughter was always directed at what seemed to the writer absurd and unreasonable opinion. It was remarked of his wit in conversation that the butts of it were often seen to laugh as heartily as the audience; there was nothing base and personal in Sydney Smith's raillery. The same with his writing when it was anonymous. His wonderful powers of humorous exaggeration were such as to detach a ridiculous opinion as far as possible from its human incarnation and present it in the bare essence of its absurdity. This was his habit as a controversialist; and, when his purpose was simply to convey information, to give the gist of a book of travels, or a system of education, or a body of statistics, he was unequalled in the art of amusing the reader with ludicrous images in the most unexpected places without departing from the main lines of a most clear, orderly, and instructive exposition. The fact is that the serious didactic purpose in all Sydney Smith's writing and the closeness of his adherence to the matter in hand are the main obstacles to the living permanence of his fame as the writer of the best colloquial prose of his generation; for though his range of topics was wide—political, ecclesiastical, educational, geographical, and otherwise miscellaneous—they were all of immediate, practical, and passing interest, and his remarks were pushed home to the life of the time so closely as to have comparatively little independent interest for posterity.

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[1] [See also *Virginia Vetus*, by E. D. Neill of Wisconsin.—Am. Ed.]

Most of Sydney Smith's contributions to the *Edinburgh Review* were sent from the country parish of Foston-le-Clay in Yorkshire, where he spent the best part of his life. He left Edinburgh for good in 1803, when the education of his pupils was completed; and, yielding to his wife's confidence in his powers—he had married Miss Pybus, an English lady of good family, while still unsettled in life—adventured on London, where he rapidly became known as a preacher, a lecturer, and a social lion. His success as a preacher, although so marked that there was often not standing room in the church in Berkeley Square, where he conducted the morning service, was not gained by any sacrifice of dignity: there was no eccentricity, nothing sensational in his preaching; it was a pure triumph of good sense, right feeling, earnestness, and freshness of pulpit oratory. He lectured on moral philosophy at the Royal Institution for three seasons from 1804 to 1808; and here also, handling the ordinary topics of a philosophy chair in a Scotch university, he treated them with such vigor, freshness, and liveliness of illustration that the London world crowded to Albemarle Street to hear him. He made no pretence to originality, and in the main followed Dugald Stewart, whose lectures he had attended in Edinburgh; but there is more originality as well as good sense in his lectures, especially on such topics as imagination and wit and humor, than in many more pretentious systems of philosophy. With the brilliant reputation that Sydney Smith had acquired in the course of a few seasons in London, he would probably have obtained some good preferment had he been on the powerful side in politics. His Whig friends came into office for a short time in 1806, and presented him with the living of Foston-le-Clay in Yorkshire. He shrank from this banishment for a time, and discharged his parish duties through a curate; but Mr. Percival's Residence Act was passed in 1808, and after trying in vain to negotiate an exchange, he quitted London in 1809 and moved his household to Yorkshire. His most famous single production, *Peter Plymley's Letters* on the subject of Catholic emancipation, ridiculing the opposition of the country clergy, appeared before this migration. From being the idol of London society to being the pastor of a country parish with no educated neighbor within 7 miles was a violent change; but Sydney Smith accommodated himself cheerfully to his new circumstances, and won the hearts of his parishioners as quickly as he had conquered a wider world. Not the least entertaining chapter in his daughter's biography of him is the account of his Yorkshire life. An interesting contrast might be drawn between it and Carlyle's life in somewhat similar circumstances at Craigenputtock. Sydney Smith's life at Foston, with its cheerful energy and ingenuity, its vigorous jesting at difficulties and eccentric ways of conquering them, is of much better example, and moralists might do worse than put the story into form for general edification.[1]

Sydney Smith, after twenty years' service in Yorkshire, obtained preferment at last from a Tory minister, Lord Lyndhurst, who presented him with a canonry in Bristol cathedral in 1828, and afterwards enabled him to exchange Foston for the living of Combe Florey near Taunton. From this time he discontinued writing for the *Edinburgh Review* on the ground that it was more becoming in a dignitary of the church to put his name to what he wrote. It was expected that when the Whigs came into power Sydney Smith would be made a bishop. There was nothing in his writings, as in the case of Swift, to stand in the way, for with all his humor and high spirits he had always, as he said himself, fashioned his manners and conversation so as not to bring discredit on his reverend profession. He had been most sedulous as a parochial clergyman. Still, though he was not without warm friends at headquarters, the opposition was too strong for them. One of the first things that Lord Grey said on entering Downing Street was, "Now I shall be able to do something for Sydney Smith"; but he was not able to do more than appoint him to a prebendal stall at St. Paul's in exchange for the one of inferior value he held at Bristol. Lord Melbourne is reported to have said that there was nothing he more regretted than the not having made Sydney Smith a bishop. Some surprise must be felt now that Sydney Smith's reputation as a humorist and wit should have caused any hesitation about elevating him to the episcopal dignity, and perhaps he was right in thinking that the real obstacle lay in his being known as "a high-spirited, honest, uncompromising man, whom all the bench of bishops could not turn upon vital questions." With characteristic philosophy, when he saw that the promotion was doubtful, he made his position certain by resolving not to be a bishop and definitely forbidding his friends to intercede for him. This loss and the much more painful loss of his eldest son did not destroy the cheerfulness of his later life. He retained his high spirits, his wit, practical energy, and powers of argumentative ridicule to the last. His *Letters to Archdeacon Singelton* on the Ecclesiastical Commission (1837), and his *Petition* and *Letters* on the repudiation of debts by the State of Pennsylvania[1] (1843), are as bright and trenchant as his best contributions to the *Edinburgh Review*. Smith died in London on 22d February, 1845.

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[1] See Lady Holland's *Memoir*, chaps. v., vi. Lady Holland, Sydney Smith's eldest daughter, was the wife of Sir Henry Holland, the famous physician,—not of Lord Holland, as is sometimes absurdly stated.

Lady Holland's *Memoir* of her father, containing such specimens of his table talk as give one some idea of his charm and worth as a mirthful companion and philosopher, is one of the most interesting of biographies. A cheap edition of his *Works* was published in 1869. (W. M.)

SMITH, Sir Thomas (1512–1577), the contemporary and friend of Sir John Cheke, was born at Saffron-Walden in Essex in 1512. He became a fellow of Queens' College, Cambridge, in 1531, and was afterwards appointed to read the public Greek lecture, in the discharge of which function he first introduced the new Greek pronunciation, which soon became universal in England. After studying in France and Italy and taking a degree in law at Padua, he was appointed first regius professor of civil law in Cambridge in 1542. During Somerset's protectorate he entered public life and was sent as ambassador first to Brussels and afterwards to France. In 1548 he was made a secretary of state and knighted. On the accession of Mary he was deprived of all his offices, but in the succeeding reign was frequently employed in public affairs. He died in 1577.

His best-known work, entitled *De Republica Anglorum: the Maner of Government or Policie of the Realme of England*, was published posthumously in 1583, and passed through many editions. His epistle to Gardiner, *De recta et emendata linguæ Græcæ pronunciatione*, was printed at Paris in 1568; the same volume includes his dialogue *De recta et emendata linguæ Anglicanæ scriptione.*

SMITH, William (1769–1839), called "the father of English geology," and among his acquaintances "Stratum Smith," will be generally remembered as the framer and author of the first complete geological map of England and Wales, and as the discoverer of the principle of the identification of strata by their included organic remains. He was born at Churchill in Oxfordshire on 23d March, 1769. Deprived of his father, an ingenious mechanic, before he was eight years old, he depended upon his father's eldest brother, who was but little pleased with his nephew's love of collecting "pundribs" (*Terebratulæ*) and "pound-stones" or "quoit-stones" (large *Echinites*, frequently employed as a pound weight by dairywomen), and had no sympathy with his propensity for carving sundials on the soft brown "oven-stone" of his neighborhood. William became a mineral surveyor and civil engineer. In the former capacity he traversed the Oolitic lands of Oxfordshire and Gloucestershire, the Lias clays and red marls of Warwickshire, and other districts, studying their varieties of strata and soils. In 1791 he surveyed an estate in Somersetshire and observed the strata of the district. In 1793 he executed the surveys and completed the levellings for the line of a proposed canal, in the course of which he confirmed a previous supposition, that the strata lying above the coal were not horizontal, but inclined in one direction—to the eastwards—so as to terminate successively at the surface, and to resemble on a large scale the ordinary disposition of the slices of bread and butter on a breakfast plate—an illustration which he was wont to use on all occasions.

On being appointed engineer to the Somerset Coal Canal in 1794, he was deputed to make a tour of observation with relation to inland navigation. During this tour, which occupied nearly two months, and extended over nine hundred miles, he carefully examined the geological structure of the country, and corroborated his preconceived generalization of a settled order of succession in the several strata, a continuity of range at the surface, and a general declination eastwards. Five years subsequently he prepared a tabular view of the *Order of the Strata, and their embedded Organic Remains, in the neighborhood of Bath, examined and proved prior to* 1799. From this period to 1812 he was completing and arranging the data for his large *Geological Map of England and Wales, with part of Scotland*, which appeared in 1815, in fifteen sheets, engraved on a scale of 5 miles to 1 inch. The map was reduced to smaller form in 1819; and from this date to 1822 separate county geological maps were published in successive years, the whole constituting a *Geological Atlas of England and Wales*. In January, 1831, the Geological Society of London conferred on Smith the first Wollaston medal; and the Government, at the request of several English geologists, conferred upon him a life-pension of £100 [$486] per annum. The degree of LL.D. he received from Dublin, at the meeting of the British Association in that city in 1835. At such meetings he was nearly always present. In 1838 he was appointed one of the commissioners to select building stone for the new Houses of Parliament. The last years of his life were spent at Hackness (of which he made a good geological map), near Scarborough, and in the latter town. His usually robust health failed in 1839, and on 28th August of that year he died at Northampton. He once said he was born on the Oolite, and should wish to be buried on it; and so he was, at Northampton.

His *Memoirs* by Professor John Phillips appeared in 1844.

SMITH, William Henry (1808–1872), best known as the author of *Thorndale*, is one of those thinkers and students whose work, whilst scarcely recognized in their own day and soon all but overlooked in the larger perspective of history, is yet of real value for an appreciation of the intellectual character of the time. The literary production of which *Thorndale* is the most representative example affords a moral countenance to contemporary workers in philosophy which is invaluable, but which for obvious reasons can never be exactly appraised. With a fine and reflective, rather than robust and active, intelligence, Smith deals suggestively in the form of conversation—which he adopts in *Thorndale* and in his later book *Gravenhurst*—with the problem of good and evil, with materialism and idealism, with most of the subtle modern perplexities in the interaction of religion, philosophy, and science. But his more exact contributions to thought, such as the *Discourse on the Ethics of the School of Paley* and the *Essays on Knowing and Feeling*, do not work out anything like a complete system, and are somewhat lacking in intellectual grip. Smith also wrote several books of verse and two plays, one of which, *Athelwold*, was produced by Macready in 1842. Much graceful reflection and a true feeling for nature are found in his verse, but it lacks energy. Smith spent a serene, uneventful life, chiefly in the studious seclusion which he loved, but which must have tended to foster the inactive tendencies that led him to call himself playfully in his latter days "the snail." He was born at Hammersmith in 1808 in comfortable surroundings, his father being a retired merchant; his mother was of German extraction, with a vein of mysticism, which is worth noticing in view of the son's metaphysical tendencies. He was sent in 1821 to Glasgow, where Byron's poetry and Scottish metaphysics seem to have had most influence upon him. Then he entered a lawyer's office, in which he remained for five years. His first writings appeared in the *Literary Gazette* and in the *Athenæum*, to which he contributed under the name of "Wool-gatherer," attracting some attention by the delicacy and finish of his style. His ambition was at the outset chiefly poetical, however, and when his first book appeared and was almost completely ignored, he dug a grave and buried the unsold copies in a fit of Byronic despondency. *Ernesto*, a philosophical romance, also belongs to this early period. In 1836 he wrote for the *Quarterly Review*, and in 1839 he formed a connection with *Blackwood's Magazine*, which lasted for thirty years, during the latter part of which he acted as its philosophical critic. In 1846 a visit to Italy led to the writing of a tale entitled *Mildred*, which was too purely reflective to be successful. In 1851 he declined the chair of moral philosophy at Edinburgh, having determined a year or two previously to retire to the English Lake district, there to study in seclusion. There he completed *Thorndale*, which was published in 1857. *Gravenhurst* appeared in 1862; a second edition contained a memoir of the author by his wife. He died at Brighton on 28th March, 1872.

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[1] [Smith in his life-time, and his publishers after him, having refused to retract or explain the injurious allegations of these *Letters*, it may be well to say here, that in 1842 (the country not having rallied from a commercial crisis), Pennsylvania passed the interest due on her bonds, but issued interest-bearing certificates therefor, which were paid in full, and repudiation is not the term for her course.—Am. Ed.]

SMITH, Sir William Sidney (1764–1840), English admiral, was the second son of Captain John Smith of the Guards, and was born at Westminster on 21st July, 1764. He entered the navy, according to his own account, "at the beginning of the American War," being only about eleven years of age. For his bravery under Rodney in the action near Cape St. Vincent in January, 1780, he was on 25th September appointed lieutenant of the "Alcide." After serving in the actions against the French fought by Graves off Chesapeake in 1781 and by Rodney at the Leeward Islands in 1782, he was on 6th May of the latter year promoted to be commander of the "Fury" sloop, and on 18th October advanced to the rank of captain. His ship having been paid off in the beginning of 1784, he spent two years in France and afterwards visited Spain. From 1790 to 1792 he was employed in advising the king of Sweden in the war with Russia, receiving for his services the honor of knighthood. After his return to England he was sent on a mission to Constantinople, and, having joined Lord Hood at Toulon from Smyrna in December, 1793, he burnt the enemy's ships and arsenal. In the following years he cleared the Channel of French privateers; but, having with the boats of his squadron boarded in Havre-de-Grâce harbor a lugger which was driven by the tide above the French forts, he was on 19th April, 1796, compelled to surrender and sent a prisoner to Paris. By means of forged orders for his removal to another prison he made his escape from the Temple, and, crossing the Channel in a small skiff picked up at Havre, arrived in London on 8th May, 1798. In October he was sent as plenipotentiary to Constantinople. Learning of Buonaparte's approach to St. Jean d'Acre, he hastened to its relief, and on 16th March, 1799, captured the enemy's flotilla, after which he successfully defended the town against several furious attacks of the French, compelling Napoleon on 20th May to raise the siege and retreat in disorder, leaving all his artillery behind. For this brilliant exploit he received the special thanks of the Houses of Parliament and was awarded an annuity of £1000 [$4860]. Subsequently he co-operated with Abercromby, under whom he served as brigadier general at the battle of Aboukir, where he was wounded. On his return to England he was in 1802 elected M.P. for the city of Rochester. In March, 1803, he was commissioned to watch the preparations of the French for an invasion of England. Having on 9th November, 1805, been promoted to be rear admiral of the blue, he was in the following January despatched on secret service for the protection of Sicily and Naples. He relieved Gaeta and captured Capri, but on 25th January, 1807, received orders to proceed to Malta, whence he joined Sir John Duckworth, who was sent to act against the Turks. On 7th February, with the rear division of the squadron, he destroyed the Turkish fleet and spiked the batteries off Abydos. In November following he was sent to blockade the Tagus and was mainly instrumental in embarking the Portuguese prince regent and royal family and sending them under safe protection to Rio de Janeiro, after which he was sent as commander-in-chief to the coast of South America. On 31st July, 1810, he was made vice-admiral of the blue and on 18th July, 1812, was despatched as second in command under Sir Edward Pellew to the Mediterranean, but the expedition was uneventful. His term of active service practically closed in 1814. He was made K.C.B. in 1815 and in 1821 admiral. The later years of his life were spent at Paris, where he died on 26th May, 1840.

See Barrow's *Life of Admiral Sir W. S. Smith*, 2 vols. 1848.

SMOKE ABATEMENT. The nuisance created by coal smoke seems to have been recognized in London as early as the reign of Queen Elizabeth; but it is only in more modern times that the question has come to be regarded as one of real practical importance, and even yet it is far from receiving that general attention which it demands. In 1785 the first smoke-abating invention was patented by James Watt, who, as the inventor of the steam-engine, is responsible for so many boiler fires and so much consumption of coal. In 1815 Cutler patented the first would-be smokeless grate for domestic purposes; and his principle of feeding underneath was afterwards adopted by Dr. Neil Arnott in a grate which has now been in use in one form or another for more than half a century. There is now a vast number of such inventions, good and bad. In 1819 the attention of parliament was directed to the question, and a select committee was appointed "to inquire how far persons using steam-engines and furnaces could erect them in a manner less prejudicial to public health and comfort." This committee gave an encouraging report. In 1843 another select committee recommended the introduction of a bill prohibiting the production of smoke from furnaces and steam-engines. In 1845 yet another select committee reported that such an Act could not in the existing state of affairs be made to

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apply to dwelling-houses. The Acts of 1845 and 1847 followed as the results of these inquiries; and since then there has been much legislation brought to bear on factories and railways. The results have been most beneficial; but very much still remains to be done. One is apt to think that, because steam-engines and factories consume individually much more coal than dwelling-houses, they alone are responsible for the smoke nuisance, forgetting how greatly the dwelling-houses outnumber the factories. In reality there is little doubt that domestic fires are mainly responsible for the smoky condition of the atmosphere of our towns; and they for the most part continue to evolve smoke undeterred by legislation or scientific invention. In 1881, however, a movement was commenced by the National Health Society and the Kyle Society which resulted in a great smoke-abatement exhibition being held at South Kensington. At the close of the exhibition a national smoke-abatement institution, with offices in London, was incorporated by authority of the Board of Trade.

Combustion of coal.

A knowledge of the nature of coal and of the chemical changes that it undergoes when burnt is essential for an understanding of the smoke problem. More detailed information on these points is given under COAL, where the several varieties are described. For the purposes of this article coals may be classified as smoke-producing and smokeless, the former including all those varieties most commonly used as fuel. The elementary constituents of such coals are carbon (generally about 80 per cent. of the whole), hydrogen, nitrogen, oxygen and sulphur; and they also contain a varying quantity of earthy impurity or ash. The process which occurs in a coal fire consists of two distinct operations. The first, which requires a comparatively low temperature, and is independent of the presence of air, is one of destructive distillation, and is similar to that which occurs in the retorts of gas works. It results in the decomposition of the coal, and in the rearrangement of its constituent elements and the formation of the following substances: (1) hydrogen, marsh gas, carbonic oxide, olefiant gas, benzine, other hydrocarbons of the type of marsh gas or of benzine, water—all of which are either gaseous at the temperature at which they are formed, or capable of being converted into gas at somewhat higher temperatures, and all of which are combustible except the water; (2) ammonia and other compounds of nitrogen, and certain compounds of sulphur, which are also volatile and combustible; (3) coke, which consists of carbon (and ash) and is non-volatile but combustible. It is these products of distillation, not the coal itself, that burn, in the strict sense of the word; and this second process requires the presence of air and also a much higher temperature than the first. If the combustion is perfect the only products are (1) water-vapor, (2) carbonic acid, (3) nitrogen, and (4) sulphurous acid, the first of which contains all the hydrogen originally present in the coal, the second all the carbon, the fourth all the sulphur, while the nitrogen is liberated as such together with the very much larger volumes of nitrogen derived from the air which has supplied the necessary oxygen. All these products of combustion are discharged through the chimney.

Two things are necessary for the ensuring of such complete combustion, viz., an adequate, but not too large, supply of air, properly administered, and the maintenance of the requisite temperature. In practice, however, these conditions are never perfectly fulfilled, and consequently the combustion of coal is always more or less imperfect and gives rise to a complex mixture of vapors. This mixture contains not only the combustion products already mentioned, but also the following unburnt or partly burnt distillation products: (5) hydrogen, (6) hydrocarbons, (7) carbonic oxide, which contains a lower proportion of oxygen than carbonic acid, (8) unburnt carbon in a very finely divided state, and also considerable volumes of unused air.

Smoke.

Usually the name "smoke" is applied to this vaporous mixture discharged from a chimney only when it contains a sufficient amount of finely divided carbon to render it dark-colored and distinctly visible. The quantity, however, of this particular ingredient is apt to be overrated. It always bears an extremely small proportion to the vast volumes of water-vapor, carbonic acid and nitrogen with which it is mixed. It probably never amounts, even in the worst cases, to 3 per cent. of the weight of the coal from which it is formed; and its importance, reckoned in terms of so much fuel wasted, is certainly not greater than that of the unburnt hydrogen and hydrocarbons. It is perhaps best to use the name "smoke" for all the products of imperfect combustion (5 to 8) which are avoidable, as contrasted with the necessary and unavoidable ingredients (1 to 4) of the mixture. The problem of smoke abatement is thus seen to resolve itself into the problem of the production of perfect combustion.

Advantages of efficient smoke abatement.

The first advantage to be gained by the solution of this problem is an important saving in fuel. It has been calculated that at least twice as much coal is used in boiler fires and six times as much in domestic fires as is theoretically required for the production of the effects obtained. A considerable portion of this loss is due to causes other than those that can be treated of here, and some is certainly unavoidable; but there is no doubt that much of this enormous waste could be prevented by improved methods of combustion, such as would solve the smoke problem. The second advantage to be looked for is a great gain in cleanliness and public convenience. Not only would there be an end to sooty chimneys, but the atmosphere of towns would no longer be polluted as it is now by the discharge of unburnt carbon, whose total quantity is enormous, though the amount contained in any given puff of smoke is very small. The "London fog" would be a thing of the past—not because fogs would become any less frequent than now in London and other large cities, but because they would lose their distinctive character of grimy opacity. It is often stated that these fogs are *caused* by the smoke that blackens them; but this is an error. The combustion of coal is certainly responsible for their existence, but it is the sulphur of the coal (oxidized ultimately to sulphuric acid) and not the carbon, that is the active agent. And so long as coal is burnt at all this manufacture of sulphuric acid and of fogs must continue; it is not to be got rid of by improved methods of combustion, though the character of the fogs may be materially altered for the better. The evil effects of town air on plant life and human lungs, also often attributed to preventible smoke, are in like manner due to this non-preventible sulphuric acid. The great gain in cleanliness, however, that would follow the abolition of smoke, cannot be overrated.

Methods of smoke abatement.

The methods that have been suggested for the abolition of smoke may be divided into two great classes, viz., those that seek to attain this end by improving the appliances for the burning of bituminous coal, and those that propose to abolish its use and substitute for it some other kind of fuel. The proposals of the first class may be divided into those applicable to domestic purposes and those applicable to boiler fires and other large-scale operations. Those of the second class may be divided according to the nature of the fuel which they suggest. The innumerable inventions of the first class depend for their success (so far as they are successful) on the attention bestowed on the scientific requisites for complete combustion, viz., a sufficient but not too great supply of air, the thorough admixture of this air with the products of the destructive distillation of the coal, and the maintenance of a high-temperature within the fire. In our old and crude methods the facts which most militate against the attainment of these desiderata are: (1) that large masses of fresh fuel are continually being thrown on at the top, which cool down the fire just at that point where highest temperature is required; (2) that the products of the distillation of this fresh fuel, heated from below, do not get properly mixed with air till they have been drawn up the chimney; (3) that unduly large volumes of cold air are continually being sucked up through the fire, cooling it and carrying its heat away from where it is wanted, and yet without remedying the second evil. In the improved methods regularity of supply of both fuel and air is sought so as to maintain a steady evolution of distillation products, a steady temperature, and a steady and complete combustion. In many cases it is sought to warm fresh air before it enters the room by a regenerative system, the heat being taken from the escaping gases which would otherwise carry it up the chimney; and in some cases the air which feeds the fire is heated in the same way.

Domestic stoves and grates—tests.

We cannot here discuss the merits of individual inventions; but we may summarize the chief results of the tests applied at the South Kensington Exhibition. These tests, for domestic grates and stoves, included a chemical examination of the chimney gases, observations of the "smoke-shade" as indicating the proportion of unburnt carbon, and a record of the amount of coal burnt, of the rise of temperature produced, of the radiation, and of the amount of heat lost by being carried away through the chimney. Domestic grates and stoves were divided into six classes as follows: (1) open grates having ordinary bottom grids and upward draught; (2) open grates having solid floors (adapted for "slow combustion") and upward draught; (3) open grates fed from below,—supplied with fresh fuel beneath the incandescent fuel; (4) open grates fed from the back or from the sides or from hoppers; (5) open grates having downward or backward or lateral draught; (6) close stoves. Each of these classes was subdivided according as the apparatus was "air-heating" or "non-air-heating," *i.e.*, according as an attempt was or was not made to save heat on the regenerative principle. This attempt does not appear to have been distinctly successful in any class except the fifth; indeed the evidence of the tests as a whole is rather against the air-heating principle. The preceding table gives the average results of tests for each class and sub-class as regards general rise of temperature and radiation per pound of coal and smoke-shade. The figures under the last head refer to a standard of shades ranging from 0 (smoke imperceptible) to 10 (black and dense). It was found in practice that the results of this smoke-shade test were in general accord with those of the chemical examination of the chimney gases. The letters "a" and "n" in the first column signify air-heating and non-air-heating respectively, the average results for the whole class being given before those for each sub-class. All the experiments were made with Wallsend coal, a fair representative of the bituminous coals.

Class.	No. of appliances tested.	Average rise of temp. per lb. of coal per hour, in degrees Fahr.	Average radiation per lb. of coal per hour, in degrees Fahr.	Average smoke-shade.
1	19	2.88	3.58	3.01
" a	9	3.37	2.88	3.22
" n	10	2.45	4.21	2.78
2	12	2.99	4.07	3.23
" a	2	2.81	3.93	4.11
" n	10	3.02	4.09	3.09
3 n	5	3.81	3.61	2.82
" a	none	...	...	...
4	6	3.05	3.14	2.66
" a	2	2.41	2.42	2.23
" n	4	3.37	3.50	2.88
5	18	3.38	3.70	2.73
" a	11	3.45	4.00	2.29
" n	7	3.28	3.22	3.21
6	10	4.14	1.66	2.11
" a	2	3.79	1.78	1.58
" n	8	4.23	1.64	2.25
1-5 (total average).	60	3.22	3.62	2.89

From this table the following facts, among others, may be deduced: (*a*) the air-heating principle has not been applied with success except in class 5; (*b*) close stoves (class 6) are superior to open grates (total average of classes 1–5) in respect of freedom from smoke and of general heating effect, but they are greatly inferior in radiating power,—a deficiency which partly explains their unpopularity in the United Kingdom; (*c*) the "slow-combustion" principle gives a high radiation factor, but is otherwise not successful; (*d*) the class of air-heating grates with downward, backward, or lateral draughts is, on the whole, most efficient.

Boiler fires.

Much attention has been devoted for many years to the question of how to work boiler fires, both for locomotives and for fixed appliances, with the least possible production of smoke and the greatest possible evaporative power. Here the desiderata are essentially the same as in the case of domestic fires, viz., adequate admixture of the combustible vapors given off by the coal with the necessary air and the maintenance of a high temperature; and the principles involved are consequently also the same, though the appliances are necessarily different. These improvements may be all classed under one or other of two heads, according as the mode of supplying the fuel or the mode of supplying the air is the subject of the improvement. These two kinds of improvement may of course be combined. The article FURNACE may be consulted; see also STEAM-ENGINE, sect. "Boilers."

Mechanical stokers.

In the old forms of furnace fresh fuel, as it is wanted, is supplied by hand labor, the furnace doors being opened and large quantities of coal thrown in. One result of this is the inrush of great volumes of cold air, which, aided by the equally cold fuel, lowers the general temperature of the furnace. Mechanical stokers meet this difficulty by supplying the coal regularly in small quantities at a time. They may be divided into those which deliver the coal at the front and gradually push it backward, those which scatter it generally over the surface of the grate, and those which raise it from below so that the products of its distillation pass through the already incandescent fuel. The mechanism by which these results are attained is often of a complex nature.

Air-supply.

It is generally recognized that air cannot be efficiently supplied to the furnace if admitted only in front, and accordingly there have been many plans devised for supplying it also at the back. In some cases currents of air are induced by steam-jets; but this plan has not proved very successful. The best inventions are on the regenerative principle. In them the air, before entering the furnace, is made to circulate through chambers heated externally by the products of combustion, and, having thus acquired a high temperature and absorbed heat that would otherwise have been lost, is admitted through openings at the bridge. Many of these appliances are almost absolutely smokeless, and they are much in use.

Substitutes for bituminous coal.

The advocates of the total or partial disuse of smoke-producing coals are variously in favor of the following substitutes—anthracite, coke, liquid fuel and gas.

Anthracite.

For some purposes anthracite and other coals containing a high percentage of carbon may be, and have long been, advantageously used as fuel. They yield a much smaller percentage of distillation products than ordinary coals, and produce no smoke, or almost none. But they are difficult to ignite, and in small fires difficult to keep burning; they give very little flame, and are comparatively expensive, so that they are under considerable disadvantage as compared with the usual kinds of coal. Many of the grates and stoves exhibited at South Kensington were specially devised for burning anthracite, and some of them are decidedly successful; but it is not likely that anthracite will ever take the place of bituminous coal to any great extent in the British Isles. There the great coal-fields undoubtedly are the natural sources of fuel, and no proposal involving a complete neglect of this fact can ever be successfully carried out.

Coke.

This remark, however, does not apply to the use of coke and of gas, which are themselves made from coal. Coke is produced in large quantities both for its own sake and as a bye-product in the manufacture of gas for lighting purposes, and is largely used in various kinds of furnace. It gives no smoke; but it resembles anthracite also in being but ill adapted to use in open grates on account of the difficulty of ignition and the absence of flame (see FUEL).

Liquid fuel.

In America, where natural petroleum is obtained in such enormous quantities, the experiment has been made of using it as the source of heat for boilers. A jet of superheated steam (at about 600° Fahr.) is blown into the hot combustion chamber and the oil and air enter mixed with it. The results are said to be excellent,—the fire smokeless and the efficiency high. The residue from coal-tar, after the naphtha and light oils have been recovered from it, can also be advantageously used in this way. The chief disadvantage attending the use of liquid fuels such as petroleum seems to lie in the fact that they are somewhat dangerous, fatal accidents having occurred in America; and the range of their application is necessarily limited. To use them for the heating of houses is of course quite out of the question.

Gaseous fuel.

Of all the schemes and inventions for the abatement of smoke that one which proposes to distil coal in one operation, and to burn the products of the distillation in another and quite separate operation, is without doubt the most thoroughly scientific; and to it, rather than to patent grates and furnaces, we must look for the ultimate solution of the question. Many arguments may be adduced in favor of gas-heating as opposed to coal-heating, the most important of which are here briefly given. (1) Coal gives, on distillation, not only gas and coke, which are both good heating agents, but intermediate products, many of which are of commercial value; these include ammonia, benzine, carbolic acid, anthracine, etc. As science advances the value of coal-tar will probably be enhanced by further discoveries; already it gives the raw material for the preparation of numberless beautiful dyes, of antiseptics, and of some drugs, and quite lately a substance described as an admirable substitute for sugar has been prepared from it. All these intermediate products are now, according to our barbarous methods of burning coal, used simply as fuel. (2) Gas can be laid on in pipes to any spot, can be lit or turned out at any moment, and can be so managed that less heat is frittered away and more applied to the specific object than in the case of coal-burning. (3) It produces no smoke and leaves no ash or cinder, so that cleanliness is attained and much labor and expense are saved. (4) The coke produced during the preparation of the gas has uses of its own as solid fuel and for other purposes. (5) As has been already said, sulphur is an ingredient of all coals, and sulphuric acid is one of the necessary results of burning them, not to be got rid of by "smoke abatement." Coal gas, however, can to a great extent be freed from sulphur compounds, and it is possible that the purification methods in vogue may hereafter be improved, so that we have here a means, if any exist, of curing the chief evils of our present system,—injury to our respiratory organs, production of fogs, and destruction of vegetation in towns. The principal disadvantage of the proposal is to be found in the high cost of coal gas, which now varies generally from 3s. to 4s. [73 to 97 cts.] per 1000 cubic feet, whereas it has been calculated that it would have to cost not more than 1s. [24 cts.] or at most 1s. 6d. [36 cts.] to compete successfully with coal. There is no doubt, however, that the cost might, and it probably will, be brought down to this, as the high rate is due to causes not inherent in the nature of things. Sir William Siemens proposed that two sets of mains should be laid in English towns, one for heating and one for lighting gas, and showed that the first and last portions of every preparation of gas are possessed of very low illuminating power, but if collected apart would do excellently for heating purposes, while the rest would be improved for lighting. It is probable, however, that electricity will ultimately drive gas out of the field as an illuminating agent and that it will then be relegated to its true place as a heating agent. When that is done coal will no longer be burnt as a whole, but only those of its products (gas and coke) which are good for heating and for nothing else.

Meanwhile, ordinary coal gas has already, expensive as it now is, been largely applied to certain purposes, notably to cooking stoves and other domestic requirements, to gas-engines (in which the generation of steam is unnecessary), and to bakers' ovens; and these inventions are calculated materially to diminish the smoke nuisance. In order to obtain an economical gas capable of being generated on the spot and used for operations on a large scale, Sir W. Siemens devised a gas-producer in which coal is partially burnt in a limited atmosphere and is wholly converted into gaseous products (chiefly carbonic oxide), only the ash being left. This "producer-gas" is a weak fuel, being largely diluted with atmospheric nitrogen, and is, therefore, inapplicable to domestic purposes; but for many others it suits admirably, one of the best examples of its application being Siemens's own regenerative gas furnace for melting steel (see SIEMENS). Other gas-producers have been patented, and the cost of the gas so made is as low as 4d. [8 cts.] per 1000 cubic feet, or even less. It is probably, however, but a temporary substitute for true coal gas. In the use of this latter we shall, without doubt, find the true scientific solution of the smoke-abatement problem. As an example of what gaseous fuel can do, it may be mentioned that in Pittsburgh in Pennsylvania the furnaces are now being fed by natural oil gas and that that city, once one of the dirtiest of manufacturing towns, is becoming one of the cleanest.

Literature.—The specifications of patents may be consulted. See also C. W. Williams, *The Combustion of Coal and the Prevention of Smoke* (London, 1858); W. W. Barr, *Practical Treatise on the Combustion of Coal* (Indianapolis, 1879); *Official Report of the Smoke-Abatement Committee* (London, 1882); *Smoke-Abatement Exhibition Review* (London, 1882); and papers and discussions in the *Journal of the Society of Chemical Industry*, 1881 and following years.

(O. M.)

SMOLENSK, a government of middle Russia, belonging partly to Great Russia and partly to White Russia, is bounded by Moscow and Kaluga on the E., Orel and Tchernigoff on the S., Moghileff and Vitebsk on the W., and Pskoff and Tver on the N. It covers an area of 21,638 square miles in the west of the great central plateau, its northern districts extending towards the hilly region of the Valdais, where the flat-topped gentle declivities reach about 1000 feet above the sea. The rivers being deeply cut in the plateau, the surface is also hilly in the western districts (Smolensk, Dorogobuzh), whence it slopes away gently towards immense plains on the east and south. Carboniferous limestones, containing a few layers of coal (in Yuchnoff) and quarried for building purposes, occupy the east of Smolensk; white Chalk appears in the southern extremity; while Tertiary sands, marls, and ferruginous clays cover all the west. The whole is overlain with a thick sheet of boulder clay, with irregular extensions to the north; Post-Tertiary sands are spread over wide surfaces; and peat-bog fills the marshy depressions. The soil, mostly clay, is generally unfertile, and stony and sandy in several districts. Many large rivers belonging to the basins of the Volga, the Oka, the Dnieper, and the Dwina have their origin in Smolensk. The Vazuza and the Gzhat, both flowing into the Volga, and the Moskva and the Ugra, tributaries of the Oka, are channels for floating timber. The two tributaries of the Dwina—the Kasplya and the Mezha—are of much more importance, as they and their affluents carry considerable numbers of boats to Riga. The Dnieper takes its origin in Smolensk and waters it for more than 300 miles; but neither this river nor its tributaries (Vop, Vyazma, Sozh, and Desna), whose upper courses belong to Smolensk, are navigable; timber only is floated down some of them. Many small lakes and extensive marshes occur in the northwest. One-third of the area is under forests. The population of Smolensk reached 1,191,172 in 1882, of whom only 106,133 lived in towns, and consists of White Russians in the west (46.7 per cent.), Great Russians in the east (42.6), and of a mixed population of both (10.4). Nearly 1000 Jews and 1000 Poles are scattered through the towns.

The climate is like that of middle Russia generally, although the moderating influence of the wet climate of western Europe is felt to some extent. The average yearly temperature at Smolensk is 45.5° Fahr. (January, 13.5°; July, 67.2°). Notwithstanding the unproductive soil and the frequent failures of crops (especially in the northwest), the chief occupation is agriculture. In 1884 3,040,000 acres were under crops, and 2,379,600 quarters of grain of various kinds were raised (2,930,400 in 1883),—the potato crop yielding 5,498,400 bushels. Nearly all the land is cultivated by the peasant communes,—only 766,500 acres (out of 6,868,900) in the hands of single individuals being under cultivation. Oats are an important crop. Hemp and flax are largely raised and exported. Cattle-breeding stands at a low level; the cattle of the peasantry suffer from a want of meadow and pasture land, which is mostly in private ownership. In 1882 there were 329,850 horses, 349,000 horned cattle, 401,000 sheep, and 162,000 pigs. The peasantry are mostly very poor, in consequence not only of the desolation inflicted on Smolensk in 1812, the effects of which are still felt, but also of insufficient allotments and want of meadows. Gardening and bee-keeping, which formerly flourished, have almost disappeared. The timber trade and boat-building are important sources of income, but do not furnish employment for all who are in need of it; more than one-half of the male population of west Smolensk leave their homes every year in search of work, principally as navvies throughout Russia. The manufactures are developing but slowly, and in 1882 employed only about 5100 workmen,—their annual production being valued at £328,800 [$1,597,968]; of this amount the distilleries yielded nearly one-third. A few cotton-mills in the east have a production valued at £62,160 [$302,097.60] per annum. A lively traffic is carried on on the rivers, principally the Kasplya, the Obzha, and the Ugra, where corn, hemp, hempseed, linseed, and especially timber are shipped to the amount of nearly £400,000 [$1,944,000] annually. A considerable quantity of corn is imported into the western districts. Smolensk is crossed by two important railways, from Moscow to Warsaw and from Riga to Saratoff; a branch-line connects Vyazma with Kaluga. The educational institutions embrace eleven gymnasia and progymnasia (830 boys and 1402 girls), and 394 primary schools (15,031 boys and 2142 girls). Smolensk is divided into twelve districts, the chief towns of which, with their populations in 1882, are—Smolensk (see below), Byelyi (7150), Dorogobuzh (8400), Duhovshina (3660), Elnya (4850), Gzhatsk (7050), Krasnyi (3550), Poryetchie (4650), Roslavl (9050), Sytchevka (5720), Vyazma (13,000), and Yuchnoff (3230).

SMOLENSK, capital of the above government, is situated on both banks of the Dnieper, at the junction of the railways from Moscow to Warsaw and from Riga to Orel, 262 miles by rail west-southwest of Moscow. The town, with the ruins of its old kremlin, is built on the high crags of the left bank of the Dnieper, its suburbs extending around and on the opposite bank of the river. Its walls are now rapidly falling into decay, as well as all other remainders of its past. The cathedral was erected in 1676–1772, on the site of a more primitive building (erected in 1101), which was blown up in 1611 by the defenders of the city. The picture of the Virgin brought to Russia in 1046, and attributed to St. Luke, which is kept in this cathedral, is much venerated throughout central Russia. Two other churches, built in the 12th century, have been spoiled by recent additions. Smolensk is neither a commercial nor a manufacturing centre; its population was 35,830 in 1882.

Smolensk, one of the oldest towns of Russia, is mentioned in Nestor as the chief town of the Crivitchis, situated on the great commercial route "from the Varyaghs to the Greeks." It maintained a lively traffic with Constantinople down to the 11th century, when the principality of Smolensk included Vitebsk, Moscow, Kaluga, and parts of the present government of Pskoff. The princes of Kieff were often recognized as military chiefs by the *vyetche* (council) of Smolensk, who mostly preferred Mstislaff and his descendants, and Rostislaff Mstislavovitch became the head of a series of nearly independent princes of Smolensk. From the 14th century these last fell more and more under the influence of the Lithuanian princes, and in 1404 Smolensk was annexed to Lithuania. In 1449 the Moscow princes renounced their claims upon Smolensk; nevertheless this important city, which was both a stronghold and a commercial centre with nearly 100,000 inhabitants, was a constant source of contention between Moscow and Lithuania. In 1514 it fell under Russian dominion; but during the disturbances of 1611 it was taken by Sigismund III. of Poland, and it remained under Polish rule until 1654, when the Russians retook it; in 1686 it was definitively annexed to Russia. In the 18th century it played an important part as a basis for the military operations of Peter I. during his wars with Sweden. In 1812 it was well fortified; but the French took it, when it suffered much from conflagrations, and generally, during the war.

SMOLLETT, TOBIAS GEORGE (1721–1771), novelist, was born at Dalquhurn, in the valley of Leven, Dumbartonshire, in 1721. His buoyant humor and energy were the gifts of nature, and early experience furnished him with abundant provocation for the harsh and cynical views of human nature to be traced in his novels. At a very early age he was placed in a position calculated to harden the heart of a proud and sensitive child. His father, the youngest son of the laird of Bonhill, a Scottish legal dignitary, married against the ambition of his family, and died young, leaving three children, of whom the future novelist was the second son, entirely unprovided for. The boy, being thus left dependent on the charity of relatives, grudgingly and insolently bestowed, as it seemed to him, learned to look with suspicion on kindly professions. He seems to have received the ordinary book education of the place and period. He was sent to the neighboring grammar-school of Dumbarton—taught at the time by one of the most eminent schoolmasters in Scotland—and thereafter to the university of Glasgow. He wished then to enter the army, as his elder brother had done, but much against his will was apprenticed to a surgeon. His grandfather died when he was in his eighteenth year, without leaving any provision for the children of his youngest son, and in his nineteenth year Smollett left Glasgow and launched himself on London in quest of fortune with the tragedy of the *Regicide* in his pocket. He failed to get the tragedy accepted, and, reduced almost to starvation, was fain to take the situation of surgeon's mate on board a ship of the line. He was present in 1741 at the siege of Cartagena. He soon quitted the navy in disgust, but during his service of a few years he acquired, as Scott says, "such intimate knowledge of our nautical world as enabled him to describe sailors with such truth and spirit of delineation that, from that time, whoever has undertaken the same task has seemed to copy more from Smollett than from nature."

Returning to England in 1746, Smollett made a desperate attempt to live by his pen, publishing the satires *Advice* and *Reproof*—satire being then in fashion—and pushing the *Regicide* and other dramatic works on theatrical managers and patrons. He revenged himself in his satires for the rebuffs given to his plays. Whether he was ever reduced to such straits as Mr. Melopoyn, whom Roderick Random met with in the Fleet, is not known for certain, but it is certain that he was sharply pinched; and he did not mend his circumstances by marrying a portionless lady whom he had met in the West Indies. His buoyant spirit was not in the least broken by adverse fortune, but it was considerably inflamed and embittered. His fierce and distempered mood when he wrote *Roderick Random* is reflected in the characters of the novel, which are drawn with a much more defiant and contemptuous hand than he used in any of his subsequent works. The author was not a cold-blooded cynic, but a proud warm-hearted man enraged by what he considered unjust usage. He was not in a mood to dwell upon lovable traits in human nature, or to find pleasure in pretty sentiments. The public, however, when *Roderick Random* was published—in 1748, a few months before *Tom Jones*—did not concern themselves with the character of the author. The wealth of humorous incident, the rapidly moving crowd of amusing figures, concealed all those harsher features in the picture of life which quiet reflection can now trace to the circumstances of the author, smarting as he was under petty insults and real or fancied indignities. This novel at once raised Smollett into reputation. It was followed after an interval of three years by *Peregrine Pickle* (1751), the immediate popularity of which was helped by the insertion into the body of the novel of two stories from real life, the memoirs of a lady of quality (Lady Vane) and the memoirs of the philanthropist M'Kercher. This second masterpiece was written with a much lighter heart than the first, although it must be confessed that the hero is not much of an improvement on Roderick Random. Scott describes him as "the savage and ferocious Pickle, who, besides his gross and base brutality towards Emilia, besides his ingratitude to his uncle, and the savage propensity which he shows in the pleasure he takes to torment others by practical jokes, resembling those of a fiend in glee, exhibits a low and ungentlemanlike tone of thinking, only one degree higher than that of Roderick Random." There is, however, this difference, that the author seems much more conscious of the bad qualities of Pickle than of Random. He expends no sympathy or fine sentiment on either, but Random's defects are represented as the results of the harsh treatment he had himself received, while Pickle's appear rather as the outcome of a naturally harsh and insolent character. Both are far from being model gentlemen, but Pickle is several degrees lower rather than one degree higher than Random. In the second novel there is a still richer crowd of characters, quaint, amusing, disgusting, and contemptible; but there is more of a tendency to secure variety by extravagant caricature. For some of the indecencies in the first edition Smollett apologized, and withdrew them in a second edition, but he still left enough to satisfy the greediest taste in that particular. He also withdrew a very offensive allusion to Fielding, and in his next novel, *The Adventures of Ferdinand, Count Fathom*, paid that great rival the compliment of imitation. Though Smollett was far from being a servile imitator, there can be no doubt that he profited greatly by Fielding's example in all the higher essentials of his craft. This, his third effort, although it has not the same exuberant humor and fresh variety of character, is vastly better in point of constructive skill and sustained power of description. It looks as if he had deliberately set himself to show that he too as well as the author of *Tom Jones* could make a plot. The vileness of Fathom's character is so repulsive that the novel is much less often read than others of Smollett's; but it is his greatest feat of invention, being not a mere string of lively adventures, but a connected series in the progressive movement of the villain's career. It contains some of Smollett's most cynical comments on human motives, as well as passages that illustrate strikingly his real goodness of heart. He was not at home, however, in the direct expression of tender sentiment; when any of his persons gush, they do so with such wordiness and extravagance as to give them an air of insincerity.

With the composition of *Count Fathom* in 1753 Smollett's invention seemed to be exhausted for the time. For the next ten years he occupied himself with miscellaneous literary work, translating *Don Quixote* (published 1755), compiling a *Compendium of Voyages and Travels* (1757), and producing a *History of England from the Landing of Cæsar to the Treaty of Aix-la-Chapelle* (1757), followed by a continuation down to the date of publication (1761–65). Smollett, in short, from the time of his first success made his living as a professional man of letters. He obtained a medical degree from a German university about 1752, and set up as a physician, but seems never to have acquired much practice. He turned this experience to account, however, by caricaturing in *Count Fathom* the arts of rising in the profession. He had very little more success in his attempts to write for the stage. The *Regicide* was never acted, and, when it was published in 1749 to expose the folly of managers in not accepting it, the verdict of the public was rather with the managers than with the author. Smollett's single success on the stage was a farce with a political object, *The Reprisals, or the Tars of Old England*, produced in 1757 to excite feeling against the French. As a journalist also Smollett was not particularly successful, partly perhaps because he attached himself to the losing side,—the Tory and High Church party. He edited their organ *The Critical Review* for some years, and in 1759 suffered imprisonment for an attack on Admiral Knowles. At the beginning of the reign of George III. he supported Lord Bute's ministry in *The Briton*, but *The Briton* was driven out of the field by Wilkes's *North Briton*. Altogether Smollett's revenue from play-writing and journalism seems to have been small, unless his party services were requited independently of the sale of his papers. But his name stood high with booksellers. He introduces himself in *Humphrey Clinker* as a dispenser of literary patronage, surrounded by a number of humble dependants. These were probably the hacks to whom he gave employment in his journals and in such booksellers' jobs as his translation of Voltaire and the compilation entitled *The Present State of all Nations, containing a Geographical, Natural, Commercial, and Political History of all the Countries of the Known World* (1763).

In the course of this hard miscellaneous task-work, under which Smollett's health gave way completely, he wrote by instalments for the *British Magazine* (in 1760 and 1761) the curious satirical romance of *Sir Lancelot Greaves*. It is only in externals that this work bears any resemblance to *Don Quixote*. The author seems to have hesitated between making Sir Lancelot a mere madman and making him a pattern of perfectly sane generosity. The fun and the seriousness do not harmonize. The young knight's craze for riding about the country to redress wrongs armed *cap-a-pie* is too harshly out of tune with the rightness of his sympathies and the grave character of the real abuses against which his indignation is directed. In execution the work is very unequal and irregular, but the opening chapters are very powerful, and have been imitated by hundreds of novelists since Smollett's time.

Upon the failure of his health in 1763 Smollett went abroad and lived in France and Italy for three years. He published two volumes of *Travels* soon after his return in 1766. Three years more he spent in England, trying in vain to get some consular post abroad, where the climate might suit his shattered constitution. His extremely clever and extremely coarse political satire, *The Adventures of an Atom*, published in 1769, was probably inspired partly by resentment at the neglect of his own claims by successive ministries. He left England soon after its publication, and spent the last two years of his life in a house at Monte Novo in the neighborhood of Leghorn. Here, laboring under a painful and wasting disease, he composed his last work, *The Expedition of Humphrey Clinker*, published in 1771. This is generally regarded as his best novel. It certainly is the most pleasant reading, much softer and more humane in tone, while equally alive with vivid sketches and studies of character and a never-failing supply of ludicrous adventures. The loose and easy plan does not require for its execution the sustained power shown in *Count Fathom;* but, on the other hand, it leaves the novelist free to introduce greater variety of character and incident. None of his novels gives a better impression of Smollett's versatility than *Humphrey Clinker*, and there is none of them to which his successors have been more indebted. But whoever would understand how much the English novel owes to Smollett must read all his five fictions and not merely the most celebrated three. His influence upon novel-writing was wider even than Fielding's. He died at Monte Novo on 21st October, 1771.

(W. M.)

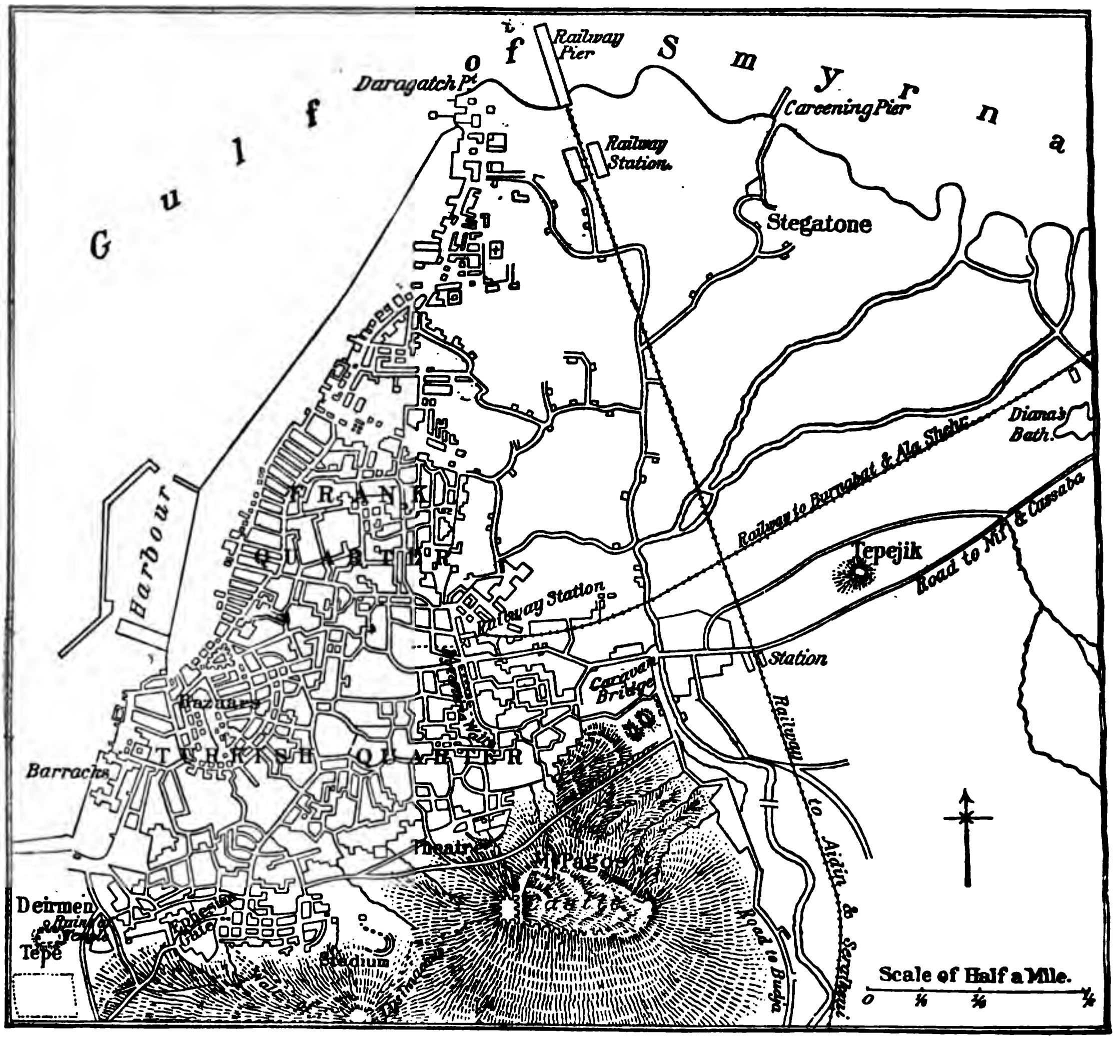
SMUGGLING denotes a breach of the revenue laws either by the importation or the exportation of prohibited goods or by the evasion of customs duties on goods liable to duty. Smuggling is, as might be expected, most prevalent where duties are high. The best preventive is the imposition of duties so low in amount and on so few articles that it becomes scarcely worth while to smuggle. Legislation on the subject in England has been very active from the 14th century downwards. In the reign of Edward III. the illicit introduction of base coin from abroad led to the provision of the Statute of Treasons (25 Edw. III. st. 5) making it treason to import counterfeit money as the money called "Lushburgh." Such importation is still an offence, though no longer treason. After the Statute of Treasons a vast number of Acts dealing with smuggling were passed, most of which will be found recited in the repealing Act of 6 Geo. IV. c. 105. In the 18th and the early years of the 19th century smuggling (chiefly of wine, spirits, tobacco, and bullion) was so generally practiced in Great Britain as to become a kind of national failing, and the smuggler was often regarded as a popular hero, like the *contrabandista* of modern Spain. The prevalence of the offence a century and a half ago may be judged from the report of Sir J. Cope's committee in 1732 upon the frauds on the revenue. The smuggler of the 18th century finds an apologist in Adam Smith, who writes of him as "a person who, though no doubt highly blamable for violating the laws of his country, is frequently incapable of violating those of natural justice, and would have been in every respect an excellent citizen had not the laws of his country made that a crime which nature never meant to be so." The gradual reduction of duties has brought the offence in the United Kingdom into comparative insignificance, and it is now almost confined to tobacco. Most of the existing legislation on the subject of smuggling is contained in the Customs Consolidation Act, 1876 (39 and 40 Vict. c. 36, ss. 169–217).

The main provisions are as follows: Vessels engaged in smuggling are liable to forfeiture and their owners and masters to a penalty not exceeding £500 [$2430]. Smuggled and prohibited goods are liable to forfeiture. Officers of customs have a right of search of vessels and persons. Fraudulent evasion or attempted evasion of customs duties renders the offender subject to forfeit either treble the value of the goods or £100 [$486] at the election of the commissioners of customs. Heavy penalties are incurred by resistance to officers of customs, rescue of person or goods, assembling to run goods, signalling smuggling vessels, shooting at vessels, boats, or officers of the naval or revenue service, cutting adrift customs vessels, offering goods for sale under pretence of being smuggled, etc. Penalties may be recovered either by action or information in the superior courts or by summary proceedings. In criminal proceedings the defendant is competent and compellable to give evidence. The Act applies to the United Kingdom, the Isle of Man, and the Channel Islands. Besides, the Customs Act, 50 Geo. III. c. 41, s. 16 (the corresponding Act for Scotland is 55 Geo. III. c. 71, s. 9), enacts that a hawker's license is to be forfeited on his conviction for knowingly selling smuggled goods. The Merchant Shipping Act, 1854 (17 and 18 Vict. c. 104, s. 243), makes any seaman or apprentice, after conviction for smuggling whereby loss or damage is caused to the master or owner of a ship, liable to pay to such master or owner such a sum as is sufficient to reimburse the master or owner for such loss or damage, and the whole or a proportional part of his wages may be retained in satisfaction of this liability. Additional provisions as to smuggling are also contained in 42 and 43 Vict. c. 21 and 44 and 45 Vict. c. 12. A smuggling contract is generally illegal. But it may be valid, and the vendor may recover the price of goods, even though he knew the buyer intended them to be smuggled, unless he actually aids in the smuggling so as to become *particeps criminis*. Contracts to defraud the revenue of a foreign state are, according to English decisions, not illegal. There is a German decision, more consonant with international morality, to the opposite effect.

The penalties for smuggling in the United States will be found mainly in tit. xxxiv. ch. 10 of the Revised Statutes. The seaman guilty of smuggling is liable to the same penalty as in England, and in addition to imprisonment for twelve months, s. 4596.

A considerable amount of historical information on this subject will be found in Dowell's *History of Taxation* and Pike's *History of Crime in England*.

SMYRNA, in ancient times one of the most important and now by far the greatest of the cities of Asia Minor (see vol. xv. Plate II.), has preserved an unbroken continuity of record and identity of name from the first dawn of history to the present time. It is said to have been a Lelegian city before the Greek colonists settled in Asia Minor. The name, which is said to be derived from an Amazon called Smyrna, is indubitably Anatolian, having been applied also to a quarter of Ephesus, and (under the cognate form Myrina) to a city of Æolis, and to a tumulus in the Troad. The Æolic settlers of Lesbos and Cyme, pushing eastwards by Larissa and Neonteichus and over the Hermus, seized the valley of Smyrna. It was the frontier city between Æolis on the north and Ionia on the south, and was more accessible on the south and east than on the north and west. At the same time it was by virtue of its favorable situation necessarily a commercial city, like the Ionian colonies. It is, therefore, not surprising that the Æolic element grew weaker; strangers or refugees from the Ionian Colophon settled in the city, and finally Smyrna passed into the hands of the Colophonians and became the thirteenth of the Ionian states. The change had taken place before 688, when the Ionian Onomastus of Smyrna won the boxing prize at Olympia, but it was probably then a recent event. The Colophonian conquest is mentioned by Mimnermus (before 600 B.C.), who counts himself equally a Colophonian and a Smyrnæan. The Æolic form of the name, Σμύρνα, was retained even in the Attic dialect, and the epithet "Æolian Smyrna" remained long after the conquest. The favorable situation of Smyrna on the path of commerce between Lydia and the west raised it during the 7th century to the height of power and splendor. It lay at the eastern end of an arm of the sea, which reached far inland and admitted the Greek trading ships into the heart of Lydia. One of the great trade routes which cross Anatolia from east to west descends the Hermus valley past Sardis, and then diverging from the valley passes south of Mount Sipylus and crosses a low pass into the little valley, about 7 miles long and 2 broad, where Smyrna lies between the mountains and the sea. Miletus, and at a later time Ephesus, situated at the sea end of the other great trade route across Anatolia, competed for a time successfully with Smyrna for the conveyance of traffic from the interior; but both Ephesus and Miletus have long ago lost their harbors, and Smyrna now remains without a rival. It was of necessity in close relation with the Lydians, and when the Mermnad kings raised the Lydian power and aggressiveness it was one of the first points of attack. Gyges (687–653) was, however, defeated in a great battle on the banks of the Hermus; the situation of the battle-field shows that the power of Smyrna extended far to the east, and probably included the valley of Nymphæum (Nif). A strong fortress, the ruins of whose ancient and massive walls are still imposing, on a hill in the pass between Smyrna and Nymphæum, was probably built by the Smyrnæan Ionians to command the valley of Nymphæum. According to the poet Theognis (about 500 B.C.), "pride destroyed Smyrna." Mimnermus laments the degeneracy of the citizens of his day, who could no longer stem the Lydian advance. Finally, Alyattes (610–563) conquered the city, and Smyrna for 300 years lost its place in the list of Greek cities. It did not entirely cease to exist, but the Greek life and political unity were destroyed, and the Smyrnæan state was organized on the village system (ᾠκεῖτο κωμηδόν). It is mentioned in a fragment of Pindar, about 500 B.C., and in an inscription of 388 B.C. A small fortification of early style, rudely but massively built, on the lowest slope of a hill behind Burnabat, is perhaps a fortified village of this period. Alexander the Great conceived the idea of restoring the Greek city; the two Nemeses who were worshipped at Smyrna are said to have suggested the idea to him in a dream. The scheme was, according to Strabo, carried out by Antigonus (316–301), and Lysimachus enlarged and fortified the city (301–281). The acropolis of the ancient city had been on a steep peak about 1250 feet high, which overhangs the northeastern extremity of the gulf; its ruins still exist, probably in much the same condition as they were left by Alyattes. The later city was founded on the site which it still occupies, partly on the slopes of a rounded hill called Pagus near the southeast end of the gulf, partly on the low ground between the hill and the sea. The beauty of the city when seen from the sea, clustering on the low ground and rising tier over tier on the hillside, is frequently praised by the ancients and is celebrated on its coins; the same impression still strikes the spectator, and must in ancient times have been much stronger, when magnificent buildings, an imposing acropolis, and the wide circle of massive walls combined with the natural scenery in one splendid picture. Symrna is shut in on the west by a hill now called Deirmen Tepe, with the ruins of a temple on the summit. The walls of Lysimachus crossed the summit of this hill, and the acropolis occupied the top of Pagus. Between the two the road from Ephesus entered the city by the "Ephesian gate," near which was a gymnasium. Closer to the acropolis the outline of the



Plan of Smyrna.

stadium is still visible, and the theatre was situated on the northern slopes of Pagus. The line of the walls on the eastern side is unknown; but they certainly embraced a greater area than is included by the Byzantine wall, which ascends the castle hill (Pagus) from the Basmakhané railway station. Smyrna possessed two harbors,—the outer, which was simply the gulf, and the inner, which was a small basin, with a narrow entrance closed by a rope in case of need, about the place now occupied by bazaars. The inner harbor was partially filled up by Timur in 1402, but it had not entirely disappeared till the beginning of the 19th century. The modern quay has encroached considerably on the sea, and the coast-line of the Greek time was about 90 yards farther to the south. The streets were broad, well paved, and regularly laid out at right angles; many were named after temples; the main street, called the Golden, ran across the city from west to east, beginning probably from the temple on Deirmen Tepe, and continuing towards Tepejik outside the city on the east, where probably the temple of Cybele, the Metroon, stood. Cybele, worshipped under the name of Meter Sipylene, from Mount Sipylus, which bounds the Smyrna valley on the north, was the tutelar goddess of the city. The plain towards the sea was too low to be properly drained, and hence in rainy weather the streets were deep with mud and water.

The river Meles, which flowed by Smyrna, is famous in literature and was worshipped in the valley. The most common and consistent tradition connects Homer with the valley of Smyrna and the banks of the Meles; his figure was one of the stock types on Smyrnæan coins, one class of which was called Homerian; the epithet "Melesigenes" was applied to him; the cave where he was wont to compose his poems was shown near the source of the river; his temple, the Homereum, stood on its banks. The steady, equable flow of the Meles, alike in summer and winter, neither swollen after rain nor dry during drought, its pleasant water, its short course, beginning and ending near the city, are celebrated by Aristides and Himerius. The description applies admirably to the stream which rises from abundant fountains, now known as Diana's Bath, some way to the east of the city, and flows into the southeastern extremity of the gulf. The common belief that the torrent, dry except after rains, which flows by Caravan Bridge is the ancient Meles flatly contradicts the ancient descriptions.

In the Roman period Smyrna was the seat of a *conventus* which included southern Æolis and great part of the Hermus valley. It vied with Ephesus and Pergamum for the title "First (city) of Asia." A Christian church existed here from a very early time, having its origin in the considerable Jewish colony. POLYCARP (*q.v.*) was bishop of Smyrna. The bishops of Smyrna were originally subject to the metropolitan of Ephesus; afterwards they became independent (*αὐτοκέφαλοι*), and finally were honored with metropolitan rank, having under them the bishops of Phocæa, Magnesia ad Sipylum, Clazomenæ, Sosandrus (Nymphæum?), Archangelus (Temnos?), and Petra (Menemen?).

When Constantinople became the seat of government the trade between Anatolia and the west lost in importance, and Smyrna declined apace. A Turkish freebooter named Tsacha seized Smyrna in 1084 and maintained himself there for some time, but it was recovered by the generals of Alexius Comnenus. The city was several times afterwards ravaged by the Turks, and had become quite ruinous when the emperor John Ducas Vatatzes about 1222 rebuilt it. The famous chieftain Aidin conquered it about 1330 and made his son Amur governor. Soon afterwards the knights of St. John established themselves in the town, but failed to conquer the citadel. In 1402 Timur stormed the town and massacred almost all the inhabitants. The Mongol conquest was only temporary, but Smyrna has remained till the present day in Mohammedan hands. It is now the greatest commercial city in the Levant; its population is about 200,000, of whom nearly half are Greeks. It is the terminus of the railway system which is gradually spreading over Anatolia. Two lines start from Smyrna: one ascends the Hermus valley by Magnesia and Sardis to Alashehr (Philadelphia), about 110 miles; the other goes south by Ephesus to the Mæander valley beside Magnesia on the Mæander and then ascends the valley to the neighborhood of Laodicea on the Lycus, 143 miles. Since the revival of the Levant trade by the Genoese and Venetians Smyrna has been the emporium for the whole produce of Anatolia; the chief raw products exported are valonea, figs, raisins, opium, madder, liquorice, cotton, sponges, emery, etc.; almost the only articles of native manufacture which are exported from Smyrna are the carpets woven at Geurdiz, Coula, Ushak, and other places in the interior. Smyrna has frequently been partially destroyed by earthquakes; that of 178 A.D. is the most famous, and in 1688, 1768 and 1880 the town suffered severely. (W. M. RA.)

SNAIL. In England the word "snail" in popular language is associated with Gasteropods which inhabit land or fresh water, and which possess large conspicuous spiral shells; terrestrial Gasteropods in which the shell is rudimentary and concealed are distinguished as "slugs." In Scotland the word "slug" is absent from the vernacular vocabulary, both shell-bearing and shell-less inland molluscs being known as snails. Marine Gasteropods are occasionally termed "sea-snails," and the compounds "pond-snails," "river-snails," "water-snails" are in common use. The commonest land-snails are those species which constitute the family *Helicidæ*, order *Pulmonata*, sub-order *Stylommatophora*. The other two families of the same sub-order, *Limacidæ* and *Onchidiidæ*, include all the slugs. In the first of these are comprised all the slugs known in Great Britain, and indeed in Europe. The *Onchidiidæ* are entitled to the name "sea-slugs," as they are shell-less Pulmonates living on the seashore, though not actually in the sea. The term "water-snails" includes the whole of the remaining sub-order of the *Pulmonata*, namely, the *Basommatophora*, in which the eyes are sessile. This division comprises two families, *Limnæidæ* and *Auriculidæ*; some of the members of the first are amphibious, some entirely aquatic; the snails of the second family are found near but not in the water; thus the whole of the *Pulmonata* which breathe air are destitute of gill-plumes and operculum, and have a complicated hermaphrodite reproductive system, are either snails or slugs. But there are a considerable number of snails, both terrestrial and aquatic, which are not Pulmonates. The land-snails, which have no gill-plume in the mantle-chamber and breathe air, but have the sexes separated and possess an operculum, belong to the order *Azygobranchia*, of which they form a distinct sub-order, the *Pneumonochlamyda*, containing three families, *Cyclostomidæ*, *Helicinidæ* and *Aciculidæ*. The fresh-water snails which are not Pulmonates are the *Paludinidæ*, *Valvatidæ* and *Ampullaridæ*, together with *Neritina*, a genus of the *Neritidæ*. These all possess a fully developed gill-plume and are typical Azygobranchiates of the sub-order *Holochlamyda*, most of the members of which are marine.

The family *Helicidæ* has a world-wide distribution. In *Helix* the spire forms a more or less obtuse-angled cone; there are above 1200 species, of which 24 are British. *Helix nemoralis*, L., of which *H. hortensis* is a variety, is one of the commonest forms. *Helix pomatia*, L., is the largest species, and is known as the "edible snail"; it is commonly eaten in France and Italy, together with other species. It was formerly believed to have been introduced into Britain by the Romans, but there is no doubt that it is a native. In *Succinea* the cone of the spire is acute-angled; three species are British. In *Vitrina* the spire is very flat and the surface glassy. In *Bulimus* the spire is elongated with a pointed apex. *Pupa* is named from its resemblance to a chrysalis, the apex being rounded. The shell of *Clausilia* is sinistral and its aperture is provided with a hinged plate. The commoner European slugs of small size all belong to the genus

Limax, in which the opening of the mantle-chamber is posterior. *L. flavus* is the cellar slug. *L. agrestis, L. arborum, L. maximus*, occur in gardens and fields. The larger black slugs are species of *Arion*, of which two are British, *A. ater* and *A. hortensis*. *Testacella haliotidea* is common in Great Britain and throughout Europe.

The *Limnæidæ* occur in all parts of the world. *Limnæus* contains the largest species. *L. pereger*, Müller, is ubiquitous in Great Britain and common all over Europe. All the species are usually infested with *Cercariæ* and *Rediæ*, the larval forms of Trematode parasites of vertebrates. *L. truncatulus* harbors the *Cercaria* of *Fasciola hepatica*, the liver-fluke, which causes rot in sheep. *Ancylus*, which occurs in rivers, has a minute limpet-like shell. *Panorbis* has the spire of the shell in one plane. *Physa* is smaller than *Limnæus* and has the upper part of the spire much shorter. In the *Auriculidæ* the aperture is denticulated. *Auricula* is confined to the East Indies and Peru. *Carychium minimum* is British.

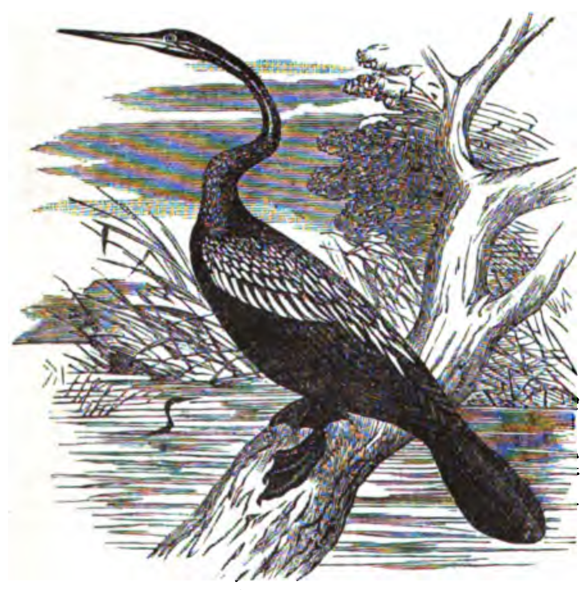
Of the *Cyclostomidæ* only one species, *Cyclostoma elegans*, Müller, is British; it hides under stones and roots. The *Helicinidæ* are exotic, ranging from the West Indies to the Philippines. Of the *Aciculidæ*, which are all minute, *Acicula lineata* is British.

The *Ampullaridæ* are confined to the tropics. *Ampullaria* has very long tentacles and a long siphon formed by the mantle. *Valvata* is common in fresh waters throughout Britain; the gill when the animal is expanded is protruded beyond the mantle-chamber. The *Paludinidæ* are common in the northern hemisphere. *Paludina* and *Bithynia* are both British genera. In *Paludina* the whorls of the spiral are very prominent; the genus is vivaparous. *Bithynia* is smaller and the shell smoother.

Neritina has a very small spire, the terminal portion of the shell containing nearly the whole animal.

For the morphology and classification of snails see MOLLUSCA, vol. xvi. p. 648 *sq.* A history of the British forms is given in Gwyn Jeffreys's *British Conchology*, 1862, and by Forbes and Hanley in *British Mollusca*. For specie-graphical details see Woodward's *Manual of the Mollusca*, 1875, and Bronn's *Thierreich* (Weichthiere). For *Fasciola hepatica* see Thomas, *Quart. Journ. Mic. Sci.*, 1882.

SNAKE-BIRD, to use the name commonly given to it by the English in North America, because of its "long, slender head and neck," which, its body being submerged as it swims, "appear like a snake rising erect out of the water" (Bartram's MS., quoted by Ord in Wilson's *Am. Ornithology*, ix. p. 81), the "Darter" of many authors, and the *Plotus anhinga*[1] of ornithology, is the type of a small but very well marked Family of Birds, *Plotidæ*, belonging to the group *Steganopodes* (the *Dysporomorphæ* of Professor Huxley), and consisting of but a single genus and three or four species. They bear a general resemblance both outwardly and in habits to Cormorants (see vol. vi. p. 361), but are much more slender in form and have both neck and tail much elongated. The bill also, instead of being tipped with a maxillary hook, has its edges beset with serratures directed backwards, and is sharply pointed—in this respect, as well as in the attenuated neck, likening the Snake-birds to the Herons (see vol. xi. p. 679); but the latter do not generally transfix their prey as do the former.



Indian snake-bird (from Col. Tickell's drawing in the library of the Zoological Society).

The male of the American species, which ranges from Illinois to the south of Brasil, is in full breeding-plumage a very beautiful bird, with crimson irides, the bare skin round the eyes apple-green, and that of the chin orange, the head, neck and most part of the body clothed in black glossed with green; but down each side of the neck runs a row of long hair-like white feathers, tinged with pale lilac. The much elongated scapulars and the small upper wing-coverts bear each a median white mark, which on the former is a stripe pointed at either end, and on the latter a broad ovate patch.[2] The larger wing-coverts are dull white, but the quill-feathers of the wings and tail are black, the last broadly tipped with brownish-red, passing into grayish-white, and forming a conspicuous band when the tail is spread in form of a fan, as it often is under water.[3] The hen differs much in appearance from the cock, having the head, neck and breast of a more or less deep buff, bounded beneath by a narrow chestnut band; but otherwise her plumage is like that of her mate, only not so bright in color. The habits of this species have been repeatedly described by American writers, and those of its congeners, to be immediately mentioned, seem to be essentially the same. The Snake-bird frequents the large rivers or back-waters connected with them, where it may be seen resting motionless on some neighboring tree, generally choosing a dead branch, or on a "snag" projecting from the bottom, whence it plunges beneath the surface in pursuit of its fishy prey, to emerge in the manner before related, showing little more than its slender head and neck. Its speed and skill under water are almost beyond exaggeration, and it exhibits these qualities even in captivity, taking—apparently without effort—fish after fish that may be introduced into its tank, however rapidly they may swim and twist, and only returning to its perch when its voracious appetite is for the moment appeased or or its supply of food temporarily exhausted. Then, after adjusting its plumage with a few rapid passes of its bill, and often expanding its wings, as though, Cormorant-fashion, to dry them, it abandons itself to the pleasurable and passive process of digestion, reawaking to activity at the call of hunger. Yet at liberty it will indulge in long flights, and those of the male at the breeding season are ostentatiously performed in the presence of his mate, around whom he plays in irregular zigzag courses. The nest is variously placed, but almost always in trees or bushes overhanging the water's edge, and is a large structure of sticks, roots and moss, in which are laid four eggs with the white chalky shell that is so characteristic of most Steganopodous birds. Not unfrequently several or even many nests are built close together, and the locality that suits the Snake-bird also suits many of the Herons, so that these, its distant relatives, are often also its near neighbors.[4] The African Snake-bird, *P. congensis* (or *levaillanti* of some authors), inhabits the greater part of that continent from Natal northwards; but, though met with on the White Nile, it is not known to have occurred in Egypt, a fact the more remarkable seeing that Canon Tristram found it breeding in considerable numbers on the Lake of Antioch, to which it is a summer visitor, and it can hardly reach its home without passing over the intervening country. The male bird is easily distinguishable from the American species by its rufous coronal patch, its buff throat and its chestnut greater wing-coverts. A third species, *P. melanogaster*, ranges from Madagascar to India, Ceylon, Borneo, Java and China. This so closely resembles the last-mentioned that the differences between them cannot be briefly expressed. The Australian region also has its Snake-bird, which is by some regarded as forming a fourth species, *P. novæ-hollandiæ*; but others unite it to that last-mentioned, which is perhaps somewhat variable, and it would seem (*P. Z. S.*, 1877, p. 349) that examples from New Guinea differ somewhat from those inhabiting Australia itself.

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[1] "Anhinga," according to Marcgrave, who first described this bird (*Hist. Rer. Nat. Brasiliæ*, p. 218), was the name it bore among the natives.

[2] These feathers are very characteristic of each species of the genus, and in India, says Jerdon, are among the Khasias a badge of royalty.

[3] This peculiarity, first pointed out to the writer by Mr. Bartlett, who observed it in birds in the Zoological Society's possession, doubtless suggested the name of "Water-Turkey," by which in some places *Plotus anhinga* is said to be known.

[4] The curious but apparently well-attested fact of the occurrence in England, near Poole, in June, 1851, of a male bird of this species (*Zoologist*, pp. 3601, 3654) has been overlooked by several writers who profess to mention all cases of a similar character.

The anatomy of the genus *Plotus* has been dealt with more fully than that of most forms. Beside the excellent description of the American bird's alimentary canal furnished to Audubon by Macgillivray, other important points in its structure have been well set forth by Garrod and Forbes in the Zoological *Proceedings* (1876, pp. 335–345, pls. xxvi.–xxviii.; 1878, pp. 679–681; and 1882, pp. 208–212), showing among other things that there is an appreciable anatomical difference between the species of the New World and of the Old; while the osteology of *P. melanogaster* has been admirably described and illustrated by Prof. Milne-Edwards in M. Grandidier's great *Oiseaux de Madagascar* (pp. 691–695, pls. 284, 285). In all the species the neck affords a feature which seems to be unique. The first seven of the cervical vertebræ form a continuous curve with its concavity forward, but the eighth articulates with the seventh nearly at a right angle, and when the bird is at rest, lies horizontally. The ninth is directed downwards almost as abruptly, and those which succeed present a gentle forward convexity. The muscles moving this curious framework are as curiously specialized, and the result of the whole piece of mechanism is to enable the bird to spear with facility its fishy prey. (A. N.)

SNAKE-ROOT. In most countries where snakes abound some root or herb is used by the natives as an antidote for the bites of venomous species, and many herbs have consequently received the name of snake-root. Botanically speaking the name properly belongs to *Ophiorrhiza Mungos*, L., a plant of the Cinchona family used in the East Indies for the purpose above indicated. In medicine, however, the roots of *Aristolochia Serpentaria*, L., *Polygala Senega*, L., or *Cimicifuga racemosa*, Elliott, are alike understood by this name, being distinguished respectively as the Virginia, Seneka, and Black Snake-roots. The first is now employed as an aromatic antiseptic tonic in typhoid fever, the second as a stimulant expectorant in bronchitis, and the third as a sedative in rheumatic or inflammatory affections, especially in muscular rheumatism and lumbago. The root of *Aristolochia reticulata*, Nutt., which is known in the United States as Red River or Texan Snake-root, is the kind most frequently met with in the United Kingdom as Serpentary or Virginian Snake-root. (See GUACO.)

The roots or rhizome of *Liatris spicata*, Willd., *Eryngium aquaticum*, L., and *Eupatorium altissimum*, L., have all been used in North America for snake-bites, the first two being known as Button Snake-root and the last as White Snake-root. The rhizome of *Asarum canadense*, L., passes under the name of Canadian Snake-root. All of these contain acrid or aromatic principles which, when a warm decoction of the drug is taken, exercise a powerfully diaphoretic or, in some cases, diuretic action, to which any benefit that may be derived from their use must be attributed.

SNAKES constitute an order (*Ophidia*) in the class of Reptiles which is characterized by an exceedingly elongate body, cylindrical or sub-cylindrical, and terminating in a tapering tail. The integuments are folded into flat imbricate scales, which are rarely tubercular or granular. The spinal column consists of a very great number of vertebræ, with which the numerous ribs are movably articulated. Limbs are entirely absent, or only rudiments of the posterior occur more or less hidden below the skin; there is no sternum. The bones of the palate and jaws are movable; the mandibles are united in front by an elastic ligament and are very distensible. Generally both jaws and the palate are toothed, the teeth being thin and needle-like. There are no eyelids, no ear-opening. The vent is a transverse slit.

Snakes and lizards.

Great as is the difference in appearance between a typical snake and a typical lizard, the two orders of Ophidians and Lacertilians are nearly allied; the former is probably merely a specialized descendant of the latter or of the pythonomorphous reptiles, or perhaps of both. Moreover, the living Lacertilians include forms which approach the Ophidians by having a greatly increased number of vertebræ, a much advanced degradation of the scapular and pelvic arches and limbs, a simple dentition, and the absence of eyelids and external ear-opening. And on the other hand we find Ophidians with a greatly diminished flexibility of the vertebral column, with closely adherent, smooth and polished scales, with a narrow mouth—totally unlike the enormous gape of the typical snakes—and even without that longitudinal fold in the median line of the chin which is so characteristic of the order (*Typhlopidæ*). Thus of the Ophidian characters as given above only that taken from the loose connection of the bones of the skull remains as a sharp line of separation between snakes and lizards. The mandibulary symphysis is not by suture but by an elastic band; the intermaxillary, palatine, and pterygoid bones are so loosely attached to the cranium that they can be easily pressed outwards and forwards, and the maxillary and mandibulary of one side can be moved in those directions independently of their fellows opposite. The intermaxillary is small, generally toothless, and coalesces with the nasals and vomer into a single movable bone; finally, the suspensory is much elongate and movable at both ends. This arrangement insures an extraordinary degree of mobility and elasticity of all parts of the gape, which, however, varies in the different families of the order. For the other characteristic points of their structure and for their distribution, see REPTILES.

Distribution and habits.

The number of known species of snakes has been given as 1500 by some authorities and as 1800 by others. The limits of their distribution seem to be the 70th parallel N. lat. in Europe, the 54th in British Columbia, and the 40th parallel S. lat. in the southern hemisphere. The number of species and of individuals in a species is small in the temperate zones, but increases as the tropics are approached. In the tropical zone they are abundant, especially where a well-watered soil nourishes a rich vegetation, with glades open to the sun, and where a variety of small animals serve as an abundant and easily obtained prey. It is in the tropics also that the largest (boas, pythons) and the most specialized kinds occur (tree snakes, sea snakes, the large poisonous snakes). On the other hand, every variety of soil is tenanted by some kind of snakes: they form a contingent in every desert fauna. In accordance with this general distribution snakes show a great amount of differentiation with regard to their mode of life and general organization; and from the appearance alone of a snake a safe conclusion can be drawn as to its habits. The following categories may be distinguished.

(1) Burrowing snakes, which live under ground and but rarely appear on the surface. They have a cylindrical rigid body, covered with generally smooth and polished scales; a short strong tail; a short rounded or pointed head with narrow mouth; teeth few in number; small or rudimentary eye; no abdominal scutes or only narrow ones. They feed chiefly on invertebrate animals, and none are poisonous. (2) Ground snakes, living chiefly on the ground, and rarely ascending bushes or entering water. Their body is cylindrical, flexible in every part, covered with smooth or keeled scales, and provided with broad ventral and subcaudal scutes. All the various parts of their body and head are well proportioned; the non-poisonous kinds of ground snakes are in fact the typical and least

specialized snakes, and more numerous than any of the other kinds. They feed chiefly on terrestrial vertebrates. The majority are non-poisonous; but the majority of poisonous snakes must be referred to this category. (3) Tree snakes, which are able to climb bushes or trees with facility or pass even the greater part of their existence on trees. Their body is rarely cylindrical, generally compressed and slender; their broad ventral scutes are often carinate on the sides. Those kinds which have a less elongate and cylindrical body possess a distinctly prehensile tail. The eye is generally large. Their coloration consists often of bright hues, and sometimes resembles that of their surroundings. They feed on animals which likewise lead an arboreal life, rarely on eggs. Poisonous as well as innocuous snakes are represented in this category. (4) Freshwater snakes, living in or frequenting fresh waters; they are excellent swimmers and divers. The nostrils are placed on the top of the snout and can be closed whilst the animal is under water. Their body is cylindrical, moderately long, provided with narrow ventral scutes; the tail tapering; head flat, rather short; and the eyes of small size. They feed on fish, frogs, and other aquatic animals, and are innocuous and viviparous. (5) Sea snakes are distinguished by the compressed, rudder-shaped tail, supported by erect neural and hæmal spines. They never leave the sea (with the exception of one genus) and are unable to move on land. They feed on fishes, are viviparous and poisonous.

The majority of snakes are active during the day, their energy increasing with the increasing temperature of the air; whilst some delight in the moist sweltering heat of dense tropical vegetation, others expose themselves to the fiercest rays of the midday sun. Not a few, however, lead a nocturnal life, and many of them have, accordingly, their pupil contracted into a vertical or more rarely a horizontal slit. Those which inhabit temperate latitudes hibernate. Snakes are the most stationary of all vertebrates; as long as a locality affords them a sufficiency of food and some shelter to which they can readily retreat, they have no inducement to change it. Their dispersal, therefore, must have been extremely slow and gradual.

Locomotion.

Although able to move with extreme rapidity, they cannot maintain it for any length of time. Their organs of locomotion are the ribs, the number of which is very great, nearly corresponding to that of the vertebræ of the trunk. They can adapt their motions to every variation of the ground over which they move, yet all varieties of snake locomotion are founded on the following simple process. When a part of the body has found some projection of the ground which affords it a point of support, the ribs are drawn more closely together, on alternate sides, thereby producing alternate bends of the body. The hinder portion of the body being drawn after, some part of it (*c*) finds another support on the rough ground or a projection; and, the anterior bends being stretched in a straight line, the front part of the body is propelled (from *a* to *d*) in consequence. During this peculiar locomotion the numerous broad shields of the belly are of great advantage, as by means of their free edges the snake is enabled to catch and use as points of support the slightest projections of the ground. A pair of ribs corresponds to each of these ventral shields. Snakes are not able to move over a perfectly smooth surface. Thus it is evident that they move by dragging their body over the ground, or over some other firm base, such as the branch of a tree; hence the conventional representation of the progress of a snake, in which its undulating body is figured as resting by a series of lower bends on the ground whilst the alternate bends are raised above it, is an impossible attitude. Also the notion that snakes when attacking are able to jump off the ground is quite erroneous; when they strike an object, they dart the fore part of their body, which was retracted in several bends, forwards in a straight line. And sometimes very active snakes, like the cobra, advance simultaneously with the remainder of the body, which, however glides in the ordinary fashion over the ground; but no snake is able to impart such an impetus to the whole of its body as to lose its contact with the ground. Some snakes can raise the anterior part of their body and even move in this attitude, but it is only about the anterior fourth or third of the total length which can be thus erected.

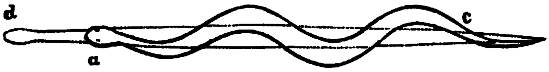

FIG. 1.—Diagram of natural locomotion of a snake.

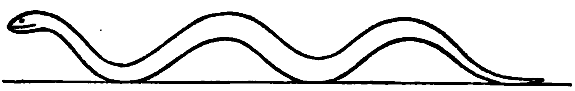

FIG. 2.—Diagram of conventional idea of a snake's locomotion.

Integuments.

With very few exceptions, the integuments form imbricate scale-like folds arranged with the greatest regularity; they are small and pluriserial on the upper parts of the body and tail, large and uniserial on the abdomen, and generally biserial on the lower side of the tail. The folds can be stretched out, so that the skin is capable of a great degree of distension. The scales are sometimes rounded behind, but generally rhombic in shape and more or less elongate; they may be quite smooth or provided with a longitudinal ridge or *keel* in the middle line. The integuments of the head are divided into non-imbricate shields or plates, symmetrically arranged, but not corresponding in size or shape with the underlying cranial bones or having any relation to them. The form and number of the scales and scutes, and the shape and arrangement of the head-shields, are of great value in distinguishing the genera and species, and it will therefore be useful to explain in the accompanying woodcut (Fig. 3) the terms by which these parts are designated. The skin does not form eyelids; but the epidermis passes over the eye, forming a transparent disk, concave like the glass of a

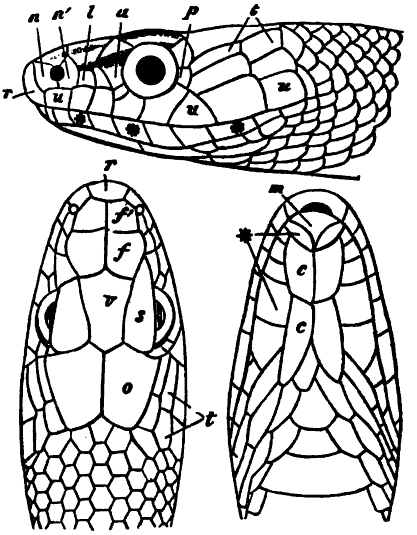

FIG. 3.—Head-shields of a snake (*Ptyas korros*). *r*, Rostral; *f*, posterior frontal; *f'*, anterior frontal; *v*, vertical; *s*, supraciliary or supraocular; *o*, occipital; *n*, *n'*, nasals; *l*, loreal; *a*, anterior ocular or orbital, or præorbital or anteocular; *p*, post-oculars; *u*, *u*, upper labials; *t*, *t*, temporals; *m*, mental; *, *, lower labials; *c*, *c*, chin-shields.

watch, behind which the eye moves. It is the first part which is cast off when the snake sheds its skin; this is done several times in the year, and the epidermis comes off in a single piece.

Tongue.

The tongue in snakes is narrow, almost worm-like, generally of a black color and forked; that is, it terminates in front in two extremely fine filaments. It is often exserted with a rapid motion, sometimes with the object of feeling some object, sometimes under the influence of anger or fear.

Dentition.

Snakes possess teeth in the maxillaries, mandibles, palatine, and pterygoid bones, sometimes also in the intermaxillary; they may be absent in one or the other of the bones mentioned. In the innocuous snakes the teeth are simple and uniform in structure, thin, sharp like needles, and bent backwards; their function consists merely in seizing and holding the prey. In some all the teeth are nearly of the same size; others possess in front of the jaws (Lycodonts) or behind in the maxillaries (Diacrasterians) a tooth more or less conspicuously larger than the rest; whilst others again are distinguished by this larger posterior tooth being grooved along its outer face. The snakes with this grooved kind of tooth have been named *Opisthoglyphi*, and also *Suspecti*, because some herpetologists were of opinion that the function of the groove of the tooth was to facilitate the introduction of poisonous saliva into a wound. The venomous nature of these snakes, however, has never been proved, and persons are frequently bitten by them without any evil consequences. Nevertheless as the depth of the groove, the length of the tooth, and the development of the salivary glands in its vicinity vary greatly, it is quite possible that the function and the physiological effect of this apparatus are not the same in all Opisthoglyphs. In the true poisonous snakes the maxillary dentition has undergone a special modification. The so-called Colubrine Venomous snakes, which retain in a great measure an external resemblance to the innocuous snakes, have the maxillary bone not at all, or but little, shortened, armed in front with a fixed, erect fang, and provided with a deep groove or closed canal for the conveyance of the poison, the fluid being secreted by a special poison-gland. One or more small ordinary teeth may be placed at some distance behind this poison-fang. In the other venomous snakes (Viperines and Crotalines) the maxillary bone is very short, and is armed with a single very long curved fang with a canal and aperture at each end. Although firmly anchylosed to the bone, the tooth, which when at rest is laid backwards, is erectile,—the bone itself being mobile and rotated round its transverse axis by muscles. One or more reserve teeth, in various stages of development, lie between the folds of the gum and are ready to take the place of the one in function whenever it is lost by accident, or shed, which seems to happen at regular intervals. The gland which secretes the poison is described under REPTILES (vol. xx. p. 470).

Food.

All snakes are carnivorous, and as a rule take living prey only; a few feed habitually or occasionally on eggs. Many swallow their victim alive; others first kill it by smothering it between the coils of their body (constriction). The effects of a bite by a poisonous snake upon a small mammal or bird are almost instantaneous, preventing its escape; and the snake swallows its victim at its leisure, sometimes hours after it has been killed. The prey is always swallowed entire, and, as its girth generally much exceeds that of the snake, the progress of deglutition is very laborious and slow. Opening their jaws to their fullest extent, they seize the animal generally by the head, and pushing alternately the right and left sides of the jaws forward, they press the body through their elastic gullet into the stomach, its outlines being visible for some time through the distended walls of the abdomen. Digestion is quick and much accelerated by the quantity of saliva which is secreted during the progress of deglutition, and in venomous snakes probably also by the chemical action of the poison. The primary function of the poison-apparatus in the economy of snakes is without doubt to serve as the means of procuring their food. But, like the weapons of other carnivorous animals, it has assumed the secondary function of an organ of defence. Only very few poisonous snakes (like *Ophiophagus elaps*) are known to resent the approach of man so much as to follow him on his retreat and to attack him. Others, as if conscious of their fearful power of inflicting injury, are much less inclined to avoid collision with man than innocuous kinds, and are excited by the slightest provocation to use that power in self-defence. They have thus become one of the greatest scourges to mankind, and Sir J. Fayrer[1] has demonstrated that in India alone annually some 20,000 human beings perish from snake-bites. Therefore it will not be out of place to add here a few words on snake-poison and on the best means (ineffectual though they be in numerous cases) of counteracting its deleterious effects.

Action of snake-poison.

Chemistry has not yet succeeded in separating the active principle of snake-poison or in distinguishing between the secretions of different kinds of poisonous snakes;[2] in fact it seems to be identical in all, and probably not different from the poison of scorpions and many *Hymenoptera*. The physiological effects of all these poisons on warm-blooded Vertebrates are identical, and vary only in degree, the smallest quantities of the poison producing a local irritation, whilst in serious cases the whole mass of the blood is poisoned in the course of some seconds or minutes, producing paralysis of the nerve-centres. That there is some difference, however, in the action of the poisons upon the blood has been shown by Fayrer, who found that the poison of Viperine snakes invariably destroys its coagulability, whilst nothing of the kind is observed in animals which perished from the bite of a Colubrine Venomous snake. The same observer has also experimentally demonstrated that the blood of a poisoned warm-blooded animal assumes poisonous properties, and, when injected, kills like the poison itself, although the bodies of the animals may be eaten by man with impunity. On the other hand, he has proved that the opinion generally adopted since Redi's time, viz., that snake-poison is efficacious only through direct injection into the blood, is fallacious, and that it is readily absorbed through mucous and serous membranes, producing the same effects, though in a milder degree.

Causes influencing snake-bites.

The degree of danger arising from a snake-bite to man depends in the first place on the quantity of poison injected: a large vigorous snake which has not bitten for some time is more to be feared than one of small size or one which is weakly or has exhausted its stock of poison by previous bites. The bite of some of the smaller Australian Diemenias and *Hoplocephali* is followed by no worse consequences than those arising from the sting of a wasp or a hornet, while immediately fatal cases are on record of persons bitten by the cobra or the large South-American Crotalines. In the second place it depends on the strength of the individual bitten: a man of strong physical constitution and energetic mental disposition is better able to survive the immediate effects of the bite than a child or a person wanting in courage. Thirdly, it depends on the position and depth of the bite: the bite may be merely a superficial scratch, or may penetrate into tissue having few blood-vessels, and thus be almost harmless; or it may be deep in vascular tissue or even penetrate a vein, producing immediate and fatal effects. It must be mentioned also that Fayrer is distinctly of opinion that the poison of some kinds is more powerful than that of others. The mere shock produced by the bite of a snake upon a nervous person may be sufficiently severe to be followed by symptoms of collapse, although no actual poisoning of the blood has taken place, or although the bite was that of an innocuous snake. It is said that persons have actually died under such circumstances from mere fright. The local appearances in the neighborhood of a poisoned wound, which soon after the bite is much swollen and discolored and very painful, readily prove its character; but this can be often ascertained also immediately after the bite by the inspection of the wound, —the teeth, which are so differently arranged in poisonous and non-poisonous snakes, leaving a different pattern on the skin. As a non-poisonous snake has four rows of teeth in the upper jaw, the pattern of its bite will more or less resemble Fig. 4, whilst a poisonous snake leaves two rows of more distinctly marked punctured wounds in the place of the two outer series in the non-poisonous (see Fig. 5). Of course, there may be modifications of these patterns, as, for instance, when one fang only hits or penetrates the part aimed at, or when the direction of the stroke is slanting, producing merely a scratch.

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[1] *The Thanatophidia of India*, fol., London, 1872.

[2] [The venoms of poisonous serpents have been found by Mitchell and Reichert to contain globulins and a venom peptone. Their analyses show that "the dried venom of *Crotalus adamanteus* contains 24.6 *per cent.* of globulins, the *Ancistrodon* 7.8 *per cent.*, and the Cobra 1.75 *per cent.*" The latter venom contains one-third more peptone than does Crotalus venom. These differences in the proportions of the various globulins, and of the globulins and peptones in different venoms, are of immense importance in affording an explanation of the physiological peculiarities exhibited in poisoning by different species of snakes.—*Researches upon the Venoms of Poisonous Serpents* by S. Weir Mitchell and E. T. Reichert; *Smithsonian Contributions to Knowledge, No.* 647. Washington, 1886.—AM. ED.]

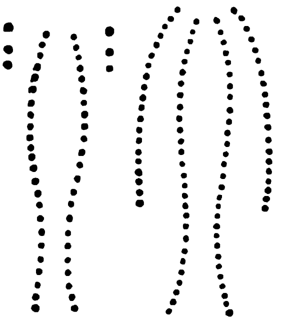

FIG. 4. FIG. 5.

FIG. 4.—Diagram of toothmarks of an innocuous snake.
FIG. 5.—Diagram of toothmarks of a poisonous snake (cobra).

Remedies and treatment.

Unfortunately no antidote is known capable of counteracting or neutralizing the action of snake-poison. Some years ago injections of ammonia or liquor potassæ were recommended, but there is the obvious objection that hardly in one out of a thousand cases of snake-bite would either the appliances or the operator be at hand. Fayrer's experiments, however, have distinctly disproved the efficacy of this remedial measure. Equally useless is permanganate of potassium; it is indeed true that a solution of this compound destroys the properties of snake-poison when mixed with it; and therefore such of the poison as remains in the wound will be neutralized by the external application or injection of the permanganate, but the remedy is entirely without effect after the poison has passed into the circulation. Treatment is therefore limited to endeavors to prevent by mechanical means the poison from entering the circulation, or by chemical agencies to destroy or remove as much of it as possible that remains in the wound, and to save the patient from the subsequent mental and physical depression by the free use of stimulants. Whatever is or can be done must be done immediately, as a few seconds suffice to carry the poison into the whole vascular system, and the slightest delay diminishes the chances of the patient's recovery. Courageous persons badly bitten in a finger or toe are known to have saved their lives by the immediate amputation of the wounded member. To the mode of treatment summarized by Günther[1] but little can be added. (1) If the wound is on some part of the extremities, one or more ligatures should be made as tightly as possible at a short distance above the wound, to stop circulation; this is most effectually done by inserting a stick under the ligature and twisting it to the uttermost. The ligatures are left until means are taken to destroy the virus in the wound and other remedial measures are resorted to, or until the swelling necessitates their removal. (2) The punctured wounds should be enlarged by deep incisions, to cause a free efflux of the poisoned blood, or should be cut out entirely. (3) The wound should be sucked either by the patient or some other person whose mouth is free from any solution of continuity. Cupping-glasses, where they can be applied, answer the same purpose, but not with the same effect. (4) By cauterization with a red-hot iron, a live coal, nitrate of silver or carbolic or mineral acid, or by injections of permanganate of potassium, the poison which remains in the wound can be destroyed or neutralized. Ammonia applied to the wound as a wash and rubbed into the neighboring parts is likewise undeniably of great benefit, especially in less serious cases, since it alleviates the pain and reduces the swelling. (5) Internally, stimulants are to be taken freely; they do not act as specifics against the virus, but are given to excite the action of the heart, the contractions of which become feeble and irregular, to counteract the physical and mental depression, and to prevent a complete collapse. Brandy, whiskey, and ammonia in any of its officinal forms should be taken in large doses and at short intervals. The so-called "snake-stones" can have no other effect than, at the best, to act as local absorbents, and can be of use only in the very slightest cases.

Propagation.

Snakes are oviparous; they deposit from ten to eighty eggs of an ellipsoid shape, covered with a soft leathery shell, in places where they are exposed to and hatched by moist heat. The parents pay no further attention to them, except the pythons, which incubate their eggs by coiling their body over them, and fiercely defend them. In some families, as many freshwater snakes, the sea snakes, *Viperidæ*, and *Crotalidæ*, the eggs are retained in the oviduct until the embryo is fully developed. These snakes bring forth living young, and are called "ovo-viviparous."

Classification.

The order of snakes may be divided into the following sub-orders and families or groups.

First Sub-order.—Hopoterodontes.

Small burrowing snakes, with a cylindrical body, which is nearly of the same thickness from its anterior to its posterior extremity, and is covered with smooth polished scales of the same size in its whole circumference. No mental groove. Head small, not distinct from the trunk, with imbricate scale-like scutes. Eye rudimentary. Mouth very narrow, at the lower side of the head, armed with small teeth in one jaw only.

Family 1. TYPHLOPIDÆ.—Teeth in the upper jaw only.

Genera: *Typhlina*, *Onychocephalus*, *Typhlops* (see Figs. 6, 7).

Family 2. STENOSTOMATIDÆ.—Teeth in the lower jaw only.

Genera: *Stenostoma*, *Siagnodon*.

Second Sub-order.—Ophidii Colubriformes.

Innocuous snakes. Teeth in both jaws, none of the anterior being grooved or perforated. Scales more or less differentiated. A mental groove is generally present. Eye developed.

Family 1. TORTRICIDÆ.—Body cylindrical, with a rounded head not distinct from the neck; tail very short. Rudiments of hind limbs hidden in a small groove on each side of the vent. Scales rounded, polished, those of the ventral series but little enlarged; only one pair of frontals; six upper labials. Eye small. Mouth of moderate width; teeth few in number, sub-equal in size.

Genera: *Ilysia* (tropical America); *Cylindrophis* (India).

Family 2. XENOPELTIDÆ.—Body cylindrical, with a rounded head not distinct from the neck; tail short. No rudimentary hind limbs. Scales rounded, polished; ventral shields well differentiated; two pairs of frontals; occiput covered with five shields. Eye small. Mouth of moderate width; teeth numerous, sub-equal.

One genus, from the Indian region; *Xenopeltis*.

Family 3. UROPELTIDÆ (Rough Tails).—Body cylindrical, with a short head not distinct from the neck; tail very short, truncated or scarcely tapering, frequently terminating in a rough naked disk or covered with keeled scales. Scales rounded and polished, those of the ventral series being always somewhat larger than the rest; only one pair of frontals; four upper labials. Eye very small. Mouth of moderate width; teeth few in number, small, sub-equal, none on the palate. Mental groove generally absent. Small burrowing Indian snakes.

Genera: *Rhinophis*, *Uropeltis*, *Silybura*, *Plectrurus*, *Melanophidium*.

Family 4. CALAMARIIDÆ.—Small snakes, with a rather rigid body; the short head not distinct from the neck; tail more or less short. Scales in from thirteen to seventeen series; ventral shields well developed, generally less than 200 in number; the normal number of head-shields always reduced by two or more of them being confluent. Cleft of the mouth of moderate width; nostril lateral; palatine teeth present.

African genera: *Homalosoma*, *Calamelaps*, *Prosymna*, *Opisthotropis*, *Xenocalamus*, *Amblyodipsas*, *Elapops*, *Urobelus*, *Uriechis*. Europeo-Asiatic genera: *Rhynchocalamus*, *Psilosoma*. Indian genera: *Calamaria*, *Macrocalamus*,

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[1] *Reptiles of British India*, London, 1864, 4to.

Typhlogeophis, *Xylophis*, *Oxycalamus*, *Brachyorrhos*, *Elapoides*, *Rhinosimus*, *Aspidura*, *Haplocercus*, *Achalinus* (Japan). North-American genera: *Carphophis*, *Conocephalus*, *Streptophorus*, *Contia*. Tropical American genera: *Homalocranium*, *Arrhyton*, *Rhegnops*, *Colobognathus*, *Geophidium*, *Catostoma*, *Stenognathus*, *Leptocalamus*, *Chersodromus*, *Elapomorphus*, *Cercocalamus*, *Microdromus*, *Stenorhina*, *Rhinostoma*, *Rhynchonyx*. Genus with wide distribution: *Geophis*.

Family 5. OLIGODONTIDÆ.—Body rather rigid, covered with smooth rounded scales; head short, not distinct from neck, and nearly always with symmetrical arrow-shaped markings above. Ventral scutes broad; rostral shield large, more or less produced backwards. Maxillary teeth few in number, the hindmost enlarged, not grooved. Indian.

Genera: *Oligodon*, *Simotes*.

Family 6. COLUBRIDÆ.—This family comprises the majority of the non-venomous snakes and the least specialized forms. Their body of moderate length compared to its circumference, flexible in every part; the head, trunk, and tail—in fact all parts—well proportioned; nostril lateral; teeth numerous in the jaws and on the palate, but without fangs in front or in the middle of the maxillary. Double row of sub-caudals. This family may be divided in accordance with the general habitus or mode of life into several groups, which, however, are connected by numerous intermediate forms.

The group of (i.) Ground Colubrides, *Coronellina*, consists of small forms, generally of brilliant coloration, and comprises the following genera:

Genera with wide distribution: *Ablabes*, *Cyclophis*, *Tachymenis*, *Coronella*, *Liophis*. African: *Psammophylax*, *Ditypophis*. Indian: *Megablabes*, *Nymphophidium*, *Odontomus*. Tropical American: *Erythrolamprus*, *Pliocercus*, *Hypsirhynchus*.

The group of (ii.) True Colubrides, *Colubrina*, are land snakes, which swim well when driven into the water, or climb when in search of food; they are of moderate or rather large size.

Genera with wide distribution: *Coluber*, *Elaphis*, *Ptyas*, *Zamenis*. African genera: *Xenurophis*, *Herpetæthiops*, *Scaphiophis*. Indian genera: *Compsosoma*, *Xenelaphis*, *Cynophis*, *Lielaphis*, *Lytorhynchus*. Europeo-Asiatic: *Rhinechis*. North-American: *Pituophis*. South-American: *Spilotes*. Australian: *Zamenophis*.

The group of (iii.) Bush Colubrides, *Dryadina*, leads up to the true Tree snakes, its members having a more or less elongate and compressed body, frequently of green color; they are more numerous in the New than in the Old World, and belong to the following

Genera: *Dromicus*, *Herpetodryas*, *Herpetoreas*, *Philodryas*, *Diplotropis*, *Zaocys*, *Dryocalamus*.

Finally the group of (iv.) Freshwater Colubrides, *Natricina*, are generally neither elongate nor compressed, and possess frequently keeled scales. They freely enter water in pursuit of their prey,—chiefly frogs and fishes.

Genera with wide distribution: *Tropidonotus*, *Heterodon*. African: *Grayia*, *Neusterophis*, *Limnophis*, *Hydræthiops*, *Macrophis*. Indian: *Xenochrophis*, *Prymnomiodon*, *Atretium*. North-American: *Ischnognathus*. South-American: *Xenodon*, *Tomodon*.

Family 7. HOMALOPSIDÆ (Freshwater Snakes).—Body of moderate length, cylindrical or slightly compressed; head rather thick, broad, not very distinct from neck; tail strong, of moderate length. Ventral scutes rather narrow; double row of sub-caudals. Eye small. Nostrils on the upper surface of the head, small, provided with a valve; nasal shields enlarged at the expense of the anterior frontals, which are frequently confluent into a single shield. The other head shields may deviate from the usual arrangement.

Indian genera: *Fordonia*, *Cantoria*, *Cerberus*, *Hypsirhina*, *Ferania*, *Homalopsis*, *Hipistes*, *Herpeton* (see Fig. 8), *Gerrarda*, *Tachyplotus*. American genera: *Calopisma*, *Helicops*, *Hydrops*, *Tachynectes*, *Hydromorphus*.

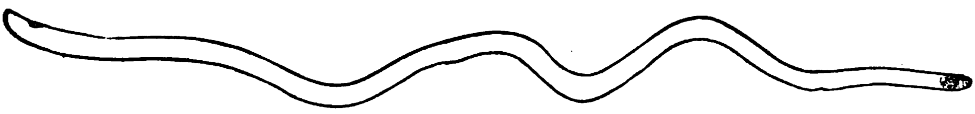

FIG. 6.—*Typhlops bothriorhynchus*, from India.

Family 8. PSAMMOPHIDÆ (Desert Snakes).—Loreal region very concave. Scales smooth; double row of sub-caudals. Cleft of the mouth wide; nostril lateral. Eye of moderate size. Shields of the head normal; posterior frontals rounded or angular behind; vertical narrow; supraciliaries prominent. Loreal present. One of the four or five anterior maxillary teeth longer than the others, and the last grooved. Old World.

Genera: *Psammophis*, *Cœlopeltis*, *Taphrometopon*, *Rhagerrhis*, *Psammodynastes*, *Mimophis*.

Family 9. RHACHIODONTIDÆ (Egg-Eaters).—Body of moderate dimensions; head short, deep. Eyes small, pupil round. Scales strongly keeled, in twenty-three or twenty-five series. Maxillary teeth very small and few in number; the lower spinous processes of the posterior cervical vertebræ penetrate the œsophagus and act as supplementary teeth. African.

One genus: *Dasypeltis* (see Fig. 9).

Family 10. DENDROPHIDÆ (Tree Snakes).—Body and tail much compressed or very slender and elongate; head generally elongate and distinct from the very slender neck; snout rather long, obtuse or rounded in front. Cleft of the mouth wide. Eye of moderate size or large, with round pupil. Shields of the head normal; scales generally narrow and much imbricate; ventral scutes keeled laterally; double row of sub-caudals. No large fang either in front or in the middle of the upper jaw.

African genera: *Bucephalus*, *Hapsidophrys*, *Rhamnophis*, *Philothamnus*, *Ithycyphus*. Indian and Australian genera: *Gonyosoma*, *Phyllophis*, *Dendrophis*, *Chrysopelea*. Tropical American: *Ahætulla*.

Family 11. DRYOPHIDÆ (Whip Snakes).—Body and tail excessively slender and elongate; head very narrow and long with tapering snout, which sometimes is produced into a longer or shorter appendage. Mouth very wide. Eye of moderate size, generally with a horizontal pupil. Scales very narrow, much imbricate; double row of sub-caudals. Posterior maxillary teeth grooved.

Genera: *Tropidococcyx*, *Cladophis*, *Dryophis*, *Tragops*, *Passerita* (see Fig. 10), *Langaha*.

Family 12. DIPSADIDÆ.—Body much compressed, elongate or of moderate length; head short, broad behind, with short rounded snout distinct from neck. Eye large, generally with vertical pupil. Cleft of the mouth wide. Scales of the vertebral series frequently enlarged. Dentition strong, frequently with enlarged anterior and posterior maxillary teeth.

Genera: *Chamætortus*, *Leptodira*, *Tropidodipsas*, *Hemidipsas*, *Thamnodynastes*, *Dipsas*, *Dipsadoboa*, *Rhinobothryum*, *Pythonodipsas*.

Family 13. SCYTALIDÆ.—Head, trunk, and tail of moderate dimensions. Eye of moderate size, with elliptical pupil. Scales smooth, in seventeen or nineteen rows; anal entire; single or double row of sub-caudals. Posterior maxillary teeth grooved, anterior ones equal in length.

Genera: *Scytale*, *Oxyrhopus*, *Hologerrhum*, *Pseudoxyrhopus*, *Rhinosimus*.

Family 14. LYCODONTIDÆ.—Body of moderate length or rather elongate; snout generally depressed, flat, and elongate. Eye rather small, often with vertical pupil. Upper head-shields regular, with the posterior frontals enlarged. Maxillary with a fang in front, but without posterior grooved tooth.

African genera: *Boodon*, *Holuropholis*, *Alopecion*, *Lycophidium*, *Bothrophthalmus*, *Bothrolycus*, *Lycodryas*, *Hormonotus*, *Simocephalus*, *Lamprophis*. Indian genera: *Lycodon*, *Dinodon*, *Tetragonosoma*. *Leptorhytaon*, *Ophites*, *Cercaspis*, *Ulupe*.

Family 15. AMBLYCEPHALIDÆ (Blunt Heads).—Body compressed, slender, and of moderate length; head short, thick, very distinct from neck; nostril in a single shield. Eye with vertical pupil. Cleft of the mouth narrow and not very extensible. Scales smooth or faintly keeled, those of the vertebral series generally enlarged. Maxillary dentition feeble, no grooved tooth.

Indian genera: *Dipsadomorus*, *Amblycephalus*, *Pareas*, *Asthenodipsas*, *Elachistodon*. South-American genera: *Leptognathus*, *Opisthophis*.

Family 16. ERYCIDÆ (Sand Snakes).—Body of moderate length, cylindrical, covered with small short scales; tail very short, with a single series of sub-caudals. Eye small, with vertical pupil. None of the labials are pitted. Anterior teeth longest. Adult individuals of some of the species with rudiments of hind limbs.

Genera: *Eryx*, *Cursoria*, *Gongylophis*, *Bolyeria*, *Erebophis*, *Lichanura*, *Calabaria*, *Wenona*, *Charina*.

Family 17. BOIDÆ.—Body and tail of moderate length or elongate; tail prehensile; snout rounded in front. Eye with vertical pupil. Scales in numerous series; single or double row of sub-caudals. In some of the genera the upper and lower labials are pitted. Teeth strong, unequal in size, none grooved; no inter-maxillary teeth. Rudiments of hind limbs are generally present.

Genera: *Boa* (see Fig. 11), *Pelophilus, Xiphosoma, Corallus, Epicrates, Chilabothrius, Enygrus, Leptoboa, Ungalia, Trachyboa.*

Family 18. PYTHONIDÆ (Rock Snakes).—Distinguished from the preceding family by the presence of intermaxillary teeth.

Genera: *Python* (see Fig. 12), *Morelia, Chondropython, Liasis, Aspidiotes, Nardoa, Loxocemus.*

Family 19. ACROCHORDIDÆ (Wart Snakes).—Body of moderate length, covered with small, non-imbricate, tubercular or spiny scales; tail rather short, prehensile. Head covered with scales like the body; nostrils close together, at the top of the snout. Eye small. Teeth short, strong, sub-equal in size. Aquatic. Viviparous. India.

Genera: *Acrochordus, Chersydrus.*

Family 20. XENODERMIDÆ.—Distinguished from the preceding family by possessing broad ventral and sub-caudal scutes.

One genus: *Xenodermus* (Java). ? *Nothopsis* (Central America).

Third Sub-order.—Ophidii Colubriformes Venenosi.

Venomous Colubrine snakes. An erect grooved or perforated tooth in front of the maxillary which is not capable of rotation in its transverse axis. Scales differentiated. A mental groove.

Family 1. ELAPIDÆ.—Toil conical, tapering. Head with shield: loreal absent. Venom-fang grooved; maxillary long, with short teeth behind the fang.

Genus with wide distribution: *Naja* (see Fig. 13). Indian genera: *Callophis, Megærophis, Hemibungarus, Xenurelaps, Bungarus, Ophiophagus.* African genera: *Pæcilophis, Elapsoidea, Cyrtophis.* South-American genus: *Elaps* (see Fig. 14). Australian genera: *Vermicella, Brachysoma, Neelaps, Brachyurophis, Rhinelaps, Diemenia, Cacophis, Hoplocephalus, Tropidechis, Pseudechis, Pseudonaja, Pseudohaje, Ogmodon.*

Family 2. ATRACTASPIDIDÆ.—Body cylindrical, of moderate proportions; tail short. Head short, not distinct from neck. Mouth narrow. Maxillary short, with perforated poison-fang, without other teeth behind. Africa.

Genus: *Atractaspis.*

Family 3. CAUSIDÆ.—Body of moderate proportions, tail moderate or rather short. Head distinct from neck. Mouth wide. Maxillary short, with perforated poison-fang, without other teeth behind.

African genera: *Sepedon, Causus.* South-American: *Dinodipsas.*

Family 4. DINOPHIDÆ (Venomous Tree Snakes).—Body and tail much elongate; head distinct from neck. Mouth wide. A perforated poison-fang, without other teeth behind. Africa.

Genus: *Dinophis* (*Dendraspis*).

Family 5. HYDROPHIDÆ (Sea Snakes).—Body generally compressed, and without broad ventral scutes; tail compressed, rudder-shaped. Nostrils directed upwards. Poison-fangs small, grooved. Viviparous.

Genera: *Platurus, Aipysurus, Disteira, Acalyptus, Hydrophis, Enhydrina, Pelagophis, Pelamis* (see (Fig. 15).

Fourth Sub-order.—Ophidii Viperiformes.

Viperine snakes. Maxillary very short, capable of rotation in its transverse axis, and armed with a single long tooth, which is perforated. Viviparous.

Family 1. VIPERIDÆ (Vipers).—Loreal region flat, without pit.

Old World genera: *Vipera, Cerastes, Daboia, Echis* (see Fig. 17), *Atheris.* Australian: *Acanthophis.*

Family 2. CROTALIDÆ (Pit Vipers, Rattlesnakes).—Loreal region with a pit.

Old World genera: *Halys, Hypnale, Trimeresurus* (see Fig. 18), *Calloselasma, Peltopelor.* New World genera: *Cenchris, Bothrops, Bothriopsis, Bothriechis,* (*Rhinocerophis*), *Atropos, Trigonocephalus, Lachesis, Crotalophorus, Crotalus* (see Fig. 16).

This list, from which many genera or sub-genera that are not well defined have been excluded, will give an idea of the great variety of forms by which the Ophidian type is represented at the present period. Additions more or less numerous, are made to it every year; but the discoveries of late years have not revealed any new important modifications of structure, but rather have undermined the distinctions hitherto made between genera, groups, and families, so that it would appear as if we were acquainted with all the principal forms of snakes now living.

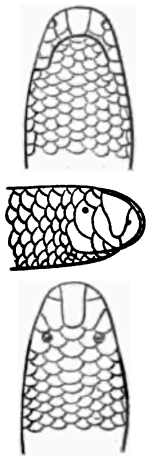

FIG. 7.—Three views of head of *Typhlops braminus* (India), magnified.

Burrowing snakes.

We have now to add some notes on snakes to which special interest is attached, or which are most frequently brought to the notice of the observer or reader. The snakes most remote from the true Ophidian type are the members of the first family, *Typhlopidæ*. They are a small degraded form, adapted for burrowing and leading a subterranean life, like worms. Their body is cylindrical, rigid, covered with smooth, short, highly polished, and closely fitting scales, without broad ventral scutes; tail very short; head joined to the trunk without neck-like constriction behind, and short, rounded, or with an acute rostral shield,—the principal instrument for burrowing in loose soil or mould. Their eye is quite rudimentary and can only give them a general perception of light. Their mouth is narrow, small, armed with but a few teeth in one of the jaws, and not distensible, allowing them only to feed on very small animals, such as worms, larvæ, and burrowing insects. They are found in all tropical countries and the parts adjoining, and some of the small species have a wide range, having been probably transported by accident on floating objects to distant countries. Some species attain to a length of 24 inches, whilst others scarcely grow to one-fourth that size.

An almost unbroken series leads from these degraded worm-like snakes to the typical *Colubridæ*, of which the Smooth Snake of Europe (*Coronella*), the Corn Snake of North America (*Coluber*), the Rat Snake of India and South America (*Ptyas, Spilotes*), Æsculapius's Snake of the south of Europe, the common Ring Snake of England (*Tropidonotus*), are well-known representatives.

Smooth snake.

The Smooth Snake (*Coronella lævis*) is common in the warmer parts of Europe, extending northwards into the New Forest district of England. In coloration, general habits, and size it somewhat resembles the viper; but, although it is rather fierce and ready to bite when caught, it is quite harmless and soon becomes tame in captivity. The shields on its head readily distinguish it from the viper. Its chief food consists of lizards, and it attains a length of 2 feet.

Indian rat snakes.

The Indian Rat Snakes (*Ptyas mucosus* and *P. korros*) are two of the most common species of India, the former inhabiting India proper and Ceylon, the latter the East Indian Archipelago, Siam, and southern China. *P. mucosus* is a powerful snake, attaining to a length of 7 feet, the tail being one-third or rather more; it is easily recognized by having three loreal shields, one above the other two; its scales are arranged in seventeen rows. Its food consists of mammals, birds, and frogs; and it frequently enters the dwellings of man, rendering itself useful by clearing them of rats and mice. It is of fierce habits, always ready to bite; when irritated it utters a peculiar diminuendo sound, not unlike that produced by a tuning-fork when struck gently.

Æsculapius's snake.

Æsculapius's Snake (*Coluber æsculapii*) was probably the species held in veneration by the ancient Romans. It grows to a length of about 5 feet, is of mild disposition, and can be readily domesticated. Its original home is Italy, where it is common, but it has extended its range northwards across the Alps into the south of France, and thence into northern Spain. Following the course of the Inn and the Danube, it has reached the Black Sea; and it is also now common in several localities along the middle parts of the Rhine. From direct observations made during the last twenty years there can be no doubt that it is still extending its range. Naturalists believed formerly that the occurrence of this snake at widely distant and isolated localities was due to its introduction by the Romans, who had settlements in those localities.

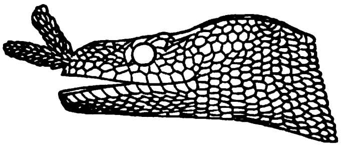

FIG. 8.—Head of *Herpeton tentaculatus*.

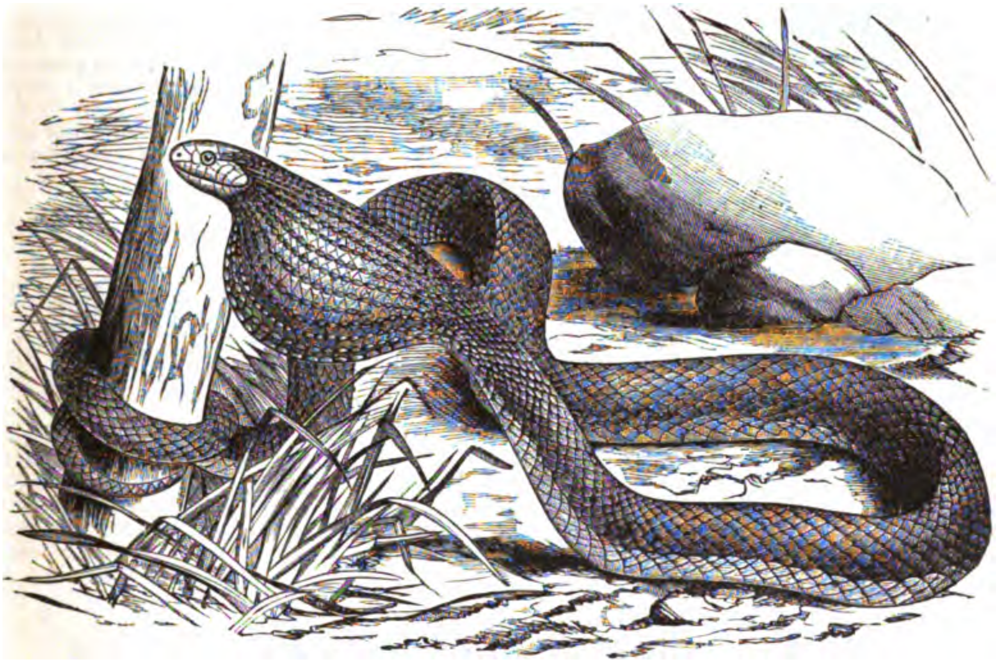

FIG. 9.—*Dasypeltis unicolor*, in the act of swallowing a fowl's egg.

British ring snake.

The common British Snake or Ring Snake (*Tropidonotus natrix*) is extremely common all over Europe (except in the northern parts), and belongs to a genus extremely rich in species, which are spread over Europe, Asia, India, Australia, and North America. Some of the species, like the Indian *T. quincunciatus* and *T. stolatus* and the North American *T. ordinatus*, are perhaps more abundant as regards the number of individuals than any other snake. *T. natrix* is easily recognized even at a distance by two yellow or white spots which it has behind its head. It grows rarely to a length of 4 feet; it never bites, and feeds chiefly on frogs and toads. Its eggs, which are of the size and shape of a dove's egg, and from fifteen to thirty in number, are deposited in mould or under damp leaves, and are glued together into one mass.

Egg-eaters.

A very peculiar genus of snakes, *Dasypeltis*, represented by three species only, is the type of a separate family and is restricted in its distribution to Central and South Africa. In Cape Colony these snakes are well known under the name of "eyervreter," *i.e.*, "egg-eaters." Their principal diet seems to consist of eggs, their mouth and œsophagus being so distensible that an individual scarcely 20 inches in length, and with a body not surpassing a man's little finger in circumference, is able to swallow a hen's egg. The teeth in the jaws are very small and few in number; but the inferior processes of the posterior cervical vertebræ are prolonged and provided with a cap of enamel, and penetrate the œsophagus, forming a kind of saw. As the egg passes through the œsophagus its shell is broken by this apparatus, and, whilst its contents are thus retained and swallowed without loss, the hard fragments of the shell are rejected. This peculiar apparatus occurs also in another snake, *Elachistodon*, which belongs to the Indian fauna and has been referred (provisionally) to the family *Amblycephalidæ*. Also two prominences at the base of the skull of the Indian Coronelline *Nymphophidium* probably have the same function. Besides the snakes mentioned, we have observed species of *Dipsas* feeding on eggs of parrots, the eggs reaching the stomach entire, as these snakes lack a special apparatus for breaking the shell. The Indian cobra also is said to rob birds of their eggs.

Tree snakes.

The Tree Snakes (*Dendrophidæ*) are among the greatest ornaments of tropical fauna. The graceful form of their body, the elegance and rapidity of their movements, and the exquisite beauty of their colors have been the admiration of all who have had the good fortune to watch them in their native haunts. The majority lead an exclusively arboreal life; only a few descend to the ground in search of their food. They prey upon every kind of arboreal animal,—birds, tree-frogs, tree-lizards, etc. All seem to be diurnal, and the larger kinds attain to a length of about 4 feet. The most beautiful of all snakes are perhaps certain varieties of *Chrysopelea ornata*, a species extremely common in the Indian Archipelago and many parts of the continent of tropical Asia. One of these varieties is black, with a yellow spot in the centre of each scale; these spots are larger on the back, forming a series of tetrapetalous flowers; the head is similarly ornamented. Another variety has a red back, with pairs of black crossbars, the bands of each pair being separated by a narrow yellow space; sides brown, dotted with black; belly dark green, the outer portion of each ventral shield being yellow, with a blackish spot.

Whip snakes.

The features by which the tree snakes are distinguished are still more developed in the family of Whip Snakes (*Dryophidæ*), whose excessively slender body has been compared to the cord of a whip. Although arboreal, like the former, they are nocturnal in their habits, having a horizontal instead of a round pupil of the eye. They are said to be of a fierce disposition, feeding chiefly on birds; and indeed a long tooth placed about the middle of the maxillary seems to assist them much in penetrating the thick covering of feathers and in obtaining a firm hold on their victims. In some of the species the elongate form of the head is still more exaggerated by a pointed flexible appendage of the snout (*Passerita*), which may be nearly half an inch in length, and leaf-like, as in the Madagascar *Langaha*.

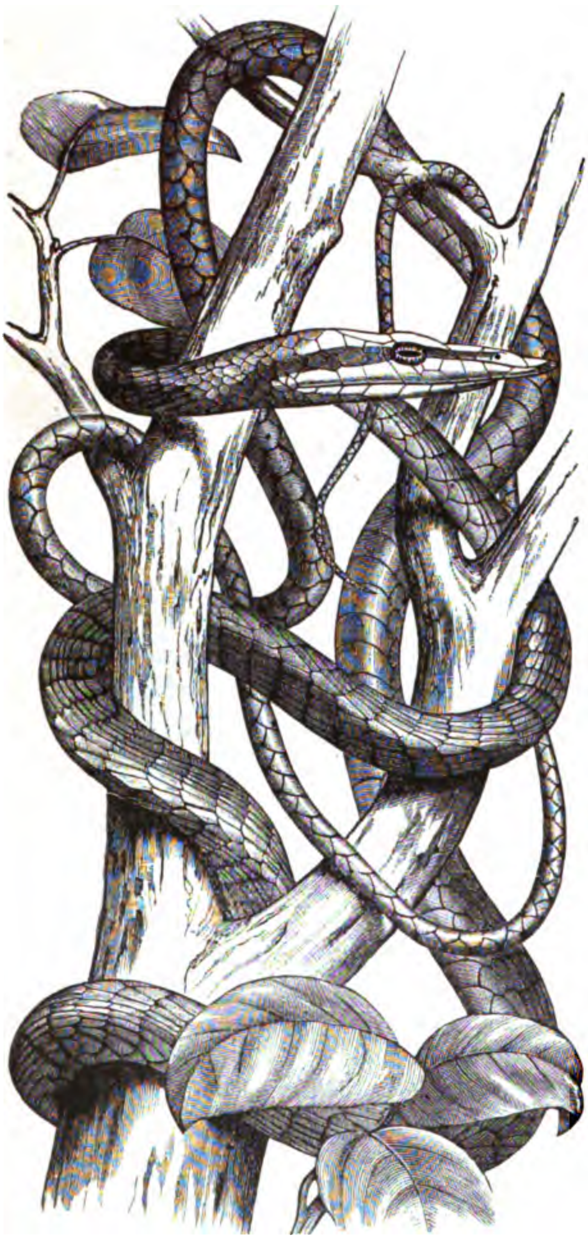

FIG. 10.—Indian Whip Snake. *Passerita mycterizans.*

Lycodontidæ.

The well-defined family of *Lycodontidæ* is chiefly composed of ground snakes, but a few of its members have a sufficiently elongate body to indicate arboreal habits. The Indian genera are principally reptilivorous, while the African prey upon mice, rats, and other small nocturnal mammals. Scarcely any other snake is so common in collections as the Indian *Lycodon aulicus*, which inhabits the continent of India and Ceylon, some of the islands of the East Indian Archipelago (Timor), and the Philippines. It occurs in many varieties, but generally is of a uniform brown, or with some whitish cross-bands on the anterior part of the body. Although only 2 feet long, it is a fierce snake, which when surprised bites readily, but its bite is innocuous.

Boas

The *Boidæ* are so similar in their habits to the Pythons (see PYTHON, vol. xx. p. 150) that it is sufficient to refer in a few words to the species most frequently mentioned in the literature dealing with the fauna of the virgin forests of tropical America. The real *Boa constrictor* is common from the northern parts of Central America to southern Brazil, and is frequently brought alive to Europe. Generally it is only about 7 feet long; but the present writer has seen skins of specimens which must have been nearly twice that length. The gigantic snakes of from 20 to 30 feet in length mentioned in books of South American travels belong to a different species, the Anaconda or *B. murina*, which has the same habits as the *B. constrictor*, haunting the banks of rivers and lakes and lying in wait for peccaries, deer, and other mammals of similar size, which come to the water to drink. It has already been stated (see REPTILES) that this family is not restricted to South America, but is well represented in the tropical Pacific region. The Boid most common in that region is *Enygrus*, which ranges all over New Guinea, the Fiji Islands, the Solomon group, Samoa, and many other Pacific islands; it is of small size, scarcely 30 inches long.

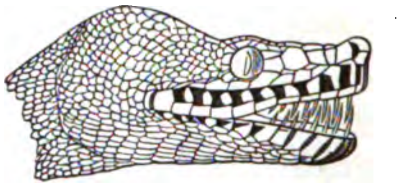

FIG. 11.—Head of *Boa canina.*

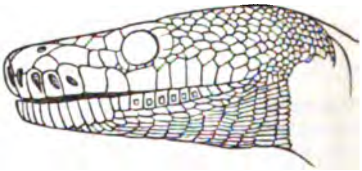

FIG. 12.—Head of *Python reticulatus.*

We pass now to the Venomous Colubrine snakes, that is, snakes which combine with the possession of a perfect poison apparatus the scutellation and general appearance of the typical non-poisonous snakes. It is a remarkable fact, however, that the snakes of this sub-order agree in the absence of the small shield on the side of the snout, the so-called "loreal"; and this is all the more remarkable as the same shield has by no means a similar taxonomic significance in the non-venomous snakes, many of which are without it, although it is present in the majority.

Cobras.

No snake of this sub-order is more widely known and more dreaded than the species of the genus

Naja or cobras. Probably more than two species should be distinguished; but the two which cause the greatest loss of life are the Indian Cobra or Cobra di Capello or Naga (*N. tripudians*) and the African Cobra (*N. haje*). In a report to the Bengal Government the commissioner of Burdwan states that he has ascertained from statistics collected during a series of nine years that above 1000 persons are killed annually by snakes in a population of nearly 6,000,000, the majority being bitten by the cobra, which is by far the most common. And other districts in India seem to suffer still more severely, although it is difficult to obtain information of all the accidents caused by snakes. The cobra is found throughout India, extending westwards to the Sutlej and eastwards to the Chinese island of Chusan; in the Himalayan alps it reaches an altitude of 8000 feet; it occurs also in abundance in many of the islands of the East Indian Archipelago, and is here joined by another apparently distinct species (*N. sputatrix*), whilst in the central portions of Asia, which geographically separate it from the African cobra, it is replaced by a fourth, *N. oxiana*. The Indian cobra appears in many varieties of color, which are distinguished by separate names in the nomenclature of the Hindu snake-charmers. The ground color varies from a yellowish olive to brown and to black with or without whitish or white crossbands on the back, and with from one to four or without any black bars across the anterior part of the belly. Some of these varieties are characterized by a pair of very conspicuous white, black-edged spectacle-like marks on the expansible portion of the neck, called the "hood"; but these marks may lose their typical form and become merely a pair of ocellated spots, or be confluent into a single ocellus, or may be absent altogether. All these varieties, however, are the same species, which generally attains to a length of 5 feet, but sometimes exceeds 6. It is more of nocturnal than of diurnal habits, feeding on every kind of small Vertebrates and also eating eggs. The cobra and the other species of this genus have the anterior ribs elongated, and can move them so as to form a right angle with the spine. The effect of this movement is the dilatation of that part behind the head which is generally ornamented with the spectacles or ocelli. When the cobra is irritated or excited it spreads its "hood," raising the anterior third of the body from the ground, gliding along with the posterior two-thirds, and holding itself ready to strike forwards or sidewards. All accounts agree that the cobra is not aggressive unless interfered with or impelled by a sense of danger. It is said to share the habitations of man where superstition prevents people from molesting it, and to live peacably with the inmates; and there is no doubt that professional snake-charmers exercise a certain control over them, for, although generally the cobras exhibited are rendered harmless by the removal of the poison-fangs, they very rarely attempt to injure their masters even after the fangs have been reproduced. Of the natural enemies of the cobra, the mungoos (see vol. xii. p. 665) does probably the greatest amount of execution; many are destroyed by fowls shortly after being hatched. The cobra is oviparous, depositing from eighteen to twenty-five eggs in the year. The African cobra is extremely similar to its Indian congener in size, form, and habits, and varies in coloration to the same extent. It inhabits the whole of Africa, from Egypt to the Cape of Good Hope, but has been nearly exterminated in the cultivated districts of the Cape Colony. One of its greatest enemies (as indeed of all snakes) is the secretary bird of South Africa (*Serpentarius*), which, therefore, is protected by law. Accidents from this snake do not appear to be of common occurrence; they happen more frequently to domestic animals than to man. In the Egyptian hieroglyphics the cobra occurs constantly with the body erect and hood expanded; its name was *ouro*, which signifies "king," and the animal appears in Greek literature as *ouraios* and *basiliscus*. With the Egyptian snake-charmers of the present day the cobra is as great a favorite as with their Hindu colleagues. They pretend to change the snake into a rod, and Geoffroy St.-Hilaire maintains that the supple snake is made stiff and rigid by a strong pressure upon its neck, and that the animal does not seem to suffer from this operation, but soon recovers from the cataleptic fit into which it has been temporarily thrown.

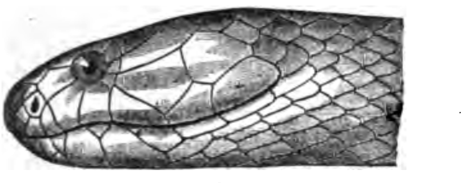

FIG. 13.—Head of cobra.

Ophiophagus elaps.

More dangerous than either of the species of cobra, which it exceeds in size, is *Hamadryas* or *Ophiophagus elaps*, the largest poisonous snake of the Old World, attaining to a length of 14 feet. It has almost the same geographical range as the cobra, but is much scarcer; it greatly resembles it also in general habit, but differs from it in scutellation, possessing three large shields behind the occipitals. It has the reputation of occasionally attacking and pursuing man; its favorite food consists of other snakes. Snake-charmers prize it highly for exhibition on account of its size and its docility in captivity, but are always careful to extract the fangs. It lives in captivity for many years.

Bungarums.

The species of *Bungarus*, four in number, are extremely common in India, Burmah, and Ceylon, and are distinguished by having only one row of undivided sub-caudal shields. Three of the species have the body ornamented with black rings, but the fourth and most common (*B. cœruleus*), the "krait" of Bengal, possesses a dull and more uniform coloration. The fangs of the bungarums are shorter than those of the cobras, and cannot penetrate so deeply into the wound. Their bite is therefore less dangerous and the effect on the general system slower, so that there is more prospect of recovery by treatment. Nevertheless, according to Fayrer, the krait is probably, next to the cobra, the most destructive snake to human life in India.

Narrow-mouthed species.

Several genera of this sub-order of Venomous Colubrines are similar to the innocuous *Calamariidæ* in general habit; that is, their body is of a uniform cylindrical shape, terminating in a short tail, and covered with short polished scales; their head is short, the mouth rather narrow, and the eye small. They are the tropical American *Elaps*, the Indian *Callophis*, the African *Pœcilophis*, and the Australian *Vermicella*. The majority are distinguished by the beautiful arrangement of their bright and highly ornamental colors; many species of *Elaps* have the pattern of the so-called coral snakes, their body being encircled by black, red, and yellow rings,—a pattern which is peculiar to snakes, venomous, as well as non-venomous, of the fauna of tropical America. Although the poison of these narrow-mouthed snakes is probably as virulent as that of the preceding, man has much less to fear from them, as they bite only under great provocation. Moreover, their bite must be frequently without serious effect, owing to their narrow mouth and the small size of their poison-fangs. They are also comparatively of small size, only a few species rarely exceeding a length of 3 feet.

Australian poisonous colubrine snakes.

No part of the world possesses so many snakes of this sub-order as Australia, where, in fact, they replace the non-venomous Colubrine snakes. Of the genus *Diemenia* six species, of *Pseudechis* three, and of *Hoplocephalus* some twenty species have been described, and many of them are extremely common and spread over a considerable area. Fortunately the majority are of small size, and their bites are not followed by more severe effects than those from the sting of a hornet, especially if the simple measures of sucking or cauterizing the wound are resorted to. Only the following are dangerous to man and larger animals: the Brown Snake (*Diemenia superciliosa*), found all over Australia and attaining to a length of over 5 feet; the Black Snake (*Pseudechis porphyriacus*), likewise common throughout the Australian continent, especially in low marshy places, and upwards of 6 feet in length; it is black, with each scale of the outer series red at the base; when irritated it raises the fore part of its body and flattens out its neck like a cobra; the Brown-banded Snake (*Hoplocephalus curtus*), with a similar distribution, and also common in Tasmania, from 5 to 6 feet long, and considered the most dangerous of the tribe.[1]

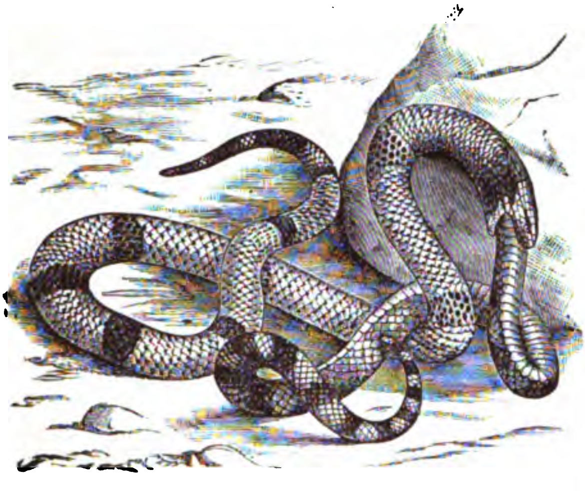

FIG. 14.—A poisonous snake (*Elaps fulvius*) swallowing a non-poisonous (*Homalocranium semicinctum*).

African Causidæ.

The small family *Causidæ* contains two African genera well known to and much feared by the inhabitants of South Africa. One, *Sepedon hæmachates*, is named by the Boers "roode koper kapel" or "Ring-Neck Snake," the latter name being, however, often applied also to the cobra. It resembles in color some varieties of the latter snake, and, like this, it has the power, though in a less degree, of expanding its hood. But its scales are keeled and its form is more robust. It is equally active and courageous, not rarely attacking persons who approach too near to its resting-place. In confinement it evinces great ferocity, opening its mouth and erecting its fangs, from which the poison is seen to flow in drops. During such periods of excitement it is even able, by the pressure of the muscles on the poison-duct, to eject the fluid to some distance; hence it shares with the cobra a third Dutch name, that of "spuw slang" (Spitting Snake). It grows to a length of 2 or 3 feet. The second African snake of this family is the "schapsticker" (Sheep Stinger), *Causus rhombeatus*. It is extremely common in South Africa and extends far northwards along the eastern as well as western coast. It is of smaller size than the preceding and causes more injury to animals, such as sheep, dogs, etc., than to man. It varies in color, but a black mark on the head like an inverted V remains nearly always visible.

Dinophidæ.

The *Dinophidæ* are the arboreal type of this sub-order; they resemble non-venomous tree snakes in their gracile form, narrow scales, generally green coloration, and in their habits; nevertheless the perfect development of their poison-apparatus, their wide mouth, their large size (they grow to a length of 7 feet), leave no doubt that they are most dangerous snakes. They do not appear to be common, but are spread over all districts of tropical Africa in which vegetation flourishes.

Sea snakes.

Of Sea Snakes (*Hydrophidæ*) some fifty species are known. All are inhabitants of the tropical Indo-Pacific ocean, and most numerous in and about the Persian Gulf, in the East Indian Archipelago, and in the seas between southern China and northern Australia. One species which is extremely common (*Pelamis bicolor*), and which is easily recognized by the black color of its upper and the yellowish tints of its lower parts (both colors being sharply defined), has extended its range westwards to the sea round Madagascar, and eastwards to the Gulf of Panama. Sea snakes are viviparous and pass their whole life in the water; they soon die when brought on shore. The most striking feature in their organization is their elevated and compressed tail. The hind part of the body is compressed, and the belly forms a more or less sharp ridge. The ventral shields would be of no use to snakes moving through a fluid, and therefore they are either only rudimentary or entirely absent. The genus *Platurus*, however, is a most remarkable exception in having broad ventral shields; probably these serpents frequently go on shore, sporting or hunting over marshy ground. In many sea snakes the hind part of the body is curved and prehensile, so that they are able to secure a hold by twisting this part of the body round corals, seaweed, or any other projecting object. Their tail answers all the purposes of the same organ in fish, and their motions in the water are almost as rapid as they are uncertain and awkward when the animals are removed out of their proper element. Their nostrils are placed quite at the top of the snout, as in crocodiles and in fresh-water snakes, so that they are enabled to breathe whilst the entire body and the greater part of the head are immersed in the water. These openings are small and subcrescentic, and are provided with a valve interiorly, which is opened during respiration, and closed when the animal dives. They have very capacious lungs, extending backwards to the anus, and consequently all their ribs are employed in performing the respiratory function; by retaining air in these extensive lungs they are able to float on the surface of the water without the slightest effort, and to remain under water for a considerable length of time. The scales of sea snakes are frequently very different from those of other snakes: they overlap one another in only a few species; in others they are but little imbricate and are rounded behind; and in others they are of a subquadrangular or hexagonal form, placed side by side, like little shields. The less imbricate they are the more they have lost the polished surface which we find in other snakes, and are soft, tubercular, sometimes porous. Sea snakes shed their skin very frequently; but it peels off in pieces as in lizards, and not as in the fresh-water snakes, in which the integuments come off entire. Several species are remarkable for the extremely slender and prolonged anterior part of the body, which is termed the "neck," and terminates in a very small

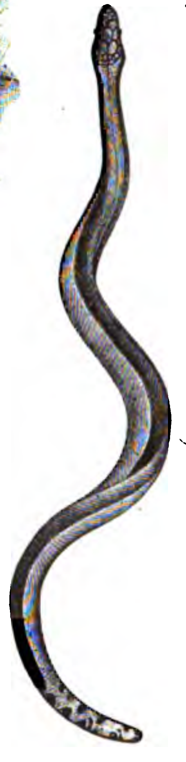

FIG. 15.—Sea snake, *Pelamis bicolor*.

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[1] Good descriptions and figures of all these snakes are given in Krefft's *Snakes of Australia*, Sydney, 1869, 4to.

head. The eye is small, with round pupil, which is so much contracted by the light when the snake is taken out of the water that the animal becomes blinded and is unable to hit any object it attempts to strike. The tongue is short, and the sheath in which it lies concealed opens near to the front margin of the lower jaw; scarcely more than the two terminating points are exserted from the mouth when the animal is in the water. The mouth shuts in a somewhat different way from that of other snakes: the middle of the rostral shield is produced downwards into a small lobule, which prevents the water from entering the mouth; there is generally a small notch on each side of the lobule for the passage of the two points of the tongue. Cantor says that when the snake is out of the water and blinded by the light it freely makes use of its tongue as a feeler. The food of sea snakes consists entirely of small fish; the present writer has found all kinds of fish in their stomach, among them species with very strong spines (*Apogon*, Siluroids). As all these animals are killed by the poison of the snake before they are swallowed, and as their muscles are perfectly relaxed, their armature is harmless to the snake, which commences to swallow its prey from the head, and depresses the spines as deglutition proceeds. There cannot be the slightest doubt that sea snakes belong to the most poisonous species of the whole order. Russell and Cantor have ascertained it by direct observation: tortoises, other snakes, and fish died from their bite in less than an hour, and a man succumbed after four hours. Accidents are rarely caused by them, because they are extremely shy and swim away on the least alarm; but, when surprised in the submarine cavities forming their natural retreats, they will, like any other poisonous terrestrial snake, dart at the disturbing object; and when out of the water, they attempt to bite every object near them, even turning round to wound their own bodies (Cantor). They cannot endure captivity, dying in the course of two or three days, even when kept in capacious tanks. The greatest size to which some species attain, according to positive observation, is about 12 feet, and therefore far short of the statements as to the length of the so-called sea serpents (see SEA-SERPENT). The largest examples the present writer has seen measured only 8 feet.

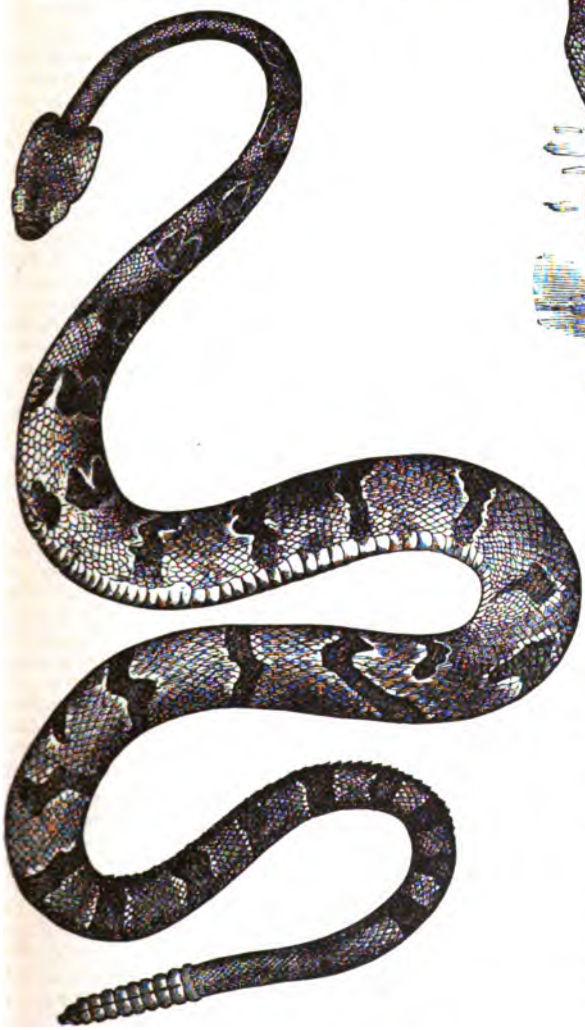
FIG. 16.—Rattlesnake (*Crotalus durissus*).

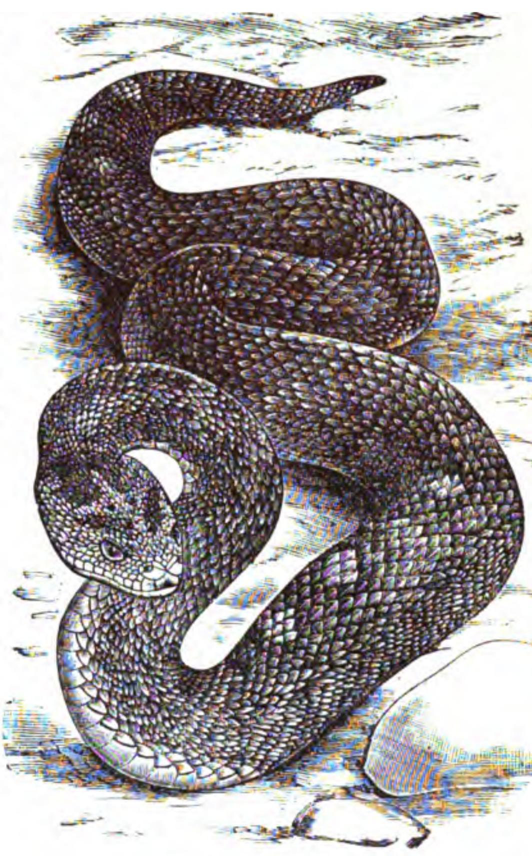
FIG. 17.—*Echis carinata* (India).

Passing over Rattlesnakes (Fig. 16) and Vipers, which are treated of in separate articles, we notice the following types of the fourth sub-order, the *Ophidii viperiformes*.

Death adder of Australia.

The sole representative of the sub-order in Australia is the Death Adder (*Acanthophis antarctica*), a short stout snake having a similar habitus and habits to vipers and scarcely attaining 3 feet in length. It differs from the other Viperines in having the poison-fang permanently erect. Although much feared, and justly, there is reason to believe that its bite is not so dangerous as has been represented, and that the majority of the fatal accidents ascribed to it are in fact caused by other snakes, probably *Hoplocephalus curtus*. It occurs throughout the whole of Australia, except Tasmania and perhaps South Australia. Generally it is of a uniform gray color, relieved by some forty dark rings of irregular outline.

Daboia russellii.

The "tic-polonga" of the Singalese (*Daboia russellii*) is beautifully marked: on a light chocolate ground color three series of large black white-edged rings run along the back and sides of the body, a yellow line borders the surface of the head on each side, the two lines being convergent on the snout. It attains to a length of 50 inches, and occurs locally in abundance in southern India, where it is called "cobra monil"; in Bengal, where it is called "jessur"; in the plains of central India, as well as in the Himalayas to an altitude of 6000 feet; and in Burmah. It is highly poisonous, probably causing many deaths. Fortunately its loud hissing when disturbed warns those who come within dangerous proximity to it.

Echis.

The small Viperine snake, *Echis carinata* (Fig. 17), which scarcely exceeds a length of 20 inches, shares with the preceding part of its range, being found in the arid districts of southern India, and extending through the intervening parts of Asia to North Africa. It is a desert type, having the lateral scales curiously arranged, strongly keeled, with the tips directed downwards. It produces with their aid a rustling sound. Whilst some observers deny that fatal consequences have resulted from its bite, Dr. Imlach reports that it (the "kuppur") is "the most deadly poisonous snake in Sind." This desert type is replaced farther south in Africa where vegetation flourishes by a closely allied genus, *Atheris*, which, however, possesses a prehensile tail and vivid coloration and has assumed truly arboreal habits.

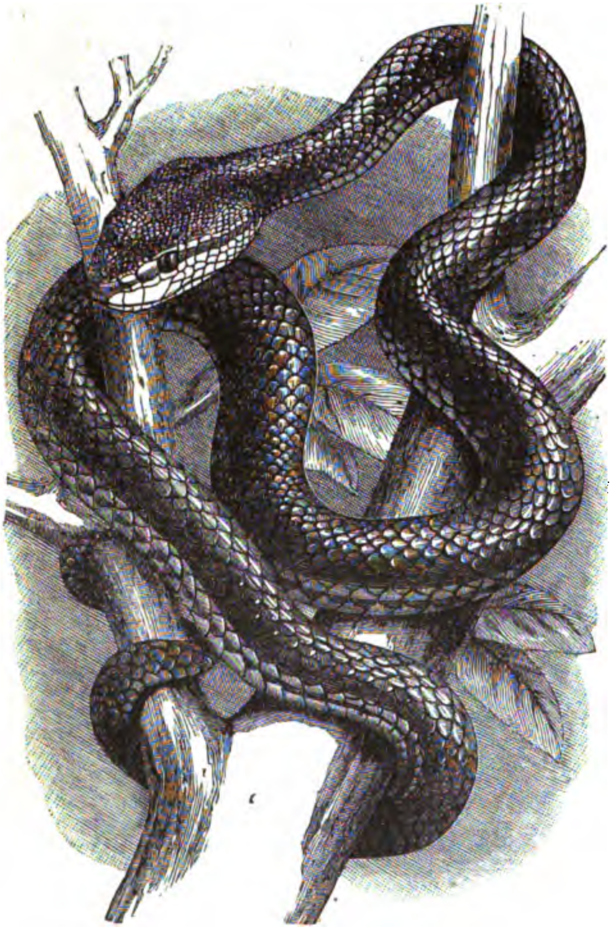

FIG. 18.—*Trimeresurus erythrurus* (India).

Pit vipers without rattles.

Of the pit vipers without rattles the largest and most formidable inhabit tropical America. *Trigonocephalus iararaca*, *T. atrox*, and *T. lanceolatus* attain to a length of 6 feet, the first two being common in Brazil and northwards to Central America. The last is limited to some islands in the West Indies, especially Martinique and St. Lucia, and is generally known by the name of "fer de lance," which has been given to it from the markings on its head. It infests the sugar-plantations, and has greatly multiplied in consequence of the protection which the cover of the cane-fields afforded it, and the abundance of food supplied by the rats which swarm on the plantations. Thus, whilst it did a certain amount of good by the destruction of vermin, it caused a great number of deaths among the black laborers who were engaged in the fields. These three species of *Trigonocephalus* are surpassed in size by *Lachesis mutus*, probably the largest[1] of terrestrial poisonous snakes, which is said to exceed a length of 10 feet, and is bulky in proportion. It is confined to the hottest parts of tropical America. Similar snakes, but smaller in size, inhabit the warmer and temperate parts of North America, viz., the Copper-head (*Cenchris contortrix*), and the Crater-moccasin (*C. piscivorus*), the former of terrestrial habits, the latter being always found near water, and feeding chiefly on aquatic animals. Both are much feared and cause accidents more frequently than rattlesnakes, being more aggressive and striking the intruder without previously warning him of their presence. In the Indian region this type of pit vipers without rattles is likewise well represented, one genus (*Trimeresurus*) being adapted for an arboreal life, like *Atheris* among the *Viperidæ*. Their body (Fig. 18) is not more elongate than that of other ground Crotalines, but their tail is prehensile, and their color generally resembles that of the bright foliage among which they live. Sometimes bright yellow or red markings render these snakes still more pleasing to the eye. Accidents caused by them are of not uncommon occurrence, but fortunately only a few individuals exceed a length of 2 feet, and the consequences of their bite are less to be dreaded than of that of other allied genera. Indeed, numerous cases are on record which show that the constitutional symptoms caused by their poison were of short duration, lasting only from two to forty-eight hours, and being confined to nausea, vomiting, and fever. The bite of larger specimens, of from 2 to 3 feet long, is more dangerous and has occasionally proved fatal. They feed on frogs, mammals, and birds. (A. C. G.)

SNAKE-STONE, a name sometimes applied to Water-of-Ayr stone (see HONE, vol. xii. p. 138. Certain stones reputed, on insufficient grounds, to possess efficacy as antidotes to snake-bites are known as snake-stones (see above, p. 202.) The term is also popularly applied to ammonites and certain other fossils which, owing to their spiral shape, were formerly regarded as petrified snakes.

SNEEK, a town of the Netherlands, in the province of Friesland, 18 miles south-southwest of Leeuwarden, with which it is connected by canal and (since 1885) by rail. It is one of the great butter and cheese markets of the country and has communal buildings (1863), a town-house, a court-house, an orphanage, a synagogue, and several churches, in one of which (the Groote or Maartenskerk) is the tomb of the naval hero Lange Pier (Long Peter). The population of the town was in

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[1] [See *Ophiophagus Elaps*, p. 207—AM. ED.]

1870 8456; that of the commune, which numbered only 3253 in 1714, was 9248 in 1870 and 10,496 in 1880.

Sneek appears in the list of Frisian towns in 1268. It was almost reduced to ashes in 1295, and again in 1417 and 1457. In 1515 it was attacked and in 1517 formally besieged by the Burgundians. A diet met in the town in the close of this latter year; and long after, in 1672, Sneek was again the seat of an assembly of the states. In 1570 and 1825 there were severe inundations.

SNELL, WELLEBRORD (1591–1626), commonly known as SNELLIUS, astronomer and mathematician, was born at Leyden in 1591. In 1613 he succeeded his father as professor of mathematics in the university of Leyden. In 1615 he planned and carried into practice a new method of finding the dimensions of the earth, by determining the distance of one point on its surface from the parallel of another, by means of a triangulation. His work, *Eratosthenes Batavus*, published in 1617, describes the method and gives as the result of his operations between Alkmaar and Bergen-op-Zoom a degree of the meridian equal to 55,100 toises = 117,449 yards. (A later recalculation has given 57,033 toises = 121,569 yards, after applying some corrections to the measures indicated by himself.) Snell also distinguished himself as a mathematician, and discovered the law of refraction, which, however, is generally attributed to Descartes, who made it more widely known. Snell died at Leyden on 30th October, 1626.

In addition to the *Eratosthenes Batavus* he published *Cyclometria sive de circuli dimensione* (Leyden, 1621, 4to), and edited *Cœli et siderum in eo errantium observationes Hassiacæ* (ibid., 1618, 4to), containing the astronomical observations of Landgrave William IV. of Hesse. About his *Tiphys Batavus s. Histiodromice de navium cursibus et re navali* (1624), see NAVIGATION, vol. xvii. p. 261, note. A trigonometry (*Doctrina triangulorum*) by him was published a year after his death.

SNIPE (Anglo-Saxon *Snite*, Icelandic *Snípa*, Dutch *Snip*, German *Schnepfe*), one of the commonest Limicoline birds, in high repute no less for the table than for the exciting sport it affords. It is the *Scolopax gallinago* of Linnæus, but by many later writers separated from that genus, the type of which is the WOODCOCK (*q.v.*), and hence has been variously named *Gallinago cœlestis*, *G. media*, or *G. scolopacina*. Though considerable numbers are still bred in the British Islands, notwithstanding the diminished area suitable for them, most of those that fall to the gun are undoubtedly of foreign origin, arriving from Scandinavia towards the close of summer or later, and many will outstay the winter if the weather be not too severe, while the home-bred birds emigrate in autumn to return the following spring. Of late years British markets have been chiefly supplied from abroad, mostly from Holland.

The Snipe is fortunately too well known to need description for a description of its variegated plumage, if attempted, would be long. It may be noticed, however, as subject to no inconsiderable variation, especially in the extent of dark markings on the belly, flanks, and axillaries, while examples are occasionally seen in which no trace of white, and hardly any of buff or gray, is visible,—the place of these tints being taken by several shades of chocolate-brown. Such examples were long considered to form a distinct species, the *S. sabinii*, but its invalidity is now generally admitted. Other examples in which buff or rust-color predominates have also been deemed distinct, and to these has been applied the epithet *russata*. Again, a slight deviation from the ordinary formation of the tail, whose rectrices normally number 14, and present a rounded termination, has led to the belief in a species, *S. brehmi*, now wholly discredited. But, setting aside two European species, to be presently noticed more particularly, there are at least a score, more or less nearly allied, belonging to various parts of the world, for no considerable territory is without its representative. Thus North America produces *G. wilsoni*, so like the English Snipe as not to be easily distinguished except by the possession of 16 rectrices, and Australia has *G. australis*, a larger and somewhat differently colored bird with 18 rectrices. India, while affording a winter resort to multitudes of the common species, which besides Europe extends its breeding range over the whole of northern Asia, has the so-called Pin-tailed Snipe, *G. stenura*, in which the number of rectrices are still greater, varying from 20 to 28, it is said, though 22 seems to be the usual number. This curious variability, deserving more attention than it has yet received, only occurs in the outer feathers of the series, which are narrow in form and extremely stiff, there being always 10 in the middle of ordinary breadth.

Those who only know the Snipe as it shows itself in the shooting season, when without warning it rises from the boggy ground uttering a sharp note that sounds like *scape, scape*, and after a few rapid twists, darts away, if it be not brought down by the gun, to disappear in the distance after a desultory flight, have no conception of the bird's behavior at breeding time. Then, though flushed quite as suddenly, it will fly round the intruder, at times almost hovering over his head. But, if he have patience, he will see it mount aloft and there execute a series of aerial evolutions of an astounding kind. After wildly circling about, and reaching a height at which it appears a mere speck, where it winnows a random zigzag course, it abruptly shoots downwards and aslant, and then as abruptly stops to regain its former elevation, and this process it repeats many times. A few seconds, more or less according to the distance, after each of these headlong descents a mysterious sound strikes his ear—compared by some to drumming and by others to the bleating of a sheep or goat,[1] which sound evidently comes from the bird as it shoots downwards, and then only; but how the sound is made is a question on which many persons are still undecided. There are those who maintain that it proceeds from the throat, while some declare it is produced by the wings, which sharp-sighted observers say they can see in tremulous motion. Others, again, assert that it is caused by the vibration of the webs of the outer rectrices, and these last have in support of their opinion the fact that a similar sound may be made by affixing those feathers to the end of a rod and drawing them rapidly downwards in the same position as they occupy in the bird's tail while it is performing the feat.[2] But, however it be produced, the air will also ring with loud notes that have been syllabled *tinker, tinker, tinker*, while other notes in a different key, something like *djepp, djepp, djepp*, rapidly uttered, may be heard as if in response. The nest is always on the ground and is a rather deep hollow wrought in a tuft of herbage, and lined with dry grass leaves. The eggs are four in number, of a dark olive color, blotched and spotted with rich brown. The young when freshly hatched are beautifully clothed in down of a dark maroon, variegated with black, white, and buff.

The Double or Solitary Snipe of English sportsmen, *S. major*, a larger species, also inhabits northern Europe and may be readily recognized by the white bars in its wings and by its 16 or occasionally 18 rectrices. It has also a very different behavior. When flushed it rises without alarm-cry, and flies heavily. In the breeding season much of its love-performance is exhibited on the ground, and the sounds to which it gives rise are of another character; but the exact way in which its "drumming" is effected has not been ascertained. Its gesticulations at this time have been well described by Prof. Collett in a communication to Mr. Dresser's *Birds of Europe* (vol. vii. pp. 635–637). It visits Great Britain every year at the close of summer, but in very small numbers, and is almost always seen singly—not uncommonly in places where no one could expect to find a Snipe.

The third species of which any details can here be given is the Jack-[3] or Half-Snipe, *S. gallinula*, the smallest and most beautifully colored of the group. Without being as numerous as the common or full Snipe, it is of frequent occurrence in Great Britain from September to April (and occasionally both earlier and later); but it breeds only, so far as is known, in northern Scandinavia and Russia; and the first trustworthy information on that subject was obtained by Wolley in June, 1853, when he found several of its nests near Muonioniska in Lapland.[1] Instead of rising wildly as do most of its allies, it generally lies so close as to let itself be almost trodden upon, and then takes wing silently to alight at a short distance (if it escape the gun), and to return to the same place on the morrow. In the breeding-season, however, it is as noisy and conspicuous as its larger brethren while executing its aerial evolutions.

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[1] Hence in many languages the Snipe is known by names signifying "Flying Goat," "Heaven's Ram," as in Scotland by "Heatherbleater."

[2] Cf. Meves, (*Œfvers. K. Vet.-Akad Förh.*, 1856, pp. 275–277 (transl. *Naumannia*, 1858, pp. 116, 117), and *Proc. Zool. Society*, 1858, p. 202, with Wolley's remarks thereon, *Zool. Garten*, 1876, pp. 204–208.

[3] Though this word is clearly not intended as a nickname, such as is the prefix which custom has applied to the Daw, Pie, Redbreast, Titmouse, or Wren, one can only guess at its origin or meaning. It may be as in Jackass, an indication of sex, for it is a popular belief that the Jack-Snipe is the male of the common species; or, again, it may refer to the comparatively small size of the bird, as the "jack" in the game of bowls is the smallest of the balls used, and as fisherman call the smaller Pikes Jacks.

As a group the Snipes are in several respects highly specialized, but here there is only space to mention the sensitiveness of the bill, which, though to some extent noticeable in many Sandpipers (see vol. xxi. p. 272), is in Snipes carried to an extreme by a number of filaments, belonging to the fifth pair of nerves, which run almost to the tip, and open immediately under the soft cuticle in a series of cells that give this portion of the surface of the premaxillaries, when exposed, a honeycomb-like appearance. Thus the bill becomes a most delicate organ of sensation, and by its means the bird, while probing for food, is at once able to distinguish the nature of the objects it encounters, though these are wholly out of sight. So far as is known, the sternum of all the Snipes, except the Jack-Snipe, departs from the normal Limicoline formation, a fact which tends to justify the removal of that species to a separate genus, *Limnocryptes*.[2] (A. N.)

SNORRO STURLUSON (Snorri, son of Sturla) (1179–1241), the celebrated Icelandic historian, born in 1179, the youngest son of a chief in the Vestfirðir (western fiords), was brought up by a powerful chief, Jon Loptsson, in Odda, who seems first to have awakened in him an interest for history and poetry. His career begins with his marriage, which made him a wealthy man; in 1206 he settled at Reykjaholt, where he constructed magnificent buildings and a bath of hewn stones, preserved to the present day, to which water was conducted from a neighboring hot spring. He early made himself known as a poet, especially by glorifying the exploits of the contemporary Norse kings and earls; at the same time he was a learned lawyer, and from 1215 became the "lögsögumaðr" or president of the legislative assembly and supreme court of Iceland. The prominent features of his character seem to have been cunning, ambition, and avarice, combined with want of courage and aversion to effort. By royal invitation he went in 1218 to Norway, where he remained a long time with the young king Hakon and his tutor Earl Skuli. When, owing to disputes between Icelandic and Norwegian merchants, Skuli thought of a military expedition to Iceland, Snorro persuaded him to give up this plan, promising to make the inhabitants submit to Hakon of their own free will. Snorro himself became the "lendrmaðr," vassal or baron, of the king of Norway, and held his lands as a fief under him. On his return home, Snorro sent his son to the king as a hostage, and made peace between Norway and Iceland, but his power and influence were used more for his own enrichment and aggrandizement—he was "lögsögumaðr" again from 1222 to 1232—than for the advantage of the king. Hakon, therefore, stirred up strife between Snorro's kinsman Sturla and Snorro, who had to fly from Reykjaholt in 1236; and in 1237 he left the country and went back to Norway. Here he joined the party of Skuli, who was meditating a revolt. Learning that his cousin Sturla in Iceland had fallen in battle against Gissur, Snorro's son-in-law, Snorro, although expressly forbidden by his liege lord, returned to Iceland in 1239, and once more took possession of his property. Meanwhile Hakon, who had vanquished Skuli in 1240, sent orders to Gissur to punish Snorro for his disobedience, either by capturing him and sending him back to Norway or by putting him to death. Gissur took the latter course, attacked Snorro at his residence, Reykjaholt, and slew him on 22d September, 1241.

Snorro is the author of the *Edda* and of the *Sagas of the Norwegian Kings*. The *Edda*, now called the Prose Edda to distinguish it from the Poetic or Sæmund's Edda, was finished in 1222, and consists of three parts. (1) The *Gylfaginning*, or the Delusion of Gylfi, with a short preface, gives a summary of the ancient Norse mythology, founded on the *Völuspá*, and other mythical poems; the author gives a euhemeristic account of the ancient gods, regarding them as chiefs versed in witchcraft who had immigrated to the north and there introduced their special religion. (2) The *Skáldskaparmál*, or Art of Poetry, gives, under the form of a dialogue between the god Bragi and the giant (jötun) Ægir, an explanation of all figurative mythological expressions of the ancient poetry, and the rules for using them. (3) The *Háttatal*, or Enumeration of Metres, is a running commentary on three poems composed by Snorro in 1222 in honor of Hakon and Skuli, the stanzas of which, numbering about a hundred, are each in a different metre. In the MSS. the *Edda* has received many additions, which are wrongly ascribed to Snorro. For different editions, see EDDA. The *Sagas of the Norwegian Kings* gives a connected series of biographies of the kings of Norway down to Sverri in 1177; here the author stops, because the history of Sverri and his successors had already been written. The work opens with the *Ynglinga Saga*, a brief history of the pretended immigration into Sweden of the Æsir, of their successors in that country, the kings of Upsala, and of the oldest Norwegian kings, their descendants. Next come the biographies of the succeeding Norwegian kings, the most detailed being those of the two missionary kings, Olaf Tryggvason and St. Olaf. Snorro's sources were partly succinct histories of the realm, as the chronological sketch of Ari; partly more voluminous early collections of traditions, as the *Noregs Konungatal* (*Fagrskinna*) and the *Jarlasaga*; partly legendary biographies of the two Olafs; and, in addition to these, studies and collections which he himself made during his journeys in Norway. All these he worked up with great independence and critical sagacity into an harmonious whole. His critical principles are explained in the preface, where he dwells on the necessity of starting as much as possible from trustworthy contemporary sources, or at least from those nearest to antiquity,—the touchstone by which verbal traditions can be tested being contemporary poems. He inclines to rationalism, rejecting the marvellous and recasting legends containing it in a more historical spirit; but he makes an exception in the accounts of the introduction of Christianity into Norway and of the national saint, St. Olaf. Snorro's style is peculiar to himself. He strives everywhere to impart life and vigor to his narrative, to express the sentiments and feelings of the actors, and he gives the dialogues in the individual character of each person. Especially in this last he shows a tendency to epigram, and often uses humorous and pathetic expressions. Besides his principal work, he elaborated in a separate form its better and larger part, the *History of St. Olaf* (the great *Olaf's Saga*). In the preface to this he gives a brief extract of the earlier history and, as an appendix, a short account of St. Olaf's miracles after his death; here, too, he employs critical art, as appears from a comparison with his source, the Latin legend.

The Sagas of the Norwegian Kings has been preserved in several MSS. of the 13th century; the oldest of these, no longer extant, had lost at an early period its first leaf containing the preface, and thus came to begin with the words, *Kringla heimsins* (= orbis terrarum), which caused first this MS. and later (about 1700) the whole work to be called the *Heimskringla*. Editions: By Peringskiöld, 3 vols. fol., Stockholm, 1697; by Gerhard Schöning and Skule Thorlacius, 3 vols. fol., Copenhagen, 1777–1783; by C. R. Unger, 1 vol. 8vo., Christiania, 1868. Modern translations: Into Danish, by N. F. S. Grundtvig, 1818–22; Norwegian, by Jacob Aall, 1838–39, and by P. A. Munch, 1859; Swedish, by Richert, 1816–29, and by H. Hildebrand, 1869–71; German, by Wachter, 1835–36; English, by Laing, 1844. (G. S.†)

SNOW. See METEOROLOGY, vol. xvi. p. 159; also GEOLOGY, vol. x. p. 249.

SNOWDROP, *Galanthus nivalis*, is the best-known representative of a small genus of Amaryllids, all the species of which have bulbs, linear leaves, erect flower-stalks, destitute of leaves but bearing at the top a solitary pendulous bell-shaped flower. The white perianth is six-parted, the outer three segments being larger and more convex than the inner series. The

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[1] His account was published by Hewitson in May, 1855 (*Eggs Br. Birds*, 3d ed., ii. pp. 356–358).

[2] The so-called Painted Snipes, forming the genus *Rhynchæa*, demand a few words. Four species have been described, natives respectively of South America, Africa, India with China, and Australia. In all of these it appears that the female is larger and more brilliantly colored than the male, and in the Australian species she is further distinguished by what in most birds is emphatically a masculine property, though its use is here unknown,—namely, a complex trachea, while the male has that organ simple. He is also believed to undertake the duty of incubation.

six anthers open by pores or short slits. The ovary is three-celled, ripening into a three-celled capsule. The snowdrop is a doubtful native of Great Britain, but is largely cultivated for market in Lincolnshire. There are numerous varieties, differing in the size of the flower and the period of flowering. The double form is probably the least attractive. Other distinct species of snowdrop, not to be confounded with the varieties before mentioned, are the Crimean snowdrop, *G. plicatus*, with broad leaves folded like a fan, and *G. Elwesii*, a native of the Levant, with large flowers, the three inner segments of which have a much larger and more conspicuous green blotch than the commoner kinds. All the species are very graceful, and as universal favorites amply repay cultivation.

SNOW-SHOES are a kind of foot-gear used by Indians and trappers in Canada for travelling over the frozen surface of snow. In the long North American winters they are the sole means of locomotion when railways and roads are snowed up,[1] as the frozen surface of snow is not sufficiently consistent to support the weight of the human body without artificial aid. The snow-shoer protects his feet by wearing moccasins of moose-skin. The framework of a snow-shoe consists of a long narrow piece of pliable hickory wood placed edgeways and then bent round with an oval-shaped front, and is adorned on the sides with tufts of crimson wool. The ends taper gradually to the rear, where they are fastened firmly to each other. The total length is about 39 inches, and the width from 13 to 16 inches. Across the oval, and fitted into the inside of the framework by mortices, are two battens of wood, 5 or 6 inches clear of both ends. Over the front one at an open space a deerskin thong is fastened, forming an aperture for the reception of the great toe. The thong is then crossed over the top of the foot, passed round and tied to the sides. This leaves the heel free to move up and down on the shoe, and rests the weight of it on the toes. Over the remainder of the oval is stretched a network of tightly drawn strips of leather. At a convention held in Montreal on 30th December, 1871, a rule was passed that a "pair of racing shoes, including strings, shall not weigh less than 1½ ℔, nor measure less than 10 inches of gut in width." The motion of a snowshoer in the distance is curious, and resembles that of some ungainly webb-footed animal. On using the implements, the knees must be turned inwards and the forepart of the feet outwards to avoid wounding the ankles with the frameworks. At first the fatigue and consequent stiffness are great; but with practice this wears off and the motions become easy. The speed attained as compared to that in skating is not quick. The following are the best recorded times in Montreal, Canada, with shoes of regulation size and weight: 100 yards, 12 sec.; 220 yards, 26 sec.; ¼ mile, 1 min. 7¾ sec.; ½ mile, 2 min. 33 sec.; ¾ mile, 4 min. 21 sec.; 1 mile, 5 min. 42½ sec.; 2 miles, 11 min. 52¾ sec.; 3 miles, 20 min. 18 sec.; 4 miles, 27 min. 10 sec.; 4½ miles, 30 min. 36 sec.; 5 miles, 33 min. 49½ sec. The best history of the pastime and its records is *Montreal Snowshoe Club*, sm. 8vo., Montreal, 1882.[2]

SNUFF. See TOBACCO.

SNYDERS, FRANZ (1579–1657), painter of animals and still life, was born at Antwerp in 1579. In 1593 he was studying under Peter Breughel, and afterwards he received instruction from Henry van Balen, the first master of Vandyke. He devoted himself to painting flowers, fruit, and subjects of still life, but afterwards turned to animal-painting, and executed with the greatest skill and spirit hunting pieces and combats of wild animals. His composition is rich and varied, his drawing correct and vigorous, his touch bold and thoroughly expressive of the different textures of the furs and skins of the animals represented. His excellence in this department excited the admiration of Rubens, who frequently employed him to paint animals, fruit, and still life in his own pictures, and he assisted Jordaens in a similar manner. In the lion and boar hunts which bear the name of Snyders the hand of Rubens sometimes appears. He was appointed principal painter to the archduke Albert, governor of the Low Countries, for whom he executed some of his finest works. One of these, a Stag-Hunt, was presented to Philip III., who commissioned the artist to paint several subjects of the chase, which are still preserved in Spain. Snyders died at Antwerp in 1657.

SOAP may in general terms be defined as a chemical compound resulting from the union of fatty oils and fats with alkaline bodies. In a scientific definition the compounds of fatty acids with basic metallic oxides, lime, magnesia, lead oxide, etc., should also be included under soap; but, as these compounds are insoluble in water, while the very essence of a soap in its industrial relations is solubility, it is better to speak of the insoluble compounds as "plasters," limiting the name "soap" to the compounds of fatty acids with soda and potash. Soap both as a medicinal and as a cleansing agent was known to Pliny (*H. N.*, xxviii. 51), who speaks of two kinds—hard and soft—as used by the Germans. He mentions it as originally a Gallic invention for giving a bright hue to the hair ("rutilandis capillis"). There is reason to believe that soap came to the Romans from Germany, and that the detergents in use in earlier times and mentioned as soap in the Old Testament (Jer. ii. 22; Mal. iii. 2, etc.) refer to the ashes of plants and other such purifying agents (comp. vol. x. p. 621).

Till Chevreul's classical researches on fatty bodies (1811–23) it was believed that soap consisted simply of a binary compound of fat and alkali. Claude J. Geoffroy in 1741 pointed out that the fat or oil recovered from a soap solution by neutralization with a mineral acid differs from the original fatty substance by dissolving readily in alcohol, which is not the case with ordinary fats and oils. The significance of this observation was overlooked; and equally unheeded was a not less important discovery by Scheele in 1783. In preparing lead plaster by boiling olive oil with oxide of lead and a little water—a process palpably analogous to that of the soap-boiler—he obtained a sweet substance which, called by himself "Oelsüss" ("principium dulce oleorum"), is now known as "glycerin." These discoveries of Geoffroy and Scheele formed the basis of Chevreul's researches by which he laid bare the constitution of oils and the true nature of soap. (See OILS, vol. xvii. p. 761, and GLYCERIN, vol. x. p. 621.) In those articles it is pointed out that all fatty oils and fats are mixtures of glycerides, that is, of bodies related to the alcohol glycerin $C_3H_5(OH)_3$, and some fatty acid such as palmitic acid $(C_{16}H_{31}O_2)H$. Under suitable conditions

$$\underset{\text{Glycerin.}}{C_3H_5(OH)_3} + \underset{\text{Palmitic Acid.}}{3(C_{16}H_{31}O_2)H} \text{ give } \underset{\text{Palmitin.}}{C_3H_5(C_{16}H_{31}O_2)_3} + \underset{\text{Water.}}{3H_2O}$$

The corresponding decomposition of palmitin into palmitic acid and glycerin takes place when the glyceride is distilled in superheated steam, and similarly it can be realized by boiling in water mixed with a suitable proportion of caustic potash or soda. But in this case the fatty acid unites with the alkali into its potash or soda salt, forming a soap—

$$\underset{\text{Palmitin.}}{C_3H_5(C_{16}H_{31}O_2)_3} + \underset{\text{Soda Hydrate.}}{3NaOH} = \underset{\text{Soap.}}{3NaC_{16}H_{31}O_2} + \underset{\text{Glycerin.}}{C_3H_5(OH)_3}$$

Of the natural fats or glycerides contained in oils the most important in addition to palmitin are stearin and olein, and these it may be sufficient to regard as the principal fatty bodies concerned in soap-making.

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[1] [Snow-shoes are used in those parts of Canada, Maine, and the northwestern territories where the country is *not* opened up by railroads and turnpikes, and the population is sparse. They disappear, except for amusement, before modern methods of travel, even on the frontier.—AM. ED.]

[2] [The skid, or Scandinavian snow-shoe, four or five inches wide and from six to sixteen feet long, is in constant use in Norway and Sweden. See Du Chaillu's *Land of the Midnight Sun*, p. 57 *sq.* New York, 1882.—AM. ED.]

The general characters of a soap are a certain greasiness to the touch, ready solubility in water, with formation of viscid solutions which on agitation yield a tenacious froth or "lather," an indisposition to crystallize, readiness to amalgamate with small proportions of hot water into homogeneous slimes, which on cooling set into jellies or more or less consistent pastes. Soaps give an alkaline reaction and have a decided acrid taste; in a pure condition—a state never reached in practice—they have neither smell nor color. Almost without exception potash soaps even if made from the solid fatty acids are "soft," and soda soaps, although made with fluid olein, are "hard"; but there are considerable variations according to the prevailing fatty acid in the compound. Almost all soda soaps are precipitated from their watery solutions by the addition of a sufficiency of common salt. Potash soap with the same reagent undergoes double decomposition—a proportion being changed into a soda soap with the formation of chloride of potassium. Soap when dissolved in a large amount of water suffers hydrolysis, with formation of a precipitate of alkaliferous fatty acid and a solution containing free alkali. Its cleansing power is ordinarily explained by this reaction; but it is difficult to see why a solution which has just thrown off most of its fatty acids should be disposed to take up even a glyceride. It is more likely that the cleansing power of soap is due to the inherent property of its solution to emulsionize fats.

Resin soaps are compounds of soda or potash with the complex acids (chiefly abietic) of which coniferous resins consist. Their formation is not due to a true process of saponification; but they occupy an important place in compound soaps.

MANUFACTURE.—The varieties of soaps made are numerous; the purposes to which they are applied are varied; the materials employed embrace a considerable range of oils, fats, and other bodies; and the processes adopted undergo many modifications. As regards processes of manufacture soaps may be made by the direct combination of fatty acids, separated from oils, with alkaline solutions. In the manufacture of stearin for candles, etc., the fatty matter is decomposed, and the liquid olein, separated from the solid fatty acids, is employed as an ingredient in soap-making. A soap so made is not the result of saponification but of a simple combination, as is the case also with resin soaps. All other soaps result from the combination of fatty oils and fats with potash or soda solutions under conditions which favor saponification. The soap solution which results from the combination forms soap-size and is a mixture of soap with water, the excess alkali, and the glycerin liberated from the oil. In such condition ordinary soft soaps and certain kinds of hard soap are brought to the market. In curd soaps, however, which form the basis of most household soap, the uncombined alkali and the glycerin are separated by "salting out," and the soap in this condition contains about 30 per cent. of water. Soap may be framed and finished in this state, but almost invariably it receives a further treatment called "refining" or "fitting," in which by remelting with water, with or without the subsequent addition of other agents to harden the finished product, the soap may be made to contain from 60 to 70 per cent. of water and yet present a firm hard texture.

Among the raw materials used by the soap-boiler the principal fatty bodies are tallow, lard, palm oil, palm-kernel oil, olive oil, cotton-seed oil, sesame oil, and cocoa-nut oil for hard soaps, and fish oil, linseed oil, marrow fat, and the lower qualities of other oils obtained by extraction, etc., for potash or soft soaps. Almond oil, spermaceti, cocoa-butter, ground-nut oil, and some others form the basis of certain toilet and medicinal soaps. Resin and colophony form essential ingredients in yellow soaps. The alkalis are used almost exclusively in the condition of caustic lyes,—solutions of their respective hydrates in water. Caustic soda is now obtained direct from the soda manufacturer, and one operation, causticizing the soda, is thus spared the soap-boiler. Potash lyes are, however, principally sharpened or causticized by the soap-boiler himself from potash carbonate, the process for which is described under POTASSIUM METALS (vol. xix. p. 606).

The process of soap-boiling is carried out in large iron boilers called "soap pans" or "coppers," some of which have capacity for a charge of 30 tons or more. The pan proper is surmounted by a great cone or hopper called a curb, to provide for the foaming up of the boiling mass and to prevent loss from overflowing. Formerly the pans were heated by open firing from below; but now the almost universal practice is to boil by steam injected from perforated pipes, coiled within the pan, such injection favoring the uniform heating of the mass and causing an agitation favorable to the ultimate mixture and saponification of the materials. Direct firing is used for the second boiling of the soap mixture; but for this superheated steam may with advantage be substituted, either applied by a steam-jacket round the pan or by a closed coil of pipe within it. In large pans a mechanical stirring apparatus is provided, which in some cases, as in Morfit's steam "twirl," is formed of the steam-heating tubes geared to rotate. Closed cylinders in which the materials are boiled under pressure are also employed for certain soaps.

Curd Soap.—The oil mixture used differs in the several manufacturing countries, and the commercial name of the product is correspondingly varied. In Germany tallow is the principal fat; in France olive oil occupies the chief place and the product is known as Marseilles or Castile soap; and in England tallow and palm oil are largely used. But in all countries a mixture of several oils enters into the composition of curd soaps and the proportions used have no fixity. For each ton of soap to be made from 12 to 16 cwts. of oil is required. The soap pan is charged with the tallow or other fat, and open steam is turned on. So soon as the tallow is melted a quantity of weak lye is added, and the agitation of the injected steam causes the fat and lye to become intimately mixed and produces a milky emulsion. As the lye becomes absorbed, a condition indicated by the taste of the goods, additional quantities of lye of increasing strength are added. After some time, the contents of the pan begin to clear and become in the end very transparent. Lye still continues to be poured in till a sample tastes distinctly alkaline,—a test which indicates that the whole of the fatty acids have been taken up by and combined with the alkali. Then without further addition of alkali the boiling is continued for a few minutes, when the soap is ready for salting out or "graining." Either common salt or strong brine in measured quantity is added to the charge, and, the soap being insoluble in such salt solution, a separation of constituents takes place: the soap collects on the surface in an open granular condition, and the spent lye sinks to the bottom after it has been left for a short time to settle. Supposing now that a pure soap without resin is to be made—a product little seen in the market—the spent lye is run off, steam is again turned on, pure water or very weak lye run in, and the contents boiled up till the whole is thin, close, and clear. The soap is from this again grained off or salted out, and the underlye so thrown down carries with it colored impurities which may have been in the materials or which arise from contact with the boiler. Such washing process may have to be repeated several times when impure materials have been used. The spent lye of the washing being drained off, the soap now receives its strengthening boil. Steam is turned on, and, the mass being brought to a clear condition with weak lye or water, strong lye is added and the boiling continued with close steam till the lye attains such a state of concentration that the soap is no longer soluble in it, and it will separate from the caustic lye as from a common salt solution. The contents of the pan are once more allowed to cool and settle, and the soap as now formed constitutes a pure curd soap, carrying with it some proportion of uncombined alkali, but containing the minimum amount of water. It may be skimmed off the underlye and placed direct in the frames for solidification; but that is a practice scarcely at all followed, the addition of resin soap in the pan and the subsequent "crutching in" of silicate of soda and adulterant mixings being features common to the manufacture. The lye from the strengthening boil contains much alkali and is used in connection with other boilings.

Mottled Soap.—A pure curd soap always carries with it into the cooling frame a considerable amount of colored impurity, such as iron sulphate, etc. When it is permitted to cool rapidly the coloring matter remains uniformly disseminated throughout the mass; but when means are taken to cause the soap to cool and solidify slowly a segregation takes place: the stearate and palmitate form a semi-crystalline solid, while the oleate, solidifying more slowly, comes by itself into translucent veins, in which the greater part of the colored matter is drawn. In this way mottled or marbled soap is formed, and such mottled appearance was formerly highly valued as an indication of freedom from excess of water or other adulteration, because in fitted soaps the impurities are either washed out or fall to the bottom of the mass in cooling. Now, however, the most perfect mottle can be produced by working coloring matter into the soap in the frame, and mottling is very far from being a certificate of excellence of quality.

Yellow Soap consists of a mixture of any hard fatty soap with a variable proportion—up to 40 per cent. or more—of resin soap. That substance by itself has a tenacious gluey consistence, and its intermixture in excess renders the resulting compound soft and greasy. The ordinary method of adding resin consists in stirring it in small fragments into the fatty soap in the stage of clear-boiling; but a better result is obtained by separately preparing a fatty soap and the resin soap, and combining the two in the pan after the underlye has been salted out and removed from the fatty soap. The compound then receives its strengthening boil, after which it is fitted by boiling with added water or weak lye, continuing the boil till by examination of a sample the proper consistency has been reached. On settling a dark-colored "nigger" or underlye separates out, which, because it contains some soap and alkali, is saved for future use.

Marine Soap.—Cocoa-nut oil behaves as regards saponification quite differently from all other oils and fats in relation to the caustic alkalies. It does not form an emulsion with weak alkalies; these even under prolonged boiling have no influence on the fat. With strong alkaline solutions, on the other hand, it saponifies with the utmost readiness even without heat, and forms without the separation of any underlye a soap of stiff, firm consistence notwithstanding the presence of a very large percentage of water. Such soap is not insoluble in a strong solution of salt; hence it forms a lather and can be used for washing with sea water, from which peculiarity it derives its name "marine soap." Being thus soluble in salt water it cannot of course be salted out like common soaps; but if a very concentrated salt solution is used precipitation is effected, and a curd soap is separated so hard and refractory as to be practically useless. Cocoa-nut soap is usually prepared by the so-called cold method, in which the fat heated to 80° C. is treated with a calculated quantity of caustic soda solution of sp. gr. 1.350, the two constituents being stirred together till the setting and hardening of the combination prevents further agitation. The property that cocoa-nut soap possesses of absorbing large proportions of water, and yet presenting the appearance of a hard solid body, makes the material a favorite basis for highly sophisticated compounds, in which water, sulphate of soda, and other alkaline solutions, soluble silicates, fuller's earth, starch, etc., play an important and bulky part. Cocoa-nut soap is little prepared by itself; but it forms a principal ingredient in compound soaps meant to imitate curd and yellow soaps. Two principal methods of preparing such compound soaps are employed. In the first way the ordinary oil and the cocoa-nut oil are mixed and saponified together with such a measured quantity of alkaline solution as serves to produce a hard soap without any salting out or separation of underlye. According to the second plan, the ordinary oil is treated as for the preparation of a curd soap, and to this the cocoa-nut soap separately saponified is added in the pan and both are boiled together till they form a homogeneous soap.

Silicate Soaps.—A further means of enabling a soap to contain large proportions of water and yet present a firm consistence is found in the use of silicate of soda. The silicate in the form of a concentrated solution is crutched or stirred into the soap in a mechanical mixing machine after the completion of the saponification, and it appears to enter into a distinct chemical combination with the soap. While silicate soaps bear heavy watering, the soluble silicate itself is a powerful detergent, and it possesses certain advantages when used with hard waters, so that, taking its cheapness into account, the question whether its introduction into soap is a fraud may be fairly discussed and much said in its defence.[1]

Framing.—The frames into which hard soaps are ladled for cooling and solidification consist of rectangular boxes made of iron plates and bound and clamped together in a way that allows the sides to be removed when required. The solidification is a very gradual process, depending, of course, for its completion on the size of the block; but before cutting into bars it is essential that the whole should be set and hardened through and through, else the cut bars would not hold together. Many ingenious devices for forming bars have been produced; but generally a strong frame is used, across which steel wires are stretched at distances equal to the size of the bars to be made, the blocks being first cut into slabs and then into bars.

Soft Soap.—As already said, soft soaps are made with potash lyes, although in practice a small quantity of soda is also used to give the soap some consistence. There is no separation of underlyes in potash soap, consequently the product contains the whole constituents of the oils used, as the operation of salting out is quite impracticable owing to the double decomposition which results from the action of salt, producing thereby a hard principally soda soap with formation of chloride of potassium. Owing to this circumstance it is impossible to "fit" or in any way purify soft soap, and all impurities which go into the pan of necessity enter into the finished product. The making of soft soap, although thus a much less complex process than hard soap making, is one that demands much skill and experience for its success. From the conditions of the manufacture care must be taken to regulate the amount and strength of the alkali in proportion to the oil used, and the degree of concentration to which the boiling ought to be continued has to be determined with close observation.

Toilet Soaps, etc.—Soaps used in personal ablution in no way differ from the soaps previously alluded to, and may consist of any of the varieties. It is of consequence that they should, as far as possible, be free from excess of alkali and all other salts and foreign ingredients which may have an injurious effect on the skin. The manufacturer of toilet soap generally takes care to present his wares in convenient form and of agreeable appearance and smell; the more weighty duty of having them free from uncombined alkali is in many cases entirely overlooked. Transparent soaps are prepared by dissolving ordinary soap in strong alcohol and distilling off the greater portion of the alcohol till the residue comes to the condition of a thick transparent jelly. This, when cast into forms and allowed to harden and dry slowly, comes out as transparent soap. A class of transparent soap may also be made by the cold process, with the use of cocoa-nut oil, castor oil, and sugar. It generally contains a large amount of uncombined alkali, and that, with its unpleasant odor of cocoa-nut oil, makes it a most undesirable soap for personal use. Toilet soaps of common quality are perfumed by simple melting and stirring into the mass some cheap odorous body that is not affected by alkalies under the influence of heat. The finer soaps are perfumed by the cold method; the soap is shaved down to thin slices, and the essential oil kneaded into and mixed with it by special machinery, after which it is formed into cakes by pressure in suitable moulds.

Glycerin soap ordinarily consists of about equal parts of pure hard soap and glycerin (the latter valuable for its emollient properties). The soap is melted by heat, the glycerin is stirred in, and the mixture strained and poured into forms, in which it hardens but slowly into a transparent mass. With excess of glycerin a fluid soap is formed, soap being soluble in that body, and such fluid soap has only feeble lathering properties. Soap containing small proportions of glycerin, on the other hand, forms a very tenacious lather, and when soap bubbles of an enduring character are desired glycerin is added to the solution. Soaps are also prepared in which large proportions of fine sharp sand, or of powdered pumice, are incorporated, and these substances, by their abrading action, powerfully assist the detergent influence of the soap on hands much begrimed by manufacturing operations.[2]

Medicated Soaps contain certain substances which exercise a specific influence on the skin. A few medicated soaps are prepared for internal use, among which are croton soap and jalap soap, both gentler cathartics than the uncompounded medicinal principles. Medicated soaps for external use are only employed in cases of skin ailments and as prophylactic washes. Among the principal varieties are those which contain carbolic acid, petroleum, borax, camphor, chlorine, iodine, mercurial salts, sulphur, and tannin. Arsenical soap is very much employed by taxidermists for the preservation of the skins of birds and mammals. It consists of a mixture of white arsenic, hard soap, and slaked lime, say 4 oz. of each, with 12 oz. of carbonate of potash, the whole being made into a stiff paste with water.

The following table indicates the average composition of several commercial soaps:

	Water.	Fatty Acid.	Soda.		Potash.	Soluble Silica.	Glycerin.	Other Salts.	Loss.
			Combined.	Free.					
Tallow soap.........	28.8	58.0	6.8	1.6	...	...	...	2.3	2.5
Marseilles soap, mottled............	10.15	76.0	8.65	0.25	...	...	...	4.95	
Palm-oil soap.......	35.4	49.9	7.0	1.0	...	...	...	1.1	5.6
Yellow soap.........	22.23	62.95[3]	8.03	...	...	...	...	6.79	
Cocoa-nut oil soap	58.74	32.82	4.26	1.50	...	...	...	2.26	0.42
Silicate soap.........	50.4	5.5	10.7	...	...	33.4	...	...	...
Soft soap.............	48.3	41.9	...	...	10.2	...	4.6	...	...

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[1] [Borax also has a commercial value as a detergent ingredient of certain soaps. See BORAX, vol. iv. p. 45.—AM. ED.]

[2] "Soap powders" and "soap extracts" are simply preparations of alkalies.

[3] Including resin acids.

Soap Analysis.—Here it will be sufficient to mention a few tests which can be executed without special chemical knowledge. To determine the water in a soap—a most important question—a few thin slices are weighed and dried in a stove at 105° C. so long as loss of weight continues. The loss of weight is the measure of uncombined water in the sample. Added salts, such as alkaline silicates, sulphates, etc., and insoluble earthy admixtures are detected by boiling a sample with alcohol, in which only the soap proper dissolves. The residue is collected in a filter, washed with hot alcohol, and weighed. An excessive proportion of surplus alkali can be detected by dissolving the soap in hot water and adding a sufficiency of saturated solution of common salt to salt it out. The alkali remains in solution and can be determined by the amount of a standard acid solution it neutralizes.

Commerce.—Marseilles has long been recognized as the most important centre of the soap trade, a position that city originally achieved through its ready command of the supplies of olive oil. The city is still very favorably situated for obtaining supplies of oils both local and foreign, including sesame, ground nut, castor oil, etc. In England the soap trade did not exist till the 16th century. In the reign of Charles I. a monopoly of soap-making was farmed to a corporation of soap-boilers in London,—a proceeding which led to serious complications. From 1712 to 1853 an excise duty ranging from 1d. to 3d. [2 to 6 cts.] was levied on soap made in the United Kingdom, and that heavy impost (equal when 3d. [6 cts.] to more than 100 per cent.) greatly impeded the development of the industry. In 1793, when the excise duty was 2¼d. [4½ cts.] on hard and 1¾d. [3½ cts.] on soft soap, the revenue yielded was a little over £400,000 [$1,944,000]; in 1815 it was almost £750,000 [$3,645,000]; in 1835, when the duty was levied at 1½d. and 1d. [3 and 2 cts.] respectively (and when a drawback was allowed for soap used in manufactures), the revenue was almost £1,000,000 [$4,860,000]; and in 1852, the last year in which the duty was levied, it amounted to £1,126,046 [$5,472,583.56], with a drawback on exportation amounting to £271,000 [$1,317,060]. What the manufacture has risen to since that time there is no accurate way of estimating.

(W. D.—J. PA.)

SOAP BARK. A vegetable principle known as "saponin," and chemically analogous to the arabin of soluble gums and to mucilage, forms with water a lather, and is on that account available as a substitute for soap. Saponin is obtainable from soap nuts, the fruit of a tree, *Saponaria officinalis* and allied species; but its most important source is the Quillai bark of Chili yielded by a large tree, *Quillaja saponaria.* The inner bark of the tree, reduced to powder, is employed in Chili and elsewhere as a substitute for soap.

SOBIESKI, JOHN, king of Poland. See JOHN III., vol. xiii. p. 725, and POLAND, vol. xix. pp. 307–8.

SOCAGE is a form of tenure. Bracton, Britton, and other old writers derived the word from the French *soc*, "a ploughshare." Modern etymologists, however, prefer to derive it from the Old English *soc*, "a franchise" or "privilege," or the land over which such franchise or privilege was exercised. Socage differs from knight service in being agricultural rather than military in its nature, and from frankalmoign in being based on temporal rather than spiritual services. It is either free or villein. Free socage *in capite* was abolished by 12 Car. II. c. 24. That form of free socage called common socage is the ordinary modern freehold tenure. Varieties of it are burgage, gavelkind, and petit serjeanty. Scutage, while it existed, was another variety. The only representative of villein socage is the comparatively rare tenure of ancient demesne confined to manors, described in Domesday Book as *terræ regis.* Socage tenure is said to have formerly existed in Scotland. The descent of socage lands in Scotland seems to have been to all the sons equally, as was originally the case in England. (See BURGAGE, GAVELKIND, REAL ESTATE, SCUTAGE.)

SOCIALISM.[1]

Origin of name.

THE word "socialism" is of comparatively recent origin, having been coined in England in 1835. In that year a society which received the grandiloquent name of the "Association of all Classes of all Nations" was founded under the auspices of Robert Owen; and the words "socialist" and "socialism" were first used during the discussions which arose in connection with it. As Owen and his school had no esteem for the political reform of the time, and laid all emphasis on the necessity of social improvement and reconstruction, it is obvious how the name came to be recognized as suitable and distinctive. The term was borrowed from England by a distinguished French writer, Reybaud, in his well-known work the *Reformateurs modernes* (1839), in which he discussed the theories of Saint-Simon, Fourier, and Owen. Through Reybaud it soon gained wide currency on the Continent, and is now the accepted world-historic name for one of the most remarkable movements of the 19th century.

Vague usage of current speech.

The name was thus first applied in England to Owen's theory of social reconstruction, and in France to those also of Saint-Simon and Fourier. The best usage has always connected it with the views of these men and the cognate opinions which have since appeared. The word, however, is used with a great variety of meaning not only in popular speech and by politicians but even by economists and learned critics of socialism. The general tendency is to regard as socialistic any interference with property undertaken by society on behalf of the poor, the limitation of the principle of *laissez-faire* in favor of the suffering classes, radical social reform which disturbs the present system of private property as regulated by free competition. It is probable enough that the word will be permanently used to express the tendency indicated in these phrases, as a general name for the strong reaction that has now set in against the overstrained individualism and one-sided freedom which date from the latter half of the 18th century. The application is neither precise nor accurate; but it is use and wont that determine the meaning of words, and this seems to be the tendency of use and wont.

Definitions of leading writers.

Even economic writers differ greatly in the meaning they attach to the word. The great German economist Roscher defines it as including "those tendencies which demand a greater regard for the common weal than consists with human nature." Adolf Held says that "we may define as socialistic every tendency which demands the subordination of the individual will to the community." Janet more precisely defines it as follows: "We call socialism every doctrine which teaches that the state has a right to correct the inequality of wealth which exists among men and to legally establish the balance by taking from those who have too much in order to give to those who have not enough, and that in a permanent manner, and not in such and such a particular case,—a famine, for instance, a public calamity, etc." Laveleye explains it thus: "In the first place every socialistic doctrine aims at introducing greater equality in social conditions, and in the second place at realizing those reforms by the law or the state." Von Scheel simply defines it as the "economic philosophy of the suffering classes." Of all these definitions it can only be said that they more or less faithfully reflect current opinion as to the nature of socialism. They are either too vague or they are misleading, and they quite fail to bring out the clear and strongly marked characteristics that distinguish the phenomena to which the name of socialism is properly applied. To say that socialism exacts a greater regard for the common weal than is compatible with human nature is to pass sentence on the movement, not to define it. In all ages of the world, and under all forms and tendencies of government and of social evolution, the will of the individual has been subordinated to the will of society, often unduly so. It is also most misleading to speak as if socialism must proceed from the state as we know it. The early socialism proceeded from private effort and experiment. A great deal of the most notorious socialism of the present day aims not only at subverting the existing state in every form but all the existing political and social institutions. The most powerful and most philosophic, that of Karl Marx, aimed at superseding the existing governments by a vast international combination of the workers of all nations, without distinction of creed, color, or nationality.

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[1] The aim of the present article is essentially to give a history and exposition of socialism in its leading phases and principles. The point of view is objective,—to explain what socialism has been and is. A controversial or critical article on the many vexed questions suggested by the subject would have been inconsistent with the plan of this work.

Socialism not essentially violent and lawless.

Still more objectionable, however, is the tendency not unfrequently shown to identify socialism with a violent and lawless revolutionary spirit. As sometimes used, "socialism" means nothing more nor less than the most modern form of the revolutionary spirit with a suggestion of anarchy and dynamite. This is to confound the essence of the movement with an accidental feature more or less common to all great innovations. Every new thing of any moment, whether good or evil, has its revolutionary stage in which it disturbs and upsets the accepted beliefs and institutions. The Protestant Reformation was for more than a century and a half the occasion of national and international trouble and bloodshed. The suppression of American slavery could not be effected without a tremendous civil war. There was a time when the opinions comprehended under the name of "liberalism" had to fight to the death for toleration; and representative government was at one time a revolutionary innovation. The fact that a movement is revolutionary generally implies only that it is new, that it is disposed to exert itself by strong methods, and is calculated to make great changes. It is an unhappy feature of most great changes that they have been attended with the exercise of force, but that is because the powers in possession have generally attempted to suppress them by the exercise of force.

Its central principle economic.

In point of fact socialism is one of the most elastic and protean phenomena of history, varying according to the time and circumstances in which it appears and with the character and opinions and institutions of the people who adopt it. Such a movement cannot be condemned or approved *en bloc*. Most of the current formulæ to which it has been referred for praise or censure are totally erroneous and misleading. Yet in the midst of the various theories that go by the name of "socialism" there is a kernel of principle that is common to them all. That principle is of an economic nature, and is most clear and precise. The central aim of socialism is to terminate the divorce of the workers from the natural sources of subsistence and of culture. The socialist theory is based on the historical assertion that the course of social evolution for centuries has gradually been to exclude the producing classes from the possession of land and capital and to establish a new subjection, the subjection of workers, who have nothing to depend on but precarious wage-labor. The socialists maintain that the present system (in which land and capital are the property of private individuals freely struggling for increase of wealth) leads inevitably to social and economic anarchy, to the degradation of the working man and his family, to the growth of vice and idleness among the wealthy classes and their dependants, to bad and inartistic workmanship, and to adulteration in all its forms; and that it is tending more and more to separate society into two classes,—wealthy millionaires confronted with an enormous mass of proletarians,—the issue out of which must either be socialism or social ruin. To avoid all these evils and to secure a more equitable distribution of the means and appliances of happiness, the socialists propose that land and capital, which are the requisites of labor and the source of all wealth and culture, should become the property of society, and be managed by it for the general good. In thus maintaining that society should assume the management of industry and secure an equitable distribution of its fruits socialists are agreed, but in the most important points of detail they differ very greatly.

Points of difference amongst socialists.

They differ as to the form society will take in carrying out the socialist programme, as to the relation of local bodies to the central government, and whether there is to be any central government, or any government at all in the ordinary sense of the word, as to the influence of the national idea in the society of the future, etc. They differ also as to what should be regarded as an "equitable" system of distribution. The school of Saint-Simon advocated a social hierarchy in which every man should be placed according to his capacity and rewarded according to his works. In the communities of Fourier the minimum of subsistence was to be guaranteed to each out of the common gain, the remainder to be divided between labor, capital, and talent,—five-twelfths going to the first, four-twelfths to the second, and three-twelfths to the third. At the revolution of 1848 Louis Blanc proposed that remuneration should be equal for all members of his *social workshops*. In the programme drawn up by the united social democrats of Germany (Gotha, 1875) it is provided that all shall enjoy the results of labor "according to their reasonable wants," all of course being bound to work. It is needless to say also that the theories of socialism have been held in connection with the most varying opinions in philosophy and religion. A great deal of the historic socialism has been regarded as a necessary implicate of idealism. Most of the prevailing socialism of the day is based on the frankest and most outspoken revolutionary materialism. On the other hand, many socialists hold that their system is a necessary outcome of Christianity, that socialism and Christianity are essential the one to the other; and it should be said that the ethics of socialism are closely akin to the ethics of Christianity, if not identical with them.

Great changes implied in socialism.

Still it should be insisted that the basis of socialism is economic, involving a fundamental change in the relation of labor to land and capital,—a change which will largely affect production, but will entirely revolutionize the existing system of distribution. But, while its basis is economic, socialism implies and carries with it a change in the political, ethical, technical, and artistic arrangements and institutions of society which would constitute a revolution greater probably than has ever taken place in human history, greater than the transition from the ancient to the mediæval world, or from the latter to the existing order of society. In the first place, such a change generally assumes as its political complement the most thoroughly democratic organization of society. The early socialism of Owen and Saint-Simon was marked by not a little of the autocratic spirit; but the tendency of the present socialism is more and more to ally itself with the most advanced democracy. Socialism, in fact, claims to be the economic complement of democracy, maintaining that without a fundamental economic change political privilege has neither meaning nor value. In the second place, socialism naturally goes with an unselfish or altruistic system of ethics. The most characteristic feature of the old societies was the exploitation of the weak by the strong under the systems of slavery, serfdom, and wage-labor. Under the socialistic régime it is the privilege and duty of the strong and talented to use their superior force and richer endowments in the service of their fellow-men without distinction of class or nation or creed. In the third place, socialists maintain that under their system and no other can the highest excellence and beauty be realized in industrial production and in art, whereas under the present system beauty and thoroughness are alike sacrificed to cheapness, which is a necessity of successful competition. Lastly, the socialists refuse to admit that individual happiness or freedom or character would be sacrificed under the social arrangements they propose. They believe that under the present system a free and harmonious development of individual capacity and happiness is possible only for the privileged minority, and that socialism alone can open up a fair opportunity for all. They believe, in short, that there is no opposition whatever between socialism and individuality rightly understood, that these two are complements the one of the other, that in socialism alone may every individual have hope of free development and a full realization of himself.

Essence of socialism.

Having seen, then, how wide a social revolution is implied in the socialistic scheme of reconstruction, let us repeat (1) that the essence of the theory consists in this—associated production with a collective capital with the view to an equitable distribution. In the words of Schäffle, "the Alpha and Omega of socialism is the transformation of private competing capitals into a united collective capital" (*Quintessenz des Socialismus*). A. Wagner's more elaborate definition of it (in his *Grundlegung*) is entirely in agreement with that of Schäffle. This is the principle on which all the schools of socialism, however opposed otherwise, are at one. Such a system, while insisting on collective capital (including land), is quite consistent with private property in other forms, and with perfect freedom in the use of one's own share in the equitable distribution of the produce of the associated labor. A thoroughgoing socialism demands that this principle should be applied to the capital and production of the whole world; only then can it attain to supreme and perfect realization. But a sober-minded socialism will admit that the various intermediate stages in which the principle finds a partial application are so far a true and real development of the socialistic idea. (2) Socialism is both a theory of social evolution and a working force in the history of the 19th century. Some of the most eminent socialists, such as Rodbertus, regard their theory as a prophecy concerning the social development of the future rather than as a subject of agitation. In their view socialism is the next stage in the evolution of society, destined after many generations to supersede capitalism, as capitalism displaced feudalism and feudalism succeeded to slavery. Even the majority of the most active socialists consider the question as still in the stage of agitation and propaganda, their present task being that of enlightening the masses until the consummation of the present social development, and the declared bankruptcy of the present social order, shall have delivered the world into their hands. Socialism, therefore, is for the most part a theory affecting the future, more or less remote, and has only to a limited degree gained a real and practical footing in the life of our time. Yet it should not be forgotten that its theories have most powerfully affected all the ablest recent economic writers of Germany, and have even considerably modified German legislation. Its influence is rapidly growing among the lower and also among the most advanced classes in almost every country dominated by European culture, following as a destroying negation the development of capitalism. (3) In its doctrinal aspects socialism is most interesting as a criticism of the present economic order, of what socialists call the capitalistic system, with which the existing land system is connected. Under the present economic order land and capital (the material and instruments without which industry is impossible) are the property of a class, employing a class of wage-laborers handicapped by their exclusion from land and capital. Competition is the general rule by which the share of the members of those classes in the fruits of production is determined. Against this system critical socialism is a reasoned protest; and it is at issue also with the prevailing political economy, in so far as it assumes or maintains the permanence or righteousness of this economic order. Of the economic optimism implied in the historic doctrine of *laissez-faire* socialism is an uncompromising rejection. (4) Socialism is usually regarded as a phase of the struggle for the emancipation of labor, for the complete participation of the working classes in the material, intellectual, and spiritual inheritance of the human race. This is certainly the most substantial and most prominent part of the socialist programme, the working classes being the most numerous and the worst sufferers from the present régime. This view, however, is rather one-sided, for socialism claims not less to be in the interest of the small capitalist gradually crushed by the competition of the larger, and in the interest also of the large capitalist, whose position is endangered by the huge unmanageableness of his success, and by the world-wide economic anarchy from which even the greatest are not secure. Still it is the deliverance of the working class that stands in the front of every socialistic theory; and, though the initiative in socialist speculation and action has usually come from the middle and upper classes, yet it is to the working men that they generally appeal.

While recognizing the great confusion in the use of the word "socialism," we have treated it as properly a phenomenon of the 19th century, beginning in France with Saint-Simon and Fourier, in England with Robert Owen, and most powerfully represented at the present day by the school of Karl Marx. As we have seen, however, there are definitions of the word which would give it a wider range of meaning and a more ancient beginning, compared with which capitalism is but of yesterday,—which would, in fact, make it as old as human society itself. In the early stages of human development, when the tribe or the village community was the social unit, the subordination of the individual to the society in which he dwelt was the rule, and common property was the prevalent form. In the development of the idea of property, especially as regards land, three successive historical stages are broadly recognized,—common property and common enjoyment of it, common property and private enjoyment, private property and private enjoyment. The last form did not attain to full expression till the end of the 18th century, when the principle of individual freedom, which was really a reaction against privileged restriction, was proclaimed as a positive axiom of government and of economics. The free individual struggle for wealth and for the social advantages dependent on wealth is a comparatively recent thing. In all periods of history the state reserved to itself the right to interpose in the arrangements of property,—sometimes in favor of the poor, as in the case of the English poor law, which may thus be regarded as a socialistic measure. Moreover, all through history revolts in favor of a rearrangement of property have been very frequent. And in the societies of the Catholic Church we have a permanent example of common property and a common enjoyment of it.

Early forms.

How are we to distinguish the socialism of the 19th century from these old-world phenomena, and especially from the communism[1] which has played so great a part in history? To this query socialists, especially of the school of Marx, have a clear and precise answer. Socialism is a stage in the evolution of society which could not arrive till the conditions necessary to it had been established.

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[1] As used in current speech, and also in economics, no very definite line of distinction between communism and socialism

Genesis of socialism.

The first and most essential of these was the development of the great industrialism which after a long period of preparation and gradual growth began to reach its culminating point with the inventions and technical improvements, with the application of steam and the rise of the factory system, in England towards the end of the 18th century. Under this system industry was organized into a vast social operation, and was thus already socialized; but it was a system that was exploited by the individual owner of the capital at his own pleasure and for his own behoof. Under the pressure of the competition of the large industry, the small capitalist is gradually crushed out, and the working producers become wage-laborers organized and drilled in immense factories and workshops. The development of this system still continues and is enveloping the whole world. Such is the industrial revolution. Parallel with this a revolution in the world of ideas equally great and equally necessary to the rise of socialism has taken place. This change of thought which made its world-historic announcement in the French Revolution made reason the supreme judge and had freedom for its great practical watchword. It was represented in the economic sphere by the school of Adam Smith.

Saint-Simon, Owen.

Socialism was an outcome of it too, and first of all in Saint-Simon and his school professed to give the positive and constructive corrective to a negative movement which did not see that it was merely negative and therefore temporary. In other words, Saint-Simon may be said to aim at nothing less than the completion of the work of Voltaire, Rousseau, and Adam Smith. Thus socialism professes to be the legitimate child of two great revolutions,—of the industrial revolution which began to establish itself in England towards the end of the 18th century, and of the parallel revolution in thought which about the same time found most prominent expression in France. Robert Owen worked chiefly under the influence of the former; Saint-Simon and Fourier grew up under the latter. The conspiracy of Babeuf is properly to be regarded as a crude revolutionary communism not essentially different from the rude efforts in communism made in earlier periods of history. With Saint-Simon and Owen historic socialism really begins, and is no longer an isolated fact, but has had a continuous and widening development, the succession of socialistic teaching and propaganda being taken up by one country after another throughout the civilized world.

We have seen, then, that the rise of socialism as a new and reasoned theory of society was relative to the industrial revolution and to the ideas proclaimed in the French Revolution, prominent among which, besides the much emphasized idea of freedom and the less easily realized ideals of equality and fraternity, was the conception of the worth and dignity of labor. Though Owen was most largely influenced by the former and Saint-Simon and Fourier by the latter, it is certain that all three were greatly affected by both the new movements. The motive power in Owen's career was the philanthropy and humanitarianism of the 18th century. He had grown up in the midst of the industrial revolution; he was one of the most successful pioneers in the improvement of the cotton manufacture. No one could be more deeply conscious of the enormous abuses of the factory system; and no one better knew the wonderful services it could render if technical improvement were only made subordinate to human well-being. In the career of Owen we see the new spirit of the 18th century seeking to bring the mechanism of the new industrial system under the direction of a nobler principle, in which the good of all should be the great and sole aim. The position of Saint-Simon was considerably different, yet akin. As Owen had before his eyes the evils of a young but gigantic industrialism, Saint-Simon contemplated the hoary abuses of an idle and privileged feudalism, fearfully shaken no doubt by the Revolution, but still strong in Europe, and in France as elsewhere powerfully revived during the period after Waterloo. Saint-Simon saw that a new world, an industrial world resting on labor, had arisen, while the old feudal and theological world—*fainéant* courtiers and a clergy steeped in ignorance—still ruled. All this array of parasites, who had no longer any useful function to perform for society, Saint-Simon sought to replace by the industrial chiefs and scientific leaders as the real working heads of the French people. Only he expected that these exceptionally gifted men, instead of exploiting the labor of others, should control an industrial France for the general good. Neither Owen nor Saint-Simon was revolutionary in the ordinary sense. Owen was most anxious that the English and other Governments should adopt his projects of socialistic reform. Leading statesmen and royal personages befriended him. He had no faith in the political reforms of 1832; he reckoned the political side of chartism as of no account, and he preferred socialistic experiment under autocratic guidance until the workmen should be trained to rule themselves. The same autocratic tendency was very pronounced in Saint-Simon and his school. His first appeal was to Louis XVIII. He wished to supersede the feudal aristocracy by a working aristocracy of merit. His school claim to have been the first to warn the Governments of Europe of the rise of revolutionary socialism. (For further information as to Saint-Simon and his school, see SAINT-SIMON.) The good and bad aspects of the Saint-Simon socialism are too obvious to require elucidation in this article. The antagonism between the old economic order and the new had only begun to declare itself. The extent and violence of the disease were not yet apparent; both diagnosis and remedy were superficial and premature. Such deep-seated organic disorder was not to be conjured away by the waving of a magic wand. The movement was all too utopian and extravagant in much of its activity. The most prominent portion of the school attacked social order in its essential point—the family morality—adopting the worst features of a fantastic, arrogant, and prurient sacerdotalism, and parading them in the face of Europe. Thus it happened that a school which attracted so many of the most brilliant and promising young men of France, which was so striking and original in its criticism of the existing condition of things, which was so strong in the spirit of the initiative, and was in many ways so noble, unselfish, and aspiring, sank amidst the laughter and indignation of a scandalized society.

Outlines of its history.

The beginning of socialism may be dated from 1817, the year when Owen laid his scheme for a socialistic community before the committee of the House of Commons on the poor law, the year also that the speculations of Saint-Simon definitely took a socialistic direction. The outlines of the history of socialism are very simple. Till 1850 there was a double movement in France and England. In the former country after Saint-Simon and Fourier the movement was represented chiefly by Proudhon and Louis Blanc. In England after Owen the movement was taken up by the body of Christian socialists associated with Maurice and Kingsley. The more recent socialism is due chiefly to German and also Russian thinkers, but is generally international both in sympathy and activity.

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can be drawn. Generally speaking, communism is a term for a system of common property, and this should be accepted as the reasonably correct usage of the word; but even by socialists it is frequently used as practically synonymous with socialism. Collectivism is a word which has recently come into vogue to express the economic basis of socialism as above explained.

Fourier. Considered as a purely literary and speculative product, the socialism of Fourier was prior to those of both Owen and Saint-Simon. His great work, *Théorie des Quatre Mouvements*, was published as early as 1808. The socialism of Fourier, however, scarcely attracted any attention and exercised no influence till those of Owen and Saint-Simon were on the decline. His system is one in which the wildest fantasy is mixed with ingenious theory and the most searching criticism of the present competitive system; even yet it is almost unrivalled in pungency and effectiveness. The pantheistic conception of the world which underlay the Saint-Simonian theory of the "rehabilitation of the flesh" formed the basis also of the social ethics and arrangements of Fourier. According to Fourier, evil is the artificial product and attendant of civilization, the result of perverted human institutions, which have run counter to the ordinances of the Creator in pronouncing passions and affections to be bad which are simply natural. Between the creature and the Creator there have been 5000 years of misunderstanding. There is but one way of removing this misunderstanding,—to give a free and healthy and complete development to our passions. This Fourier sought to accomplish in his *phalanges*, which, united in a system of free federation, would, as he believed, soon cover the world (see FOURIER).

Revolution of 1830. The year 1830 was an important turning-point in the history of socialism. During the fermentation of that time the activity of the Saint-Simon school came to a crisis, and the ideas of Fourier had an opportunity of taking practical effect. Some of the Saint-Simonians joined him. The movement in France was short-lived; and the numerous experiments tried in America were not more successful. One of the most notable societies suggested by Fourier's influence, but entirely free from his immoral tendencies, was Brook Farm, established by George Ripley and other cultured Americans in 1840. A most praiseworthy and successful institution also suggested by the teaching of Fourier is the *Familistère* at Guise (Aisne) conducted by M. Godin. But by far the greatest result of the revolution of 1830 was the definite establishment of the contrast between the bourgeoisie and the proletariat. Hitherto these two classes had fought side by side against feudalism and the reaction. The bourgeoisie were now rulers, and the proletariat became the revolutionary party, the first outbreak under the new conditions taking place at Lyons in 1831, when the starving workmen rose to arms with the device, "Live working or die fighting." During the latter half of the reign of the bourgeois king Louis Philippe, Paris became more than ever the centre of socialistic fermentation. In 1839 Louis Blanc published his *Organization du Travail*, and Cabet his *Voyage en Icarie*. In 1840 Proudhon published his book on property. At this period Paris counted among her visitors Lassalle, the founder of the social democracy of Germany; Karl Marx, the chief of scientific international socialism; and Bakunin, the apostle of anarchism.

Louis Blanc. The socialism of Saint-Simon and Fourier was largely speculative, imaginative, and utopian, and had only a very remote connection with the practical life of their time. With Louis Blanc (1811–1882) socialism came into real contact with the public history of France. The most conspicuous feature of Louis Blanc's teaching was that he demanded the democratic organization of the state as preparatory to social reorganization. His system, therefore, had a positive and practical basis, in so far as it allied itself to a dominant tendency in the existing state. Louis Blanc was an eminent journalist, born at Madrid, where his father had a high post on the finances of King Joseph. His celebrated work on socialism, *Organisation du Travail*, exerted a very large influence on the thought of France. The formula of progress, says Louis Blanc, is double in its unity,—moral and material amelioration of the lot of all by the free co-operation of all and their fraternal association. He saw, however, that the great end of social reform could not be attained without political reform. It was not enough to discover the true methods for inaugurating the principle of association and the organization of labor according to the rules of reason, justice, and humanity. It was necessary to have political power on the side of social reform, political power resting on the chambers, on the tribunals, and on the army; not to take it as an instrument was to meet it as an obstacle. For these reasons he wished to see the state constituted on a thoroughly democratic basis as the first condition of success. He demanded that the state thus reformed should establish associations, which he called *social workshops*, for co-operative production. The money should be provided by the state, which also should draw up the rules. The state should appoint the functionaries for the first year. After that the workmen should elect their own managers. "Though the false and anti-social education given to the present generation makes it difficult to find any other motive of emulation and encouragement than a higher salary, the wages will be equal, as the ideas and character of men will be changed by an absolutely new education." Louis Blanc hoped that private firms would not be able to exist under the competition of such associations, and that the latter would in time absorb all the production of the country. Notwithstanding the influence exerted by Louis Blanc and the working men's party in the provisional Government of 1848, it cannot be said that his plans obtained a fair hearing or a fair trial. His schemes were certainly not carried out in the national workshops of that year. These were really a travesty of Louis Blanc's proposals, instituted expressly to discredit them. They were simply means of finding work for a motley proletariat thrown out of employment during the period of revolutionary disturbance; and these men were put to unproductive work, whereas of course Louis Blanc contemplated nothing but productive work, and the men he proposed to invite to join his associations were to give guarantees of character. The months following the revolution of February were, moreover, a period of industrial stagnation and insecurity, when any new project of trade, either on the old or new lines, had very little prospect of success. This remark applies largely also to the private associations for co-operative production subsidized by the republican Government. These were more closely akin to the plans of Louis Blanc; but to them also the times were unfavorable, and the help given them was both scanty and injudicious. As one of the leaders during this difficult crisis Louis Blanc had neither personal force nor enduring political influence sufficient to secure any considerable success for his cause. He was an amiable and genial enthusiast, but without weight enough to be a controller of men on a wide scale. The labor conferences at the Luxembourg, over which he presided, ended also as his opponents desired, without any tangible result. The proletariat at Paris, incensed at the closing of the national workshops, rose in armed insurrection which was overthrown by Cavaignac in the sanguinary days of June (see CAVAIGNAC). Louis Blanc was in no way implicated in the revolt, but he found it necessary to go into exile in England. With the bloodshed of the days of June French socialism ceased for a time to be a considerable force. Socialism in the true acceptation of the word was indeed only partially responsible for the insurrection. It was a rising of a proletariat not particularly versed in theories of social reconstruction, but deeply incensed at the reactionary measures of their rulers. Inasmuch, however, as it destroyed the most enterprising leaders of the workmen and quelled the spirit of the remainder, it thoroughly repressed the tendency to innovation amongst them for a long time to come, while the false prosperity of the second empire removed their most crying grievances. Under Napoleon III. there was consequently comparative quietness in France. Even the International had very little influence on French soil, though French workingmen had an important share in starting it.

England.

Owen.

Compared with the parallel movement in France the early socialism of England had an uneventful history (see OWEN). In order to appreciate the significance of Owen's work it is necessary to recall some of the more important features of the social condition of the country in his time. The English worker had no fixed interest in the soil. He had no voice either in local or national government. He had little education or none at all. His dwelling was wretched in the extreme. The right even of combination was denied him till 1824. The wages of the agricultural laborer were miserably low. The workman's share in the benefits of the industrial revolution was doubtful. Great numbers of his class were reduced to utter poverty and ruin by the great changes consequent on the introduction of improved machinery; the tendency to readjustment was slow and continually disturbed by fresh change. The hours of work were mercilessly long. He had to compete against the labor of women, and of children brought frequently at the age of five or six from the workhouses. These children had to work the same long hours as the adults, and they were sometimes strapped by the overseers till the blood came. Destitute as they so often were of parental protection and oversight, with both sexes huddled together under immoral and insanitary conditions, it was only natural that they should fall into the worst habits, and that their offspring should to such a lamentable degree be vicious, improvident, and physically degenerate. In a country where the laborers had neither education nor political or social rights, and where the peasantry were practically landless serfs, the old English poor-law was only a doubtful part of an evil system. All these permanent causes of mischief were aggravated by special causes connected with the cessation of the Napoleonic wars, which are well known. It was in such circumstances, when English pauperism had become a grave national question, that Owen first brought forward his scheme of socialism (1817). In his communities, which were intended to be self-dependent units, Owen sought to provide the best education and the constant exercise of unselfish intelligence, to unite the advantages of town and country, and to correct the monotonous activity of the factory with the greatest variety of occupation, while utilizing all the latest improvements in industrial technique. The causes of Owen's failure in establishing his communities are obvious enough. Apart from the difficulties inherent in socialism, he injured the social cause by going out of his way to attack the historic religions and the accepted views on marriage, by his quixotry and tediousness, by refusing to see that for the mass of men measures of transition from an old to a new system must be adopted. If he had been truer to his earlier methods and retained the autocratic guidance of his experiments, the chances of success would have been greater. Above all, Owen had too great faith in human nature, and he did not understand the laws of social evolution. His great doctrine of the influence of circumstances in the formation of character was only a very crude way of expressing the law of social continuity so much emphasized by recent socialism. He thought that he could break the chain of continuity, and as by magic create a new set of circumstances, which would forthwith produce a new generation of rational and unselfish men. The time was too strong for him, and the current of English history swept past him. Even a very brief account of Owen, however, would be incomplete without indicating his relation to Malthus. Against Malthus he showed that the wealth of the country had, in consequence of mechanical improvement, increased out of all proportion to the population. The problem, therefore, was not to restrict population, but to institute rational social arrangements and to secure a fair distribution of wealth. Whenever the number of inhabitants in any of his communities increased beyond the maximum, new ones should be created, until they extended over the whole world, uniting all in one great republic with one interest. There would be no fear of over-population for a long time to come. Its evils were then felt in Ireland and other countries; but that condition of things was owing to the total want of the most ordinary common sense on the part of the blinded authorities of the world. The period would probably never arrive when the earth would be full; but if it should the human race will be good, intelligent, and rational, and would know much better than the present irrational generation how to provide for the occurrence. Such was Owen's socialist treatment of the population problem.

Chartism.

In England the reform of 1832 had the same effect as the Revolution of July (1830) in France: it brought the middle class into power, and by the exclusion of the workmen emphasized their existence as a separate class. The discontent of the workmen now found expression in Chartism. As is obvious from the contents of the charter, Chartism was most prominently a demand for political reform; but both in its origin and in its ultimate aim the movement was more essentially economic. As regards the study of socialism, the interest of this movement lies greatly in the fact that in its organs the doctrine of "surplus value" afterwards elaborated by Marx as the basis of his system is broadly and emphatically enunciated. While the worker produces all the wealth, he is obliged to content himself with the meagre share necessary to support his existence and the surplus goes to the capitalist, who, with the king, the priests, lords, esquires, and gentlemen, lives upon the labor of the working man (*Poor Man's Guardian*, 1835).

Christian socialism in England.

After the downfall of Owenism began the Christian socialist movement in England (1848–52), of which the leaders were Maurice, Kingsley, and Mr. Ludlow. The abortive Chartist demonstration of April, 1848, excited in Maurice and his friends the deepest sympathy with the sufferings of the English working class,—a feeling which was intensified by the revelations regarding "London Labor and the London Poor" published in the *Morning Chronicle* (1849). Mr. Ludlow, who had in France become acquainted with the theories of Fourier, was the economist of the movement, and it was with him that the idea originated of starting co-operative associations. In *Politics for the People*, in the *Christian Socialist*, in the pulpit and on the platform, and in *Yeast* and *Alton Locke*, well-known novels of Kingsley, the representatives of the movement exposed the evils of the competitive system, carried on an unsparing warfare against the Manchester school, and maintained that socialism rightly understood was only Christianity applied to social reform. Their labors in insisting on ethical and spiritual principles as the true bonds of society, in promoting associations, and in diffusing a knowledge of co-operation were largely beneficial. In the north of England they joined hands with the co-operative movement inaugurated by the Rochdale pioneers (1844) under the influence of Owenism. Productive co-operation made very little progress, but co-operative distribution has proved a great success.

Karl Marx.

In 1852 the twofold socialist movement in France and England had come to a close, leaving no visible result of any importance. From that date the most prominent leaders of socialism have been German and Russian. To reach the beginnings of German socialism we must go back a little, as it took its rise in the years preceding the revolution of 1848. Its most conspicuous chiefs are Karl Marx, Friedrich Engels, Lassalle, and Rodbertus (for the last two, see LASSALLE, and RODBERTUS). The greatest and most influential of the four was unquestionably Marx, who and his like-minded companion Engels are the acknowledged heads of the "scientific and revolutionary" school of socialism, which has its representatives in almost every country of the civilized world, and is generally recognized as the most serious and formidable form of socialism. Karl Marx (1818–1883) was of Jewish extraction. He was born at Treves, and studied at Berlin and Bonn, but neglected the specialty of law, which he nominally adopted, for the more congenial subjects of philosophy and history. He was a zealous student and apparently an adherent of Hegelianism, but soon gave up his intention of following an academic career as a teacher of philosophy and joined the staff of the *Rhenish Gazette*, published at Cologne as an organ of the extreme democracy. In 1843, after marrying the sister of the Prussian minister Von Westfalen, he removed to Paris, where he applied himself to the study of economic and social questions and began to publish those youthful writings which must be reckoned among the most powerful expositions of the early form of German socialism. With Arnold Ruge he edited the *Deutsch-Französische Jahrbücher*. In 1845 he was expelled from Paris and settled in Brussels, where he published his *Discours sur le Libre Échange*, and his criticisms of Proudhon's *Philosophie de la Misère*, entitled *Misère de la Philosophie*. In Paris he had already met Friedrich Engels, who was destined to be his lifelong and loyal friend and companion-in-arms, and who in 1845 published his important work, *Die Lage der arbeitenden Klasse in England*. The two friends found that they had arrived at a complete identity of opinion; and an opportunity soon occurred for an emphatic expression of their common views. A society of socialists, a kind of forerunner of the International, had established itself in London, and had been attracted by the new theories of Marx and the spirit of strong and uncompromising conviction with which he advocated them. They entered into relation with Marx and Engels; the society was reorganized under the name of the Communist League; and a congress was held, which resulted (1847) in the framing of the *Manifesto of the Communist Party*, which was published in most of the languages of western Europe, and is the first proclamation of that revolutionary socialism armed with all the learning of the 19th century, but expressed with the fire and energy of the agitator, which in the International and other movements has so startled the world. During the revolutionary troubles of 1848 Marx returned to Germany, and along with his comrades Engels, Wolff, etc., he supported the most advanced democracy in the *New Rhenish Gazette*. In 1849 he settled in London, where till his death in 1883 he applied himself to the elaboration of his economic views and to the realization of his revolutionary programme. During this period he published *Zur Kritik der politischen Oekonomie* (1859), and the first volume of his great work on capital, *Das Kapital* (1867).

Origin of German socialism.

The causes which have variously contributed to the rise of German socialism are sufficiently clear. With the accession of the romanticist Frederick William IV. to the throne of Prussia in 1840 German liberalism received a fresh expansion. At the same time the Hegelian school began to break up, and the interest in pure philosophy began to wane. It was a time of disillusionment, of dissatisfaction with idealism, of transition to realistic and even to materialistic ways of thinking. This found strongest expression in the Hegelian left, to which, after the ideals of the old religions and philosophies had proved unsubstantial, there remained as solid residuum the real fact of man with his positive interests in this life. The devotion and enthusiasm which had previously been fixed on ideal and spiritual conceptions were concentrated on humanity. To adherents of the Hegelian left, who had been delivered from intellectual routine by the most intrepid spirit of criticism, and who, therefore, had little respect for the conventionalisms of a feudal society, it naturally appeared that the interests of humanity had been cruelly sacrificed in favor of class privilege and prejudice. The greatest thinkers of Germany had recognized the noble elements in the French Revolution. To recognize also the noble and promising features of French socialism was a natural thing, especially for Germans who had been in Paris,—the great hearth of the new ideas. Here they found themselves definitely and consciously in presence of the last and greatest interest of humanity, the suffering and struggling proletariat of western Europe, which had so recently made its definite entry in the history of the world. Thus socialism became a social, political, and economic creed to Karl Marx and his associates. But they felt that the theories which preceded them were wanting in scientific basis; and it was henceforward the twofold aim of the school to give scientific form to socialism and to propagate it in Europe by the best and most effective revolutionary methods.

Views of Marx and his school.

Surplus value.

The fundamental principle of the Marx school and of the whole cognate socialism is the theory of "surplus value,"—the doctrine, namely, that, after the laborer has been paid the wage necessary for the subsistence of himself and family, the surplus produce of his labor is appropriated by the capitalist who exploits it. This theory is an application of the principle that labor is the source of value, which was enunciated by many of the old writers on economics, such as Locke and Petty, which was set forth with some vagueness and inconsistency by Adam Smith, and was more systematically expounded by Ricardo. The socialistic application of the principle in the doctrine of surplus value had been made both by Owenites and chartists. It was to prevent this appropriation of surplus value by capitalists and middlemen that the Owen school tried the system of exchange by labor notes in 1832,—the value of goods being estimated in labor-time, represented by labor notes. The principle that labor is the source of value has been accepted in all its logical consequences by Marx, and by him elaborated with extraordinary dialectical skill and historical learning into the most complete system of socialism that has ever been formulated. A like application of the principle but in a less rigorous fashion has been made by Rodbertus; and it is the same theory that underlies the extravagancies and paradoxes of Proudhon. The question whether the priority in the scientific development of the principle is due to Marx or Rodbertus cannot be fully discussed here. But it may be said that, while the *Social Letters* of Rodbertus to Von Kirchmann were published in 1850, the importance of the principle was understood by the Marx school as early as 1845, and in a broad and general way had indeed become the common property of socialists. The historical importance and scientific worth of the writings of Rodbertus should not be overlooked; nor are they likely to be when so much attention has been given to him by A. Wagner and other distinguished German economists. But in the great work of Marx the socialist theory is elaborated with a fulness of learning and a logical power to which Rodbertus has no claim. With Marx the doctrine of surplus value receives its widest application and development; it supplies the key to his explanation of the history and influence of capital, and consequently of the present economic era, which is dominated by it. It is the basis, in fact, of a vast and elaborate system of social philosophy. In any case it is an absurdity as well as an historical error to speak of Marx as having borrowed from Rodbertus. Marx was an independent thinker of great originality and force of character, who had made the economic development of modern Europe the study of a laborious lifetime, and who was in the habit, not of borrowing, but of strongly asserting the results of his own research and of impressing them upon other men.

Capital.

The great work of Marx may be described as an exposition and criticism of capital. But it is also indirectly an exposition of socialism, inasmuch as the historical evolution of capital is governed by natural laws, the inevitable tendency of which is towards socialism. It is the great aim of Marx to reveal the law of the economic movement of modern times. Now the economic movement of modern times is dominated by capital. Explain, therefore, the natural history of capital, the rise, consolidation, and decline of its supremacy as an evolutionary process, and you forecast the nature of that into which it is being transformed,—socialism. Hence the great task of the Marx school is not to preach a new economic and social gospel, not to provide ready-made schemes of social regeneration after the fashion of the early socialists, nor to counteract by alleviating measures the wretchedness of our present system, but to explain and promote the inevitable process of social evolution, so that the domination of capital may run its course and give place to the higher system that is to come.

The characteristic feature of the régime of capital, or, as Marx usually calls it, the capitalistic method of production, is, that industrial operations are carried on by individual capitalists employing free laborers, whose sole dependence is the wage they receive. Those free laborers perform the function fulfilled in other states of society by the slave and the serf. It is the tendency of the capitalistic system to consolidate those two classes,—the capitalist class, enriching itself on the profits of industry, which they control in their own interest, and the class of workers, nominally free, but without land or capital, divorced, therefore, from the means of production, and dependent on their wages, —the modern proletariat. The great aim of the capitalist is the increase of wealth through the accumulation of his profits. This accumulation is secured by the appropriation of what the socialists call surplus value. The history of the capitalistic method of production is the history of the appropriation and accumulation of surplus value. To understand the capitalistic system is to understand surplus value. With the analysis of value, therefore, the great work of Marx begins.

Value and labor.

The wealth of the societies in which the capitalistic method of production prevails appears as an enormous collection of commodities. A commodity is in the first place an external object adapted to satisfy human wants; and this usefulness gives it value in use, makes it a use value. These use values form the material of wealth, whatever its social form may be. In modern societies, where the business of production is carried on to meet the demands of the market, for exchange, these use values appear as exchange values. Exchange value is the proportion in which use values of different kinds exchange for each other. But the enormous mass of things that circulate in the world market exchange for each other in the most different proportions. They must, however, have a common quality or they could not be compared. This common quality cannot be any of the natural properties of the commodities. In the business of exchange one thing is as good as another, provided you have it in sufficient quantity. Leaving out of consideration, therefore, the physical qualities that give commodities use value, we find in them but one common characteristic,—that they are all products of human labor. They are all crystallized forms of human labor. It is labor applied to natural objects that gives them value. What constitutes value is the human labor embodied in commodities. And the relation of exchange is only a phase of this value, which is, therefore, to be considered independently of it. Further, the labor-time spent in producing value is the measure of value, not this or that individual labor, in which case a lazy or unskilled man would produce as great a quantity of value as the most skilful and energetic. We must take as our standard the average labor-force of the community. The labor-time which we take as the measure of value is the time required to produce a commodity under the normal social conditions of production with the average degree of skill and intensity of labor. Thus labor is both the source and the measure of value.

Development of capitalistic régime.

As we have seen, the characteristic feature of the capitalistic system of production is that industry is controlled by capitalists employing free wage-labor; that is, while the capitalist owns and controls the means of production, the free laborer has lost all ownership in land and capital and has nothing to depend on but his wage. This condition of things was established only after a long and gradual process of social change, which Marx copiously illustrates from the history of England, as the classic land of the fully developed capitalism. In the Middle Ages the craftsman and peasant were the owners of the small means of production then extant, and they produced for their own needs and for their feudal superior; only the superfluity went into the general market. Such production was necessarily small, limited, and technically imperfect. Towards the close of the Middle Ages a great change set in caused by a remarkable combination of circumstances,—the downfall of the feudal system and of the Catholic Church, the discovery of America and of the sea route to India. Through the breaking up of the feudal houses with their numerous retainers, through the transformation of the old peasant-holdings into extensive sheep-runs, and generally through the prevalent application of the commercial system to the management of land instead of the Catholic and feudal spirit, the peasantry were driven off the land, a multitude of people totally destitute of property were thrown loose from their old means of livelihood, and were reduced to vagabondage or forced into the towns. It was in this way that the modern proletarians made their tragic entry in history. On the other hand, there was a parallel development of the capitalist class, brought about by the slave trade, the exploitation of the American colonies and of both the Indies, and by the robbery, violence, and corruption which attended the transference of the land from the Catholic and feudal to the modern régime. The opening and extension of the great world market, moreover, gave a great stimulus to industry at home. The old guilds having already been expropriated and dissolved, the early organization of industry under the control of an infant capitalism passed through its first painful and laborious stages, till with the great mechanical inventions, with the application of steam as the motive-power, and the rise of the factory system towards the close of the 18th century, the great industrial revolution was accomplished, and the capitalistic method of production attained to its colossal manhood.

Capitalistic appropriation.

The capitalistic system thus established, we have to remember that in all its forms, and throughout all the stages of its history, the great aim of the capitalist is to increase and consolidate his gains through the appropriation of surplus value. This appropriation of surplus value is a very old phenomenon in human society. In all the forms of society which depended on slave labor, and under the feudal régime, the appropriation of the results of other men's labor was open and undisguised. Under the capitalistic system it is disguised under the form of free contract. The workman appears on the labor market with the sole commodity of which he has to dispose, his labor force, and sells it for a specified time at the price it can bring, which we call his wage, and which is equivalent to the average means of subsistence required to support himself and to provide for the future supply of labor (in his family.) But the labor force of the workman as utilized by the capitalist in the factory or the mine produces a net value in excess of his wage. That is, over and above his entire outlay, including the wage paid to his workmen, the capitalist finds himself in possession of a surplus, which can only represent the "unpaid labor" of his workmen. This surplus is the surplus value of Karl Marx, the product of unpaid labor. This it is which the capitalist seeks to obtain and to accumulate by all the methods available. These methods are described by Marx with great detail and elaboration through several hundred pages of his first volume. His account, supported at every step by long and copious citations from the best historical authorities and from the blue-books of the various parliamentary commissions, is a lurid and ghastly picture of the many abuses of English industrialism. It is the dark and gloomy reverse of the industrial glories of England. The fearful prolongation of the hours of labor, the merciless exploitation of women, and of children from the age of infancy, the utter neglect of sanitary conditions, whatever could lessen the costs of production and swell the profits of the capitalist, though every law of man and nature were violated in the process,—such are the historical facts which Marx emphasizes and illustrates with an overwhelming force of evidence. They receive ample confirmation in the history of the English Factory Acts, imposed on greedy and unscrupulous capitalists after a severe struggle prolonged for half a century, and required to prevent the moral and physical ruin of the industrial population.

Results of capitalistic system.

It will be seen that the first and most conspicuous result of the capitalistic system is that, while production is a social operation carried on by men organized and associated in factories, the product is appropriated by individual capitalists: it is social production and capitalistic appropriation. Another conspicuous and important result is that, while we have this organization in the factories, we have outside of them all the anarchy of competition. We have the capitalistic appropriators of the product of labor contending for the possession of the market, without systematic regard to the supply required by that market—each one filling the market only as dictated by his own interest, and trying to outdo his rivals by all the methods of adulteration, bribery, and intrigue,—an economic war hurtful to the best interests of society. With the development of the capitalistic system machinery is more and more perfected, for to neglect improvement is to succumb in the struggle; the improved machinery renders labor superfluous, which is accordingly thrown idle and exposed to starvation. But, as the technique improves, the productive power of industry increases, and continually tends more and more to surpass the available needs of the market, wide as it is. The consequence is that the market tends to be overstocked even to absolute repletion; goods will not sell, and a commercial crisis is established, in which we have the remarkable phenomenon of widespread panic, misery, and starvation resulting from a superabundance of wealth,—a "crise pléthorique," as Fourier called it, a crisis due to a plethora of wealth. These crises occur at periodic intervals, each one severer and more widespread than the preceding, until they now tend to become chronic and permanent, and the whole capitalistic world staggers under an atlantean weight of ill-distributed wealth. Thus the process goes on in obedience to its own inherent laws. Production is more and more concentrated in the hands of mammoth capitalists and colossal joint-stock companies, under which the proletariat are organized and drilled into vast industrial armies. But, as crisis succeeds crisis, until panic, stagnation, and disorder are universal, it becomes clear that the bourgeoisie are no longer capable of controlling the industrial world. The incompatibility between social production and anarchic distribution decidedly declares itself. With the progress of democracy the proletariat seizes the political power, and through it at last takes complete control over the economic functions of society. It expropriates the private capitalist and appropriating the means of production manages them in its own interest, which is the interest of society as a whole; society passes into the socialistic stage through a revolution determined by the natural laws of social evolution, and not by a merely arbitrary exercise of power. It is a result determined by the inherent laws of social evolution, independent of the will and purpose of individual men. All that the most powerful and clear-sighted intellect can do is to learn to divine the laws of the great movement of society, and to shorten and alleviate the birth-pangs of the new era. The efforts of reactionaries of every class to turn the wheel of history backwards are in vain. But an intelligent appreciation of its tendencies and a willing co-operation with them will make progress easier, smoother, and more rapid.

It will have been seen that what Marx and his school contemplate is an economic revolution brought about in accordance with the natural laws of historic evolution. But in order to understand the full import of this revolution in the mind of Marx we must remember that he regards the economic order of society as the groundwork of the same, determining all the other forms of social order. The entire legal and political structure as well as philosophy and religion are constituted and controlled in accordance with the economic basis. This is in harmony with his method and his conception of the world, which is the Hegelian reversed. "For Hegel the thought process, which he transforms into an independent subject under the name idea, is the creator of the real, which forms only its external manifestation. With me, on the contrary, the ideal is nothing else than the material transformed and translated in the human brain." His conception of the world is a frank and avowed materialism. His method is the dialectic applied to a world thus understood; the business of inquiry, namely, is to trace the connection and concatenation in the links that make up the process of historic evolution, to investigate how one stage succeeds another in the development of society, the facts and forms of human life and history not being stable and stereotyped things, but the ever-changing manifestations of the fluent and unresting real, the course of which it is the duty of science to reveal. The whole position of the Marx school may therefore be characterized as evolutionary and revolutionary socialism, based on a materialistic conception of the world and of human history. Socialism is a social revolution determined by the laws of historic evolution—a revolution which, changing the economic groundwork of society, will change the whole structure.

Criticism of Marx's views.

It will be seen that the work of Marx is a natural history of capital, especially in its relation to labor, and in its most essential features is a development of two of the leading principles of the classic economics,—that labor is the source of value, but that of this value the laborer obtains for himself merely a subsistence wage, the surplus being appropriated by the exploiting capitalist. Marx's great work may be described as an elaborate historical development of this glaring fundamental contradiction of the Ricardian economics, the contradiction between the iron law of wages and the great principle that labor is the source of wealth. Marx's conception of labor is the same as that of Ricardo, and as a logical exposition of the historic contradiction between the two principles on the basis of Ricardo the work of Marx is quite unanswerable. It is obvious, however, that the definition of labor assumed both in Ricardo and Marx is too narrow. The labor they broadly posit as the source of wealth is manual labor. In the early stages of industry, when the market was small and limited and the technique was of the simplest and rudest description, labor in that sense might correctly enough be described as the source of value. But in modern industry, when the market is world-wide, the technique most complex, and the competition most severe, when inventiveness, sagacity, courage, and decision in initiative, and skill in management, are factors so important, no such exclusive place as has been claimed can be assigned to labor. The Ricardian principle, therefore, falls to the ground. And it is not historically true to maintain, as Marx does, that the profits of the capitalist are obtained simply by appropriating the products of unpaid labor. In initiating and managing the capitalist is charged with the most difficult and important part of the work of production. As a natural consequence it follows that Marx is also historically inaccurate in roundly explaining capital as the accumulation of unpaid labor appropriated by the capitalist. In past accumulation, as in the control and management of industry generally, the capitalist has had the leading part. Capital, therefore, is not necessarily robbery, and in an economic order in which the system of free exchange is the rule, and the mutually beneficial interchange of utilities, no objection can be raised to the principle of lending and borrowing of money for interest. In short, in his theory of unpaid labor as supplying the key to his explanation of the genesis and development of the capitalistic system Marx is not true to history. It is the perfectly logical outcome of certain of the leading principles of the Ricardian school, but it does not give an adequate or accurate account of the facts of economic evolution.

It may indeed be maintained that in his theory of unpaid labor Marx is not consistent with the general principles of his own philosophy of social evolution. With him history is a process determined by material forces, a succession of orderly phenomena controlled by natural laws. Now we may waive the objection suggested by the principle enunciated in the Marx school itself, that it is not legitimate to apply ethical categories in judgment on economic processes that are merely natural, which, however, Marx does with revolutionary emphasis throughout some hundreds of pages of his great work. It is more important to point out, in perfect consistency with the principles of the school, that the energy and inventiveness of the early capitalists especially were the most essential factors in determining the existence and development of a great economic era, and that the assertion of freedom was an indispensable condition in breaking the bonds of the old feudal order, which the new system displaced. Instead, therefore, of living and growing rich on the produce of unpaid labor, the capitalist had a great social and industrial function to perform, and played a great part in historic evolution. The position and function of the workman was subordinate.

There can be no doubt that in his theory of surplus value obtained from unpaid labor Marx as agitator and controversialist has fallen into serious contradiction with himself as scientific historian and philosopher. The theory that labor is the source of value was widely accepted among economists during his early life, and by its justice and nobleness it was well adapted to the comfortable optimism prevalent among so many of the classical school. The economists, however, did not follow the principle to its obvious conclusion, that if labor is the source of wealth the laborer should enjoy it all. It was otherwise with the socialists, who were not slow to perceive the bearing of the theory on the existing economic order. In his controversial treatise against Proudhon Marx gives a list of writers (beginning with the political economy of Hopkins, published in 1822, only five years after the appearance of Ricardo's great work) by whom the principle was applied to revolutionary purposes. Its simplicity and seeming effectiveness must have made it most attractive. As posited by the classic economy and applied by the socialists Marx accepted the principle. It was an unanswerable *argumentum ad hominem* when addressed to an economist of the Ricardian school; but it should have broken down when confronted with historical fact. Nevertheless it was made and continued to be the foundation stone of the system of Marx, and is really its weakest point. His doctrine of surplus value is the vitiating factor in his history of the capitalistic system. The most obvious excuse for him is that he borrowed it from the classic economists. It would be the greatest possible mistake, however, to make this a reason for undervaluing the remarkable services rendered to economics by Karl Marx. He spent forty laborious years almost wholly in exile as the scientific champion of the proletariat. In the combination of learning, philosophic acumen, and literary power he is probably second to no economic thinker of the 19th century. He seems to have been master of the whole range of economic literature, and wielded it with a logical skill not less masterly. But his great strength lay in his knowledge of the technical and economic development of modern industry and in his marvellous insight into the tendencies in social evolution determined by the technical and economic factors. Whether his theories in this department are right or wrong they have suggested questions that will demand the attention of economic thinkers for a long time to come. It is in this department and not in his theory of surplus value that Marx's significance as a scientific economist is to be found.

The great merit of Marx, therefore, lies in the work he has done as scientific inquirer into the economic movement of modern times, as the philosophic historian of the capitalistic era. It is now admitted by all inquirers worthy of the name that history, including economic history, is a succession of orderly phenomena, that each phase in the line of succession is marked by facts and tendencies more or less peculiar to itself, and that laws and principles which we now condemn had formerly an historical necessity, justification, and validity. In accordance with this fundamental principle of historical evolution arrangements and institutions which were once necessary, and originally formed a stage in human progress, may gradually develop contradictions and abuses and thus become more or less antiquated. The economic social and political forms which were the progressive and even adequate expressions of the life of one era become hindrances and fetters to the life of the succeeding times. This, the school of Karl Marx says, is precisely the condition of the present economic order. The existing arrangements of landlord, capitalist, and wage-laborer under free competition are burdened with contradiction and abuse. The life of society is being strangled by the forms which once promoted it. They maintain that the really vital and powerful tendencies of our time are towards a higher and wider form of social and economic organization,—towards socialism. This we believe to be the central point of the whole question; but the fuller discussion of it can more conveniently be postponed to the close of this article, when we come to consider socialism as a whole.

The International.

The opinions of Marx were destined to find expression in two movements, which have played a considerable part in recent history,—the International and the social democracy of Germany. Of the International Marx was the inspiring and controlling head from the beginning; and the German social democracy, though originated by Lassalle, before long fell under Marx's influence. Marx wrote the famous inaugural address of the International and drew up its statutes, maintaining a moderation of tone which contrasted strongly with the outspoken vigor of the communist manifesto of 1847. But it was not long before the revolutionary socialism which underlay the movement gained the upper hand. This found strongest expression in the address drawn up by Marx in 1871 after the suppression of the commune, and entitled *The Civil War in France.* The International was not responsible for the revolt of the commune, which was a rising for the autonomy of Paris, supported chiefly by the lower classes. It was a protest against excessive centralization raised by the democracy of Paris, which has always been far in advance of the provinces, and which found itself in possession of arms after the siege of the town by the Germans. But, while it was prominently an assertion of local autonomy, it was also a revolt against the economic oppression of the moneyed classes, and thus contained within it strong socialistic tendencies. The socialists properly so called were only a small minority. In this address, however, Marx and his associates made themselves morally *solidaire* with the commune. They saw in it a great rising against the existing conditions of the Parisian proletariat, which only partially saw the way of deliverance, but was tired of oppression and full of just indignation against the tyrannous upper classes, that controlled the central government of France. This address, if it tended to increase the prestige of the International, greatly reduced its real influence. Its last meeting as controlled by Marx took place at The Hague in 1872. The chief himself was present, and succeeded in casting out the anarchist following of Bakunin; but it was the expiring effort. See INTERNATIONAL.

German social democracy.

This loss of influence by Marx was in the meantime more than compensated by his success in gaining control over the social democracy of Germany. Of the workmen's unions which had grown so rapidly in Germany in the years following 1860, and which had first been patronized by the Progressist party, some had attached themselves to the national socialism of Lassalle, but many held aloof from that movement, and under the influence of Liebknecht and Bebel were gradually drawn over to the views of Marx. At Lassalle's death in 1864 his "general workingmen's union of Germany" numbered only 4610 members. After losing its founder the union had a changeful and somewhat precarious career for a time; and it was only under the presidency of Von Schweitzer, which lasted for four years (1867–1871), that it began moderately to flourish. In the meantime the adverse party also made considerable progress. The confederation of German unions, which was founded in 1863, declared in 1865 for universal suffrage, pronounced against the Schulze-Delitzsch schemes in 1866, and in the congress at Nuremberg of 1868 by a large majority declared their adhesion to the International. In a great congress at Eisenach in 1869 they founded the "social democratic workingmen's party," and in the same year sent representatives to the International congress at Basel. Great efforts were made for a fusion of the Eisenach and the Lassalle party, and this was effected in a congress at Gotha (May, 1875). At this congress 25,000 regular members were represented, of whom 9000 belonged to the Marx party and 15,000 to that of Lassalle. The united body assumed the name of the "socialistic workingmen's party of Germany," and drew up a programme, which, as the most important manifesto hitherto published by any socialist body, deserves to be given entire.

Programme of socialistic working-men's party.

I. Labor is the source of all wealth and all culture, and as useful work in general is possible only through society, so to society—that is, to all its members—belongs the entire product of labor by an equal right, to each one according to his reasonable wants,—all being bound to work.

In the existing society the instruments of labor are a monopoly of the capitalist class; the subjection of the working class thus arising is the cause of misery and servitude in every form.

The emancipation of the working class demands the transformation of the instruments of labor into the common property of society and the co-operative control of the total labor, with application of the product of labor to the common good, and just distribution of the same.

The emancipation of labor must be the work of the laboring class, in contrast to which all other classes are only a reactionary mass.

II. Proceeding from these principles, the socialistic working-men's party of Germany aims by all legal means at the establishment of the free state and the socialistic society, to destroy the iron law of wages by abolishing the system of wage-labor, to put a term to exploitation in every form, to remove all social and political inequality.

The socialistic working-men's party of Germany, though working first of all within the national limits, is conscious of the international character of the labor movement, and resolved to fulfil all duties which this imposes on the workmen, in order to realize the universal brotherhood of men.

In order to prepare the way for the solution of the social question, the socialistic working-men's party of Germany demands the establishment of socialistic productive associations with state help under the democratic control of the laboring people. The productive associations are to be founded on such a scale both for industry and agriculture that out of them may develop the socialistic organization of the total labor.

The socialistic working-men's party demands as bases of the state—(1) universal, equal, and direct right of electing and voting, with secret and obligatory voting, of all citizens from twenty years of age for all elections and deliberations in the state and local bodies; the day of election or voting must be on a Sunday or holiday; (2) direct legislation by the people; questions of war and peace to be decided by the people; (3) universal military duty; a people's army in place of the standing armies; (4) abolition of all exceptional laws, especially as regards the press, unions, and meetings, and generally of all laws which restrict freedom of thought and inquiry; (5) administration of justice by the people; free justice; (6) universal and equal education by the state; compulsory education; free education in all public places of instruction; religion declared to be a private concern.

Within the existing society the socialistic working-men's party of Germany demands—(1) greatest possible extension of political rights and liberties in the sense of the above demands; (2) a single progressive income-tax for state and local purposes, instead of the existing taxes, and especially of the indirect taxes that oppress the people; (3) unrestricted right of combination; (4) a normal working-day corresponding to the needs of society; prohibition of Sunday labor; (5) prohibition of labor of children, and of all women's work injurious to health and morality; (6) laws for the protection of the life and health of workmen; sanitary control of workmen's dwellings; inspection of mines, of factories, workshops, and house-labor, by officials chosen by the workmen; an effective employers' liability Act; (7) regulation of prison labor; (8) workmen's funds to be under the entire control of the workmen.

By this time the socialism of Germany began to be a power, which was calculated to excite grave alarm among the ruling classes. The social democrats had returned five members to the North German diet in 1867. For the German diet in 1871 they had counted only 120,000 votes, and returned two members; but in 1877 they had returned twelve members and polled nearly half a million. In Berlin the socialist voting strength had risen from 6695 in 1871 to 57,511 in 1878,—an increase which was all the more remarkable that Lassalle could hardly obtain a hearing in the capital when he commenced his career. A much more significant feature of the movement was the admirable state of organization to which the socialist propaganda had attained. A large number of skilful, intelligent, and energetic agitators spread their doctrines throughout Germany; a whole machinery of newspapers, pamphlets, treatises, social gatherings, and even almanacs diffused the new creed. In all the great centres of population, in Berlin, Hamburg, and the industrial towns in Saxony and on the Rhine, the socialists were rapidly tending to become the strongest party. The Government accordingly intervened with exceptional legislation, which in 1878 was carried during the excitement occasioned by the attempts on the emperor's life of Hödel and Nobeling. These exceptional laws, though administered with great rigor, have not by any means succeeded in arresting the progress of the movement, as at the election to the Reichstag in 1884 the socialists polled about 600,000 votes and returned twenty-four members. Berlin alone counted 68,000 socialist voters. In the last report relating to the anti-socialist law laid before the Reichstag (1885) the continued progress of the party is admitted.

Catholic socialism of Germany.

The participation of the Catholic Church of Germany in the social question dates from the period of the Lassalle agitation. In 1863 Döllinger recommended that the church should intervene in the movement, and Bishop von Ketteler of Mainz lost no time in expressing sympathy with Lassalle. In a treatise entitled *Die Arbeiterfrage und das Christenthum* (1864) Ketteler criticises the liberalism of the Manchester school in substantially the same terms as Lassalle, and recommends the voluntary formation of productive associations with capital supplied by the faithful. In 1868 the Catholic socialism of Germany took a more practical form: it started an organ of its own and began to organize unions for the elevation of the working men. The principles of the movement have been with some precision expounded by Canon Moufang in an electoral address at Mainz (1871) and by the writers in their organ. All agree in condemning the principles of liberalism, especially in its economic aspects, as destructive of society and pernicious to the working-man, who, under the pretence of freedom, is exposed to all the precariousness and anarchy of competition and sacrificed to the iron law of wages. Self-help as practiced in the Schulze-Delitzsch schemes is also considered to be no sure way of deliverance. This general remedy is union on Catholic principles, especially the formation of trade guilds suited to modern exigencies, which some of their leaders would make a compulsory measure enforced by the state. The views of Moufang, which are most definite, may be thus summarized: legal protection for the workers, especially as regards hours of labor, wages, the labor of women and children, sanitation; subventions for workmen's productive associations; lightening of taxes on labor; control of the moneyed and speculating interests. In the organization of unions the success of Catholic socialism has been great; and the social democrats admit that they can make no progress in Catholic districts where the church has developed its social activity.

Protestant socialism.

The socialist activity of the Protestant Church of Germany dates from 1878. The most important literary product of the movement is a work by Pastor Todt entitled *Der radikale deutsche Socialismus und die christliche Gesellschaft*. In this work Todt condemns the economics of liberalism as unchristian, and seeks to show that the ideals of liberty, equality, and fraternity are entirely Scriptural, as are also the socialist demands for the abolition of private property and the wage system, that the laborer should have the full produce of his labor, and that labor should be associated. The chief leader of the movement is the court preacher Stöcker, the head also of the anti-Semitic agitation, which is largely traceable to economic causes. Stöcker founded two associations,—a central union for social reform, consisting of members of the middle classes interested in the emancipation of labor, and a Christian social working-men's party. The former has had considerable success, especially among the Lutheran clergy. The movement has met with the most strenuous resistance from the social democratic party and has been greatly hampered by the anti-socialist law of 1878.

State socialism.

Little can here be said of the state socialism of Bismarck,—a very recent movement, which has not yet had time to pass into history. Its leading principles were announced in an imperial message to the Reichstag in November, 1881. Besides the repressive measures necessary to restrain the excesses of the social democracy, the emperor declared that the healing of social evils was to be sought in positive measures for the good of the working man. The measures proposed were for the insurance of the workmen against accident, sickness, old age, and inability to work by arrangements under state control. "The finding of the right ways and means for this state protection of the working man is a difficult task, but also one of the highest that concern every society standing on the ethical foundations of the Christian national life." The message then proceeds to speak of measures for "organising the life of the people in the form of corporative associations under the protection and furtherance of the state,"—a clause which might be taken as an admission of the collectivist principle. As yet the imperial programme has only been partially realized. It will be obvious that such measures can be rightly appreciated only with reference to the general theory and practice of Prussian government.

Anarchism of Bakunin.

The acknowledged father of anarchism is PROUDHON (*q.v.*); but the doctrine owes its development chiefly to Russian thinkers who had been trained in the Hegelian left. The great apostle of the system in its advanced and most characteristic stage was Michael Bakunin. Bakunin was sprung from the highest Russian aristocracy, and was born at Torshok, in the government of Tver, in 1814. Leaving the army, in which he served for some time, he visited western Europe, chiefly Paris, where he met George Sand and Proudhon in 1847. For his share in the German disturbances of 1849 he was imprisoned in Russia for several years and then sent to Siberia, from which he escaped, and spent the rest of his life in exile in western Europe, principally in Switzerland. In 1869 he founded the Social Democratic Alliance, which, however, dissolved in the same year and entered the International. In 1870 he attempted a rising at Lyons on the principles afterwards exemplified by the Paris commune. At The Hague congress of the International in 1872 he was outvoted and expelled by the Marx party. Bakunin's activity was most remarkable as an agitator. The international socialism of the Romance countries, especially that of Spain and Italy, has been largely moulded by him. He died at Bern in 1876. Nothing can be clearer or more frank and comprehensive in its destructiveness than the socialism of Bakunin. It is revolutionary socialism based on materialism and aiming at the destruction of external authority by every available means. He rejects all the ideal systems in every name and shape, from the idea of God downwards; and he rejects every form of external authority, whether emanating from the will of a sovereign or from universal suffrage. "The liberty of man," he says in his *Dieu et L'État*, "consists solely in this, that he obey the laws of nature, because he has himself recognized them as such, and not because they have been imposed upon him externally by any foreign will whatsoever, human or divine, collective or individual." In this way will the whole problem of freedom be solved; that natural laws be ascertained by scientific discovery, and the knowledge of them be universally diffused among the masses. Natural laws being thus recognized by every man for himself, he cannot but obey them, for they are the laws also of his own nature; and the need for political organization, administration, and legislation will at once disappear. Nor will he admit of any privileged position or class, for "it is the peculiarity of privilege and of every privileged position to kill the intellect and heart of man. The privileged man, whether he be privileged politically or economically, is a man depraved in intellect and heart." "In a word, we object to all legislation, all authority, and all influence, privileged, patented, official, and legal, even when it has proceeded from universal suffrage, convinced that it must always turn to the profit of a dominating and exploiting minority, against the interests of the immense majority enslaved." The anarchy of Bakunin is therefore essentially the same as that of Proudhon, but expressed without paradox, and with a destructive revolutionary energy which has seldom been equalled in history. What they both contemplate is a condition of human enlightenment and self-control in which the individual shall be a law to himself, and in which all external authority shall be abolished as a despotic interference with personal freedom. It is an ideal to which the highest religion and philosophy look forward as the goal of man, not as one, however, which can be forthwith reached through the wholesale destruction of the present framework of society, but through a long process of ethical and social improvement. The error of the anarchists consists in their impatient insistence on this proclamation of absolute freedom in the present debased condition of the great mass of the people in every class. They insist on taking the last step in social development before they have quite taken the first. The other leading principles of anarchism will be best understood from the following extracts taken from the programme of the International Social Democratic Alliance. The Alliance demands above all things the definitive and complete abolition of classes, and political, economic, and social equality of individuals and sexes, and abolition of inheritance, so that in the future every man may enjoy a like share in the produce of labor; that land and soil, instruments of labor, and all other capital, becoming the common property of the whole society, may be used only by the workers, that is by associations of cultivators and industrialists. It looks forward to the final solution of the social question through the universal and international solidarity of the workers of all countries, and condemns every policy grounded on so-called patriotism and national jealousy. It demands the universal federation of all local associations through the principle of freedom. Bakunin's methods of realizing his revolutionary programme are not less frank and destructive than his principles. The revolutionist, as he would recommend him to be, is a consecrated man, who will allow no private interests or feelings, and no scruples of religion, patriotism, or morality, to turn him aside from his mission, the aim of which is by all available means to overturn the existing society. His work is merciless and universal destruction. The future organization will doubtless proceed out of the movement and life of the people, but it is the concern of coming generations. In the meantime all that Bakunin enables us to see as promise of future reconstruction is the free federation of free associations,—associations of which we find the type in the Russian commune.

French anarchism.

Bakunin, as we have seen, has had great influence on the socialism of the Romance countries. The important risings in Spain in 1873 were due to his activity; and the socialism of Italy has been largely inspired by him. In those countries, as well as in France and French Switzerland, anarchist doctrines of the same general type as that of Bakunin are still in vogue, and are advocated by men of mark in literature and science like Kropotkine and Elisée Reclus. The views of the propaganda which they represent were most clearly and distinctly brought out during the great anarchist trial at Lyons in 1883. What they aim at is the most absolute freedom, the most complete satisfaction of human wants, without other limit than the impossibilities of nature and the wants of their neighbors equally worthy of respect. They object to all authority and all government on principle, and in all human relations would in place of legal and administrative control substitute free contract, perpetually subject to revision and cancelment. But, as no freedom is possible in a society where capital is monopolized by a diminishing minority, they believe that capital, the common inheritance of humanity, since it is the fruit of the co-operation of past and present generations, ought to be at the disposal of all, so that no man be excluded from it, and no man seize part of it to the detriment of the rest. In a word, they wish equality, equality of fact, as corollary or rather as primordial condition of freedom. From each one according to his faculties; to each one according to his needs. They demand bread for all, science for all, work for all; for all, too, independence and justice. Even a government based on universal suffrage gives them no scope for effective action in the deliverance of the poor, as they maintain that of the eight million electors of France only some half a million are in a position to give a free vote. In such a state of affairs, and in view of the continued misery and degradation of the proletariat, they proclaim the sacred right of insurrection as the *ultima ratio servorum*.

Russian nihilism.

It is an interesting fact that socialism has taken its most aggressive form in that European country whose civilization is most recent. The revolutionary opinions of Russia are not the growth of the soil, and are not the natural and normal outcome of its own social development: they have been imported from abroad. Falling on youthful and enthusiastic temperaments which had not previously been inoculated with the principle of innovation, the new ideas have broken forth with an irrepressible and uncompromising vigor which has astonished the older nations of Europe. Another peculiarity of the situation is that the Government is an autocracy served or controlled by a camarilla largely foreign both in origin and sympathy. In this case, then, we have a revolutionary party inspired by the socialism of western Europe fighting against a Government which is also in many ways an exotic and is not rooted in the mass of the people. The chief support of the Government is to be found in the reverence of the peasantry for the person and office of the czar, while the nihilists look upon the communal institutions of the country as their great ground of hope. Considered as a national movement, three distinct stages are recognized in the phenomena called Russian nihilism. In its first stage it was a speculative and anti-religious tendency, destructive of all orthodox tradition and authority. It was the spirit of the Hegelian left frankly accepting the materialism of Büchner and Moleschott as the final deliverance of philosophy; and the time was the early years of Alexander II., when the old despotic restraints were so largely removed—a period of reform and innovation and comparative freedom. In a country where religion had little influence among the educated classes, and where philosophy was not a slow and gradual growth of the native mind, but a fashion imported from abroad, the most destructive materialism found an easy conquest. It was the prevalent form among the advanced thinkers; it was clear, simple, and thorough; and it suited well the anti-religious mood of the time. By the side of this negative speculation, however, the Russian youth became aware of a new creed, destructive also in its beginnings, but full of the positive promise of future reconstruction and regeneration,—socialism. Here they saw the struggle of the proletariat, so terribly conspicuous in the Paris commune, which attracted universal attention in 1871, a proletariat represented in Russia by a nation of peasantry sunk in immemorial ignorance and wretchedness. At this period hundreds of young Russians of both sexes were studying in western Europe, especially in Switzerland. In 1873 they were by an imperial ukaze recalled home, but they carried the new ideas with them. The period of speculation was succeeded by a period of socialist propaganda, which naturally met with implacable opposition and merciless repression from the Government. As they received no mercy, the nihilists determined to show none; and in 1878 began the terrible duel of the Russian revolutionists against the autocracy and its servants, which culminated in the violent death of Alexander II. in 1881.

How far we are to regard the revolutionary movement of Russia as cognate in principle with anarchism is not easy to determine. In despotic countries, where constitutional reform and opposition to government are not tolerated, resolute innovators are naturally driven to secret conspiracy and to violent action. What distinguishes the Russian revolutionary party from other movements of a like nature is the intensity of the enthusiastic devotion and self-sacrifice with which they have braved death, imprisonment, exile, and privation in every form and the calculating skill with which they have called the resources of modern chemistry to their aid. There is no doubt that the doctrines of men like Bakunin have had great influence on Russian socialism; but so have the writings of Marx, as also of J. S. Mill and other advanced thinkers, who have no connection with anarchism. It is certain that the leaders of the revolutionary party resorted to violent measures only after their peaceful propaganda was being ruthlessly suppressed. With regard to political reform many of their leaders have declared that they would be satisfied with constitutionalism. In the address sent to the emperor Alexander III. after the death of his father in March, 1881, the executive committee of the revolutionary party offered to submit unconditionally to a national assembly duly elected by the people. In this recognition of constitutionalism, as well as in the strongly centralized organization of their executive, the Russian revolutionary party are essentially at variance with anarchism. In economics they advocate a thoroughgoing collectivism.

Classification of schools of socialism.

We have now given a brief outline of the various forms of socialism as they have historically appeared. It may be useful to group them as accurately and clearly as possible. (1) Experiments in socialism conducted by private initiative, as carried on in the schools of Saint-Simon, Fourier, and Owen; not that they objected to state help, but that, in point of fact, their efforts were conducted by private means. (2) Productive associations with state help: the programme of economic change favored by Louis Blanc and Lassalle. (3) The Marx school of socialism, scientific and revolutionary, beyond all comparison the most important and most influential of all forms of socialism. (4) Anarchism. (5) Nihilism. (6) Christian socialism; inasmuch as the various phases of Christian socialism condemn the principle of competition as operating in modern industry, and favor the organization of labor on united principles, and especially of productive associations with a common capital and an equitable system of distribution, they must be regarded as true forms of socialism. (7) To these should be added the speculative socialism of which Rodbertus is the most remarkable example; recognizing the fundamental evils of the present system and agreeing with the Marx school in holding that socialism is the next stage in social evolution, Rodbertus believed that the period of its realization is so remote that any decidedly practical effort towards that end is inapplicable; hence he could only recommend transitional remedial measures, which will at least circumscribe the mischief inherent in the present economic order and also pave the way towards a better state. (8) And last of all may be added the various forms of state socialism, which are all examples of state action on behalf of the poor, especially of the use of the public resources for that purpose. The word "socialism" is very frequently used in this sense. As the continued use of the word in such a way is almost a certainty, this phase of the subject must be recognized here. It may be described as socialistic inasmuch as it fully admits the responsibility of society for all its members; but in many respects its tendencies are opposed to true socialism. It is a vague movement which has not yet had time to take shape, and cannot be discussed here. "Socialism of the chair" has already been discussed under Political Economy, vol. xix. p. 397.

The above classification can of course pretend only to be a rough and general one. The various heads of the classification are not exclusive. The first variety has chiefly an historical interest. The American communities (discussed under Communism) are really cases of the old crude communism. Productive associations with state help stand on the Gotha programme of the social democrats of Germany. They are recommended by Christian socialists, both Catholic and Protestant, and they form an important item in the programme of the "knights of labor" of America. The resemblance in type between the "community" of Owen, the *phalange* of Fourier, the *mir* or commune of Russia, and the free commune of Bakunin is apparent. It is the social unit as determined by obvious economic, local, and historical conditions, and in socialism naturally becomes the point of departure for a new construction of society. It will have been noted that most of the important phases of socialism have been and are international in sympathy and activity. The Marx socialism is spreading in nearly every country of the civilized world, the doctrine being diffused by energetic agitators, and not seldom by men of philosophic and literary culture. In late years this is true both of France and England. It is well known how active anarchism has been. The Christian socialist movement is more or less operative in Belgium, France, Germany, Austria, and to some extent in England.

Relation to political economy.

In this article our aim has been to give an expository and historical account of the various phases of socialism. It is impossible even to refer to all the different questions suggested in our sketch; and to discuss the relations of antagonism and affinity between socialism and the prevailing social and economic ideas and institutions would require a long and elaborate treatise. In the course of the article many obvious points of relationship, and particularly of contrast, between socialism and political economy have presented themselves. All that we can now do is to emphasize a few of the more important of these. The scope of the current political economy of Great Britain may be broadly defined as follows: given the existing arrangements with regard to land, capital, and labor, to determine the economic phenomena and the economic laws that will prevail under a system of free individual competition. As we have abundantly seen, socialism is diametrically opposed to the permanent continuance of these arrangements. It looks forward to the time when the present system of individual property in land and capital served by wage-labor will pass away, and when free competition on that basis will cease with the system of which it is a part. It regards the present economic order with the laws and conditions peculiar to it as a passing phase in the historic evolution of mankind, with no greater claim to permanence or finality than other historic eras which have had their day. What enlightened socialism above all demands is that an unprejudiced science should endeavor to distinguish between such economic laws as are permanently grounded in the nature of man and his environment and such as have their validity only in the existing economic order, between such as are enduringly founded on nature and such as are only the accidents or temporary manifestations of a changing civilization. Socialists appeal to history to prove that what the orthodox economy considered the natural and normal order of things, with its distribution of wealth under the three categories of rent, profit, and wages, is really an exceptional phenomenon limited both in extent and duration. It is therefore an obvious error to speak of socialism as roundly controverting economic law. It is no business of socialism to controvert a law grounded in nature, such as the physiological basis of the law of population; but it denies the applicability of the Malthusian precept under the present condition, when wealth is superabundant, but badly distributed owing to causes for which neither nature nor science, but human selfishness and ignorance are responsible. Nor does it lie in the principles of socialism to question the validity of those special economic laws that hold good under the present economic order. Some of these, such as the iron law of wages, socialism is disposed rather to accentuate unduly as a necessity of the present system. It is the aim of socialism to abolish the conditions under which such laws have their validity. Socialists object to the present economic order *because* of the necessity of results which are opposed to human well-being. They object entirely to the existing order with its distribution of the produce of labor into the three categories of rent, profit, and wages, because on it are founded class distinctions, with the consequent antagonism of classes, and the subjection and degradation of the lower classes,—holding that economic subjection involves all other forms of subjection and degradation. In short, scientific socialism as represented by Marx and Friedrich Engels appeals against the existing economic order, of which the orthodox political economy is an exposition and for which it is so frequently an apology, to the higher laws and principles of social evolution as determined by the nature of man in relation to the environment in which he lives and develops.

There is no space here to trace historically the influence of political economy in the genesis of socialism, nor that of socialism on the recent political economy. It has naturally been the tendency of socialism to emphasize the idea of the worth and significance of labor, so prominent in the school of Adam Smith. This was one of the most valuable features of the Saint-Simon school, otherwise so much disfigured with utopianism and extravagance. As we have seen, the socialism of Marx is in some of its most important aspects a development of Ricardian principles. Turning to the influence of socialism on political economists, we need but refer to that exercised by French socialism on J. S. Mill, as described in his *Autobiography*. The economics of Germany has for the last fifteen years been most powerfully affected by the theories of Lassalle, Marx, and latterly also of Rodbertus. The causes which have produced socialism have also affected economics; but a large part of the change is due directly to the teaching of the socialists, especially of Marx, whose great work is recognized as of the first importance. Without commanding assent to its leading conclusions, socialism has given a new direction to most of the recent Continental research in political economy. The German "socialism of the chair," the influence of which is by no means confined to the country that produced it, is sufficient evidence of this.

Relation to Darwinism.

As we have already seen, Marx and his school accept in the completest form the doctrine of evolution, which they learned first in Hegel, but finally hold as taught by Darwin; and, in common with most socialists, from Saint-Simon downwards, they recognize three stages in the economic development of society,—slavery, serfdom, and wage-labor,—which last they believe will be displaced by an era of associated labor with a collective capital. But how, it is asked, does this theory of socialism as the next goal of society consist with the Darwinian doctrine of the struggle for existence and the survival of the fittest? Is not competition, this *bête noire* of the socialists, simply the social and economic form of the struggle for existence? Is not competition, therefore, the very condition of social progress? Is not socialism, therefore, inconsistent with progress? The question suggested is a large and complicated one, to which we cannot here pretend to give an exhaustive or determinate answer, but can only indicate some of the main lines of discussion. (1) In all periods of human development, and especially in its higher stages, progress consists most essentially in a growing social and ethical virtue and in the cultivation of the beautiful both in sentiment and art. With such an enlarging ideal of progress, how harmonize a system of competition like the present, by which millions in every great European country are effectively deprived of the means of development, and even of bare livelihood? The struggle for existence has always been modified by social and ethical conditions. If it is to continue, as it will in various forms, it should be carried on under higher conditions, suitable to a higher and less animal stage in the evolution of man. (2) Human progress has undoubtedly been attained through struggle, especially through the struggle for existence; but the struggle has essentially been one of men united in society, of tribe against tribe, of city against city, of nation against nation, and race against race. Thus it is easy to exaggerate unduly the importance of the struggle of the individual man. History has only too often seen the abnormal development of private selfishness, so overgrown as to weaken, and finally dissolve and overthrow, the society in which it acted, thereby accomplishing its own destruction. This is indeed the open secret of the ruin of most of the communities that have existed. In short, a happy and healthy individual development can be secured only through its due subordination to social virtue and the general welfare. Human progress has been by strong societies with a well-developed social and public virtue. The excessive development of "individualism" within a society has been its weakness and ruin. (3) While emphasizing the extreme importance of the hereditary principle, especially as connected with the fundamental institution of the family, we should also recognize its tendency to abuse in perpetuating the enormous inequalities of property and condition, many of which originated in a less perfect system of society. The hereditary principle has indeed greatly contributed to the solidity and continuity of the social order; but it also gives an exceptional advantage in the struggle for existence to the privileged few. In this point, therefore, the present system does not best fulfil the requirements of the evolution theory as applied to society. The struggle is not one of merit. It is frequently one of merit against hereditary privilege; not seldom it is one of privilege against privilege without regard to merit at all. (4) In considering the possibilities of human progress afforded by the present system of society in the light of the evolution theory, it is impossible to ignore the fact that the continuance of the race depends most on the less fit members of society, on the lower strata, which are thriftless, the worst fed, and worst educated. While the classes which are most intelligent and endowed with self-control abstain from marriage or defer it, those who have the lowest organization marry early and have large families. Even to perpetuate disease and deformity is not considered wrong. It may be that prohibitory and restrictive laws, even if passed, would prove inoperative and ineffectual in restraining so many hasty and ill-considered unions that only serve to multiply misery and disease; but it is surely excusable at least to inquire whether this abuse of freedom could not be curtailed by strengthening the social union and increasing the pressure of the enlightenment and moral sense of the community. (5) Above all, as the tendency of the present order is to give the victory to cheapness, it may be asked whether competition—the economic form of the struggle for existence—is really such a sure and potent element of progress, unless most powerfully counteracted by other principles? In short, history is the resultant of many complex forces, and it is easy to push too far the formulæ of any system. It is out of the balance and harmony of many principles, of which the struggle for existence is but one, that human progress can proceed. (6) The main point is that in social evolution the widest phase of the struggle for existence is between forms of social organization. Hence the great question as regards socialism is whether it is the fittest form of social organization for the time coming? Is it best adapted to carry forward and develop in wider and more adequate form the progressive life of the future?

While many socialists have announced lax views regarding marriage and the family, it cannot in view of

Marriage and family.

popular misunderstanding be sufficiently emphasized that the essence of socialism is an economic change. It enunciates no special doctrine on the relation of the sexes. In common with other social reformers, socialists generally advocate the equality of the sexes and the emancipation of women; they object to the mercenary element so common in marriage; and they abhor prostitution as one of the worst and vilest of existing evils, believing, moreover, that it is a necessary result of the present distinction of classes and of the unequal distribution of wealth. The views of the anarchists have already been noted. In the Marx school there is a tendency to denounce the legally binding contract in marriage. But such views all belong to the accidents of socialism.

Religion.

So with regard to religion. Socialism has been and still is very frequently associated with irreligion and atheism. The same remark applies to Continental liberalism, and partly for a like reason: the absolute Governments of the Continent have taken the existing forms of religion into their service and have repressed religious freedom. On religion as on marriage socialism has no special teaching. While the anarchists of the school of Bakunin would overturn all forms of religion and reject the idea of God, the social democrats of Germany in their Gotha programme of 1875 declare religion to be a private concern. As we have seen, Christian socialism is a considerable force in many European countries; and in many of the other schools, especially that of Louis Blanc, the kinship and even identity of ethical spirit with that of Christianity are unmistakable.

In relation to politics.

In their revolutionary impatience the anarchists have avowed their hostility to all the existing political forms except the free commune, which alone will be left standing amid the general wreck they contemplate. The Marx school, as represented by its ablest living exponent, Friedrich Engels, also look forward to a period in the evolution of society when the state will become superfluous, and, having no longer any function to perform, will die away. The state they regard as an exploiting institution, an organization of the ruling classes for retaining the workers in economic subjection. The International was an attempt to supersede the exploiting states by a combination of the workers of all countries without distinction of creed, color, or nationality. When the workers in the name of the whole society seize political power and take over the control of production, the rule of classes, their conflicts and the excesses of the struggle for existence among them, will cease. Instead of a government over persons we shall have an administration of things and the control of productive processes. Obviously the Marx school reserve the realization of this idea till the evolution of society has prepared the way for it. In the conduct of the International they insisted on a strongly centralized form of organization as against the free federalism and the rejection of all authority maintained by Bakunin and his followers. This opposition between centralization and federalism does not concern us here; it is a question common to theoretical and practical politics. It is necessary, however, to say a word about the opposition between the national tendency of the Lassalle school and the international socialism of Marx. As we have seen, a compromise was effected in the Gotha programme of 1875, in which the importance of the nation as an existing form of human society is amply recognized. The question is still discussed in the organs of the social democrats: but the international tendency is decidedly the prevalent one. "Want of patriotism" is one of the current epithets of reproach cast at them. It is needless to point out that as most new movements of importance have been revolutionary, so also have they for good or evil been international. In becoming international the labor movement has only followed the example set by commerce, finance, diplomacy, religion, philosophy, art, music.

Conclusion.

We have now reviewed the most important aspects of the socialistic movement. As we have seen, socialism is a new form of social organization, based on a fundamental change in the economic order of society. Socialists believe that the present economic order, in which industry is carried on by private competitive capital, must and ought to pass away, and that the normal economic order of the future will be one with collective means of production and associated labor working for the general good. This principle of socialism is cardinal and fundamental. All the other theories so often connected with it and so important in relation to religion, philosophy, marriage, patriotism, etc., are with regard to socialism non-essential. Questions of method, though supremely important, must also be distinguished from the essential principle. At the same time it will be seen that an economic change, such as that contemplated in socialism, would most powerfully affect every other department of human life. Socialism, in short, means that in industry, in the economic arrangements of society, the collective or co-operative principle shall become normal or universal, that all who are able should contribute to the service of society, and that all should share in the fruits of the associated labor according to some good and equitable principle. In such a condition of things the noblest field for ambition will be in the service of society,—an ideal which is already partially realized in the democratic state. It is in this fundamental sense that J. S. Mill declared himself a socialist.[1] It is in this sense also that Albert Schäffle, one of the first living authorities on economics and sociology, has, after long years of study of the subject, come to the conclusion that "the future belongs to the purified socialism."[2]

Scientific socialists strongly insist that this economic order of the future cannot be realized by utopian schemes or arbitrary legislation or mere revolutionary disturbance. If it come at all, it must come as the consummation of the dominant tendencies of modern social development; it must be realized under the conditions prescribed by our nature and environment. In discussing the doctrines of Marx we stated that the central point of the question was this—do the strongest forces of the social development of our time really tend towards the superseding of the present economic order and towards the establishment of a new and wider order based on collective capital and associated labor? Socialists maintain that they do, and that there is at present going forward a double process of dissolution and reconstruction,—the dissolution of individualism with a constructive tendency towards collectivism. From the socialist point of view the following may be signalized as indicative of such a process. (1) The tendency towards economic anarchy already explained in treating of Marx's views. Over the whole industrial world we see great crises succeeding each other, resulting in stagnation and depression which now threaten to be chronic and permanent. While the productive forces of the world are enormously increasing, they only tend the more to intensify national and international competition, and to render labor superfluous, precarious, and dependent. Under this system the worker has neither freedom nor security. All this variety of symptoms are only a sign of the break-down of the present economic order both in principle and method. They are the necessary results of the competitive system, which has thus finally revealed its real nature and tendency,—economic and social anarchy. (2) The constant and inevitable tendency towards concentration in industrial operations, which began with the introduction of steam and of the factory system, through which the small producer has been superseded by the capitalist, the smaller capitalist by the larger. And now the single capitalist is being absorbed in the company, a growing proportion of the world's business being so large that only a great company can provide the requisite capital and organization; whilst in the large companies there is a tendency, in case they cannot drive each other out of the field, to bring about a fusion of interests. In all this we see a great constructive process inevitably going on as the result of the inherent tendencies of industrial development. Thus the control of industry will be concentrated in a few colossal companies and their chiefs. It is obvious how this process could simplify the transference of the whole to a collective management by society. (3) This leads us to a third important point, the growing tendency towards state control of industry, and the growing sense of the responsibility of society for all its members, observable in German politics, not less than under the more democratic conditions of France and England. It is apparent how under this influence the existing state might absorb one by one all the large social functions, as has already happened with regard to education, means of communication, etc. Naturally this could be accomplished only through a most comprehensive development of local and subordinate bodies of every kind. Socialism by no means implies that such an enormous burden of work should be thrown on the central government. Most socialist schools have contemplated a vast increase of communal or local autonomy,—a course which, on the other hand, does not carry with it the subversion of the central government. (4) In England during the last half century we have seen a long succession of efforts, partially successful, towards a new organization of society rendered necessary by the changes due to the industrial revolution. In economics as in other spheres the watchword of the new era has been freedom, the removal of restraint. But it has been found that positive measures of reconstruction were also necessary. Factory legislation carried in opposition to the prevailing economic theory, trades unions, employers' combinations, industrial partnerships, boards of conciliation, the co-operative system,—all these are real, if partial, endeavors towards a new organization of society suited to the new conditions. Socialism claims to be the comprehensive scheme of organization which embraces in a complete and consistent unity all these partial efforts. (5) But the great social force which is destined to work out the vast transformation consists of the human beings most directly interested in the colossal struggle,—the modern democracy. This democracy is marked by a combination of characteristics which are new to history. It is being educated and enlightened in the school and by the cheap press; it is being drilled and organized in large factories, in the national armies, by vast popular demonstrations, in the gigantic electoral struggles of the time. Thus it is becoming conscious of its enormous power, and able to make use of it. It is becoming conscious also of its unsatisfactory social and economic position. The democracy which has become the master-force of the civilized world are economically a mass of proletarians dependent on precarious wage-labor. Having transformed the political condition of things, they are ready now for an economic transformation. But the inevitable process of concentration of industrial operations already referred to is entirely against the continuance or restoration of the small producer, whether workman or peasant proprietor. Such efforts of continuance or restoration are reactionary; they are economically unsound and must fail. Production and distribution ever tend to larger dimensions. The only issue out of the present economic condition is concentrated collective industry under the control of the new democracy and its chosen leaders. On the irresistible momentum of these two inevitable and ever-growing forces—the concentration of industry and the growth of the new democracy—socialism depends for the realization of its scheme of transformation.

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[1] See his *Autobiography*; also his *Pol. Economy*, chapter on the probable future of the laboring classes.

[2] *Bau und Leben*, vol. ii. 120.

Such are the tendencies to which philosophic socialists point as already working towards a transformation of society of the kind they expect. It is essentially a question of the future, with which we have no concern in this article. Our duty has simply been to point out the forces which socialists believe to be actually at work for the realization of their theory of social organization; and here we must leave the subject.

Literature.—The literature of socialism is enormous and rapidly growing; besides those named under the special articles we now give a list of some of the leading works which are in whole or in part devoted to it:—Karl Marx, *Das Kapital* (1st vol., 3d ed., Hamburg, 1883; 2d vol., 1st ed., Hamburg, 1885); Friedrich Engels, *Eugen Dühring's Umwälzung der Wissenschaft*, a controversial work, but containing a remarkably clear and able exposition of the Marx position by its best living exponent (2d ed., Hottingen-Zurich, 1886); Albert Schäffle, *Bau und Leben des socialen Körpers* (Tübingen, 1878; the third vol. of this work supersedes his *Kapitalismus und Socialismus*, Tübingen, 1870), *Quintessenz des Socialismus* (7th ed., Gotha, 1879); Adolf Held, *Sozialismus, Sozial-Demokratie, und Social-Politik* (Leipsic, 1878); Von Sybel, *Die Lehren des heutigen Socialismus und Communismus* (Bonn, 1872); Lujo Brentano, *Die christlich-soziale Bewegung in England* (Leipsic, 1883); Von Scheel, *Die Theorie der Sozialen Frage* (Jena, 1871); Alphons Thun, *Geschichte der revolutionären Bewegungen in Russland* (Leipsic, 1883); Rudolf Meyer, *Der Emancipations-kampf des vierten Standes* (2d ed., Berlin, 1882); Franz Mehring, *Die Deutsche Socialdemokratie, ihre Geschichte und ihre Lehre* (Bremen, 1879); Laveleye, *Le Socialisme Contemporain* (2d ed., Paris, 1883); Paul Janet, *Les Origines du Socialisme Contemporain* (Paris, 1883); Paul Leroy-Beaulieu, *Le Collectivisme* (Paris, 1884); *Le Procès des Anarchistes* (Lyons, 1883); John Rae, *Contemporary Socialism* (London, 1884); Stepniak, *Underground Russia* (London, 1883); Hyndman, *Historical Basis of Socialism in England* (London, 1884). See also the relative chapters in Roscher's *Grundlagen der Nationalökonomie;* Adolph Wagner's *Lehrbuch der politischen Oekonomie* (vol. i., *Grundlegung*, 2d ed., Leipsic, 1879); Mill's *Political Economy* and *Autobiography;* and Sidgwick's *Principles of Political Economy*. (T. K.)

SOCIETIES. Under ACADEMY will be found an account of the various bodies of which that word forms part of the titles, usually denoting some kind of state support or patronage. The present article is restricted to scientific, archæological, and literary societies, chiefly those founded and carried on by private collective effort. Certain academies omitted in the previous article are, however, referred to. Governmental, collegiate, and university institutions do not come within our scope, neither as a rule do endowed societies, nor yet institutions which, although they bear the name, carry on no kind of joint literary or scientific work. With a few exceptions here and there, the societies mentioned are still flourishing.

In their modern form learned and literary societies have their origin in the Italian academies of the Renaissance; but private scientific societies have arisen chiefly during the 19th century, being due to the necessity of increased organization of knowledge and the desire among scholars for a common ground to meet and compare results and collect facts for future generalization. These bodies rapidly tend to increase in number and to become more and more specialized. Many efforts have been made from time to time to tabulate and analyze the literature published in their proceedings, as, for instance, in the indexes of Reuss (1801–21) and the Royal Society (1867–79) for physics and natural science, and those of Walther (1845) and Koner (1852–56) for history. A further development of the work done by societies was made in 1822, when, chiefly owing to Humboldt, the *Gesellschaft deutscher Naturforscher und Aerzte* first met at Leipsic. This inauguration of the system of national congresses was followed in 1831 by the *British Association for the Advancement of Science*, which has served as the model for similar societies in France, America, and elsewhere. The merit of introducing the idea of migratory congresses into France is due to the distinguished archæologist, M. Arcisse de Caumont (1802–73), who established the *Association Normande*, which since 1845 has held a reunion in one or other of the towns of the province for the discussion of matters relating to history, archæology, science, and agriculture, with local exhibitions. From the same initiation came the *Congrès Archéologique de France* (1834), which was organized by the *Société Française pour la Conservation des Monuments Historiques*, the *Congrès Scientifique*, which held its first meeting at Caen in 1833 (directed by the *Institut des Provinces*), and the *Congrès des Sociétés Savantes des Départements*, which for many years after 1850 held its annual sittings at Paris. The idea received the sanction of the French Government in 1861, when a *Congrès des Sociétés Savantes* was first convoked at the Sarbonne by the minister of public instruction. In Italy Charles Bonaparte, prince of Canino, started an association with like objects, which held its first meeting at Pisa in 1839. Russia has had an itinerant gathering of naturalists since 1867. International meetings are a natural growth from congresses in which specialists of one country or speech are alone represented. Two remarkable examples of these cosmopolitan societies are the *Congrès International d' Archéologie et d' Anthropologie Préhistoriques*, founded at Spezzia in 1865, and the *Congrès International des Orientalistes* (1873). Another step towards more complete organization was taken when the *Smithsonian Institution* (Washington, U.S.) developed the admirable system of international exchanges of its publications, as well as of other works and specimens, among societies and individuals. The *Institution* has agents in every part of the globe, and entertains relations with all the leading societies in the world. The *International Scientific Bureau*, a private enterprise, was established at Haarlem by Dr. Van Baumhauer to facilitate the sending of parcels among societies and scientific men in Holland. Since 1875 the French ministry of public instruction has organized a distribution of foreign publications among societies in France. In England local scientific societies are now officially represented at the meetings of the *British Association*. In 1883 rules were framed for the admission of corresponding societies and for the institution of a conference of delegates to hold sittings contemporaneously with the annual meeting of the Association, for the purpose of discussing "propositions bearing on the promotion of more systematic observation and plans of operation, and of greater uniformity in the mode of publishing results," as well as for the consideration of "matters in which the co-operation of corresponding societies is desired." A committee was appointed in 1882 at the Montreal meeting of the *American Association for the Advancement of Science* "to confer with committees of foreign associations for the advancement of science with reference to an international convention of scientific associations;" and a fund for the purpose has been started.

It has been thought desirable to classify the societies treated of in the present article under the following headings, the first of which includes those of the widest scope, dealing with the whole range of natural history, or with archæology and literature as well as science: I. science generally; II. mathematics; III. astronomy: IV. physics; V. chemistry; VI. geology, mineralogy, and palæontology; VII. meteorology; VIII. microscopy; IX. botany and horticulture; X. zoology; XI. anthropology; XII. sociology (embracing economic science, statistics, law, and education); XIII. medicine, surgery, etc.; XIV. engineering and architecture; XV. naval and military science; XVI. agriculture and trades; XVII. literature, archæology, and history; XVIII. geography.

I. Science generally.

United Kingdom.—First in antiquity and dignity among English societies comes the Royal Society (*q. v.*) of London, which dates from 1660. In 1683 William Molyneux, the author of *The Case of Ireland Stated*, exerted himself to form a society in Dublin after the pattern of that of London. In consequence of his efforts and labors the *Dublin Philosophical Society* was established in January, 1684, with Sir William Petty as first President. The members subsequently acquired a botanic garden, a laboratory, and a museum, and placed themselves in communication with the Royal Society of London. Their meetings after 1686 were few and irregular, and came to an end at the commencement of hostilities between James II. and William III. The society was reorganized in 1693 at Trinity College, Dublin, where meetings took place during several years. On 25th June, 1731, chiefly owing to the exertions of Dr. S. M. Madden, the *Dublin Society for Improving Husbandry, Manufactures, and other Useful Arts* came into existence. In January, 1737, they commenced to publish the *Dublin Society's Weekly Observations*, and in 1746 the society was placed on the civil establishment, with an allowance of £500 [$2430] a year from the Government. A charter of incorporation was granted in 1750, and seven years later the *Royal Dublin Society* for the first time owned a house of its own, and in the following year began the drawing school, which subsequently did so much for Irish art. Between 1761 and 1767 Government grants to the amount of £42,000 [$204,120] for promoting national agriculture and manufactures were distributed by the society, which claims to be the oldest scientific body in the United Kingdom after the Royal Society of London. It has published *Transactions* (1799–1810); and its *Proceedings* (1764–75; 1848, etc.) and *Journal* (1858, etc.) are still issued. For the *Royal Irish Academy*, see Academy.

The *Royal Physical Society of Edinburgh* was instituted in 1771, and incorporated in 1788; it is exclusively devoted to natural history and the physical sciences. With it have been merged many other societies, such as the *Chirurgo-Medical* in 1796, the *American Physical* in 1796, the *Hibernian Medical* in 1799, the *Chemical* in 1803, the *Natural History* in 1812 (which brought in Brougham and Mackintosh), and the *Didactic* in 1813. It issues *Proceedings* (1858, etc.) From the *Philosophical Society of Edinburgh* (1739) was developed the *Royal Society of Edinburgh*, whose charter is dated 29th March, 1783. It was to comprise a physical and a literary class; among the members of the latter were Robertson, Hume, Burke, and Reid, and among those of the former Hutton, Black, Playfair, Dugald Stewart, and Watt. The literary division has been much less productive than the other. A second charter was obtained in 1811. The society has published *Transactions* (4to, 1788, etc.) and *Proceedings* (8vo, 1845, etc.).

The *Linnean Society* for the promotion of zoology and botany was founded in 1788 by Dr. (afterwards Sir) J. E. Smith, in order to supplement the work of the Royal Society, and obtained a royal charter in 1802. The herbarium and collections of Linnæus, with the founder's additions, were purchased after his death. It removed from Sir Joseph Banks's old house in Soho Square to Burlington House (London) in 1857, and assumed the apartments it now occupies in 1873. It has published *Proceedings* (1849, etc.). The *Journal* (8vo, 1857, etc.) and the *Transactions* (4to, 1791, etc.) are divided into zoological and botanical sections. The *Society for the Encouragement of Arts, Commerce, and Manufactures* took its origin in 1753 from an academy established in the Strand by the landscape painter William Shipley. Attention was paid to the application of science to practical purposes, a subject passed over by the Royal Society. Exhibitions of pictures by native artists were held, and the first exhibition of the Royal Academy took place in its rooms. A fresh start in a new career was made by the *Society of Arts* in 1847, when it obtained a charter and the presidency of the Prince Consort. The International Exhibition of 1851 sprang from the smaller exhibitions previously held in its rooms. The East Indian section dates from 1869, the foreign and colonial and the chemical sections from 1874. Its organs have been *Transactions* (1783–1849) and the *Journal* (1853, etc.). Sir Joseph Banks, Count Rumford, and other fellows of the Royal Society started the *Royal Institution* in 1799, when a site was purchased in Albemarle Street for "an establishment in London for diffusing the knowledge of useful mechanical improvements," to "teach the application of science to the useful purposes of life." The institution was incorporated in the following year. One of the most important epochs in the history of chemistry must be dated from the establishment of the laboratory where Davy and Faraday pursued their investigations. Belonging to the institution are foundations for professorships in natural philosophy, chemistry, and physiology. Courses of lectures on special subjects are given as well as discourses (once a week) of a more general and literary character. Its *Journal* has been issued since 1809. The *London Institution* was established on a similar basis in 1805 and incorporated in 1807. The building in Finsbury Circus was erected in 1819. The *British Association for the Advancement of Science* was instituted at York on 27th September, 1831, in imitation of the itinerant scientific parliament held in Germany since 1822 (already referred to), and arose from a proposal by Sir D. Brewster. A meeting is held annually in one of the chief provincial towns of the United Kingdom. The object of the association is to promote science, to direct general attention to scientific matters, and to facilitate intercourse between scientific workers. Abstracts of the proceedings and reports of committees are published in the annual *Report* (1833, etc.). The *Historical Society of Science* (1841) printed a couple of volumes; and the *Ray Society* (1844), instituted for the printing of original and scarce old works (38 vols. have appeared) in zoology and botany, still flourishes. The *Royal Colonial Institute* was founded in 1868 and incorporated in 1882. It provides a place of meeting for gentlemen connected with the colonies and British India, undertakes investigations into subjects relating to the British empire, has established a museum and library, and gives lectures in its new building in Northumberland Avenue (London). It has published *Proceedings* since 1870. The *Victoria Institute*, or *Philosophical Society of Great Britain*, was founded in 1865 to form a connecting bond between men of science and others engaged in investigating important questions of philosophy and science, more especially those bearing upon the truths revealed in Holy Scripture. Its organ is the *Journal* (1867, etc.). The *Balloon Society* of Great Britain (1880) is not restricted to aeronautics, but deals with recent discoveries and inventions, and science generally. The foundation in 1821 of the *Society for the Encouragement of the Useful Arts in Scotland*, now usually known as the *Royal Scottish Society of Arts*, for the promotion of the useful arts and such branches of science as bear upon them was due to Sir D. Brewster, Sir J. Mackintosh, and others; it was incorporated in 1841, and has published *Transactions* since that year.

The leading provincial societies of Great Britain of a general character are as follows: Aberdeen, *Nat. Hist. Soc.* (1863), *Trans.*; *Phil. Soc.* (1840). Alloa, *Soc. of Nat. Hist. and Arch.* (1863), *Proc.* (1865, etc.). *Banffshire Field Club and Sc. Soc.* (1880), *Proc.* Bath, *Nat. Hist. and Antiq. Field Club* (1866), *Proc.* (1867, etc.). *Bedfordshire Nat. Hist. Soc.* (1875), *Trans.* Belfast, *Nat. Hist. and Phil. Soc.* (1821), *Proc.* (1852, etc.); *Naturalists' Field Club* (1863), *Proc.* (1875, etc.). *Berwickshire Naturalists' Club* (1831), *Proc.* (1834, etc.). Birkenhead, *Lit. and Sc. Soc.* (1857). Birmingham, *Nat. Hist. and Micr. Soc.* (1858), *Proc.* (1869, etc.); *Birmingham and Midland Institute Sc. Soc.* (1870), *Trans.* of archæological section (1871, etc.); *Phil. Soc.* (1876), has a fund for promotion of original research, *Proc.*; *Midland Union of Nat. Hist. Societies* (1877), *Midland Naturalist.* Bolton, *Lit. and Phil. Soc.* (1871). Bradford, *Phil. Soc.* (1865), with various local societies affiliated to it. Brighton, *Brighton and Sussex Nat. Hist. Soc.* (1854), *Ann. Reports* (1855, etc.). Bristol, *Museum and Library* (formed by the amalgamation of the *Institution for the Advancement of Sc., Lit., and the Fine Arts* with the *Lit. Soc.*, founded 1772); *Naturalists' Soc.* (1862), *Proc.* (1866, etc.). Burnley, *Lit. and Sc. Club* (1873), *Trans.* Burton-on-Trent, *Nat. Hist. and Arch. Soc.* (1876). Cambridge, *Phil. Soc.* (1819; incorporated 1832), for the promotion of philosophy and natural science, owns museum and library, *Proc.* (1865, etc.), *Trans.* (1821, etc). Cardiff, *Naturalists' Soc* (1867), *Trans.* Chester, *Soc. of Nat. Sc.* (1871), *Proc.* Cork. *Royal Inst.* (1807), library; *Cuvierian and Arch. Soc.* (1836). *Cornwall Royal Inst.*, at Truro (1818), devoted to natural philosophy, natural history, and antiquities, *Journal* (1864, etc.); *Royal Polytechnic Soc.*, at Falmouth (1833; founded by the daughters of R. W. Fox and others), for the encouragement of science and the fine and industrial arts, *Trans.* (1835, etc.). *Cumberland Assoc. for the Advancement of Lit. and Sc.* (1876), provides a means of union for the local scientific societies of Cumberland and Westmoreland, *Trans.* *Derby Nat. Hist and Phil. Soc.* (1772). *Devonshire Assoc. for the Advancement of Sc.* (1862). *Dorset Nat. Hist. and Antiq. Club* (1875). *Dumfriesshire and Galloway Sc., Nat. Hist., and Antiq. Soc.* (1876), *Trans.* Dundee, *Naturalists' Soc.* (1873). Eastbourne, *Nat. Hist. Soc.* (1867), *Proc.* (1869, etc.). *East of Scotland Union of Naturalists' Societies* (1884), *Trans.* Ebbw Vale, *Lit. and Sc. Inst.* (1850), owns laboratory. Elgin, *Elgin and Morayshire Lit. and Sc. Assoc.* (1836). *Essex Field Club* (1880), at Buckhurst Hill, *Trans.* Exeter, *Naturalists' Club and Arch. Assoc.* (1862). Glasgow, *Phil. Soc.* (1802), *Proc.* (1844, etc.); *Nat. Hist. Soc.* (1851), *Proc.* (1868, etc.); *Soc. of Field Naturalists* (1872), *Trans.* (1872, etc.). Gloucester, *Lit. and Sc. Assoc.* (1838). Greenock, *Phil. Soc.* (1861). Halifax, *Phil. and Lit. Soc.* (1830), museum and library. Hereford, *Woolhope Naturalists' Field Club*, *Hereford, Pomona and Trans.* (1866, etc.). *Hertfordshire Nat. Hist. Soc. and Field Club*, formed in 1879 from the *Watford Nat. Hist. Soc.* (1875), *Trans.* High Wycombe, *Nat. Hist. Soc.* (1865), *Magazine* (1866, etc.). Hull, *Lit. and Phil. Soc.* (1822), *Trans.* (1824, etc.). Inverness, *Sc. Soc. and Field Club* (1875). *Isle of Wight Phil. and Sc. Soc.* (1850). *Kent (East) Nat. Hist. Soc.*, at Canterbury (1858), *Trans.* Leeds, *Phil. and Lit. Soc.* (1820); *Naturalists' Club* (1870), *Trans.* Leicester, *Lit. and Phil. Soc.* (1837), *Trans.* Lewes, *Lewes and East Sussex Nat. Hist. Soc.* (1864). Liverpool, *Lit. and Phil. Soc.* (1812; united with *Nat. Hist. Soc.* in 1844), *Proc.* (1845, etc.); *Philomathic Soc.* (1825), *Trans.*; *Polytechnic Soc.* (1838), *Journal* (1838, etc.); *Naturalists' Field Club* (1860). Manchester, *Lit. and Phil. Soc.* (1781), two sections, one physical and mathematical, the other for microscopy and natural history,—the original statements respecting the atomic theory were given by Dalton in the *Memoirs* (1789, etc.); *Field Naturalists and Arch. Soc.* (1860), *Trans.*; *Scientific Students' Assoc.* (1861). Montrose, *Nat. Hist. and Antiq. Soc.* (1836), museum. Newbury, *District Field Club* (1870), *Trans.* (1871, etc.). Newcastle-on-Tyne, *Lit. and Phil. Soc.* (1793), library; *Northumberland, Durham, and Newcastle Nat. Hist. Soc.* (1829), a museum (opened in 1884). *Trans.* Norfolk, *Norfolk and Norwich Naturalists' Soc.* (1869), *Trans.* (1870, etc.). Nottingham, *Lit. and Phil. Soc.* (1864). *Orkney Antiq. and Nat. Hist. Soc.* (1837), museum. Oxford, *Ashmolean Soc.* (1828), promotes all branches of practical knowledge. Paisley, *Phil. Institution* (1808), free library and museum; Mr. Coats presented his observatory in 1882. Penzance, *Nat. Hist. and Antiq. Soc.* (1839), museum, *Proc.* (1845, etc.). Perth, *Lit. and Antiq. Soc.* (1784); *Perthshire Soc. of Nat. Sc.* (1867), *Proc.* (1869, etc.), *The Scottish Naturalist* (1870, etc.). Plymouth, *Plymouth Inst. and Devon and Cornwall Nat. Hist. Soc.* (1812), museum, art gallery, and library. Richmond, *Richmond and North Riding Naturalists' Field Club* (1868), *Trans.* Ripon, *Naturalists' Club and Sc. Assoc.* (1882). Scarborough, *Phil. and Arch. Soc.* (1831), museum and library. *Severn Valley Naturalists' Field Club*, at Bridgenorth (1863). Sheffield, *Lit. and Phil. Soc.* (1822). *Shetland Lit. and Sc. Soc.*, at Lerwick (1861). *Shropshire and North Wales Nat. Hist. and Antiq. Soc.* (1835) at Shrewsbury. *Somersetshire Arch. and Nat. Hist. Soc.*, at Taunton (1849), *Proc.* (1851, etc.). Southampton, *Hartley Institution* (founded under bequest of H. R. Hartley in 1859, incorporated 1862), for the promotion of scientific, antiquarian, and Oriental studies and the fine arts, owns a museum and library. *Staffordshire (North) Naturalists' Field Club and Arch. Soc.* (founded as a natural history society in 1865; enlarged 1877), holds movable meetings. Stirling, *Nat. Hist. and Arch. Soc.* (1878), *Trans.* Stockport, *Soc. of Naturalists* (1884), *Trans.* *Suffolk Inst. of Arch. and Nat. Hist.*, at Bury St. Edmunds (1848), *Proc.* (1848, etc.), *The East Anglian* (1859, etc.). Swansea, *Royal Institution* (founded 1835; incorporated 1883), with a museum and library, promotes natural history and applied science, literature, and fine arts, local history and antiquities. Tamworth, *Nat. Hist., Geolog., and Antiq. Soc.* (1871). *Teign Naturalists' Field Club* (1858). Torquay, *Nat. Hist. Soc.* (1844), museum and library. *Tweedside and Kelso Physical and Antiq. Soc.* (1834). Warrington, *Lit. and Phil. Soc.* (founded in 1870 upon the *Micr. Soc.*). *Warwickshire Nat. Hist. and Arch. Soc.* (1836), has a library and geological museum; *Warwickshire Field Club* (1854). Whitby, *Lit. and Phil. Soc.* (1822), owns a museum. *Wiltshire Arch. and Nat. Hist. Soc.*, at Devizes (1853), *Wiltshire Magazine* (1853, etc.). Windsor, *Windsor and Eton Sc. Soc.*, *Trans.* Witney, *Nat. Hist. and Lit. Soc.* (1858). *Yorkshire Phil. Soc.* (1822), the museum in the grounds of St. Mary's Abbey, York, contains a remarkable collection of Roman remains; *Geolog. and Polytechnic Soc.* (1837), quarterly meetings in various Yorkshire towns; *Naturalists' Union* of the natural history and scientific societies of the county (founded in 1861 as the *West Riding Consolidated Naturalists' Soc.*; reorganized in 1876), the *Naturalist* (1876, etc.).

AFRICA: Cape Town, *South Afr. Phil. Soc.*, *Trans.* (1878, etc.): Mauritius, *Roy. Soc. of Arts and Sc.*, *Proc.* (1846, etc.) and *Trans.* (1848, etc.). CANADA: Halifax, *Nova Scotian Inst.*, *Proc.* (1863, etc.; 1867, etc.). Montreal, *Nat. Hist. Soc.*, *Canadian Naturalist* (1857, etc.). Ottawa, *Lit. and Sc. Soc.* Toronto, *Canadian Inst.*, *Canadian Journal* (1852–76), *Proc.* (1879, etc.). Winnipeg, *Hist. and Sc. Soc.* WEST INDIES: Kingston, *Roy. Soc. of Arts of Jamaica*, *Trans.* (1854, etc.). Port of Spain, *Sc. Assoc. of Trinidad*, *Proc.* (1866, etc.). AUSTRALIA and NEW ZEALAND: Adelaide, *Phil. Soc.*, *Trans.* (1865, etc.); *South Australian Inst.* (1836), library; *Roy. Soc. of S. Australia.* Auckland, *Auckland Inst.* Brisbane, *Queensland Phil. Soc.* Christchurch, *Phil. Inst.* Hobart Town, *Roy. Soc. of Van Diemen's Land*, *Papers* (1851, etc.); *Roy. Soc. of Tasmania*, *Monthly Notices* (1864, etc.). Melbourne, *Roy. Phil. Soc. of Victoria*, *Trans.* (1855, etc.); *Nat. Hist. Soc.*; *Zoolog. and Acclim. Soc.*, *Proc.* (1872). Sydney, *Linnean Soc. of N. S. W.*, *Proc.* (1876, etc.); *Phil. Soc.*, *Trans.* (1862, etc.; 1866, etc.); *Roy. Soc. of N. S. W.*, *Trans.* (1867, etc.). Wellington, *New Zealand Inst.*, *Trans.* (1869, etc.).

UNITED STATES.—The first scientific society in the United States originated from a *Proposal for Promoting Useful Knowledge among the British Plantations*, issued by Dr. Franklin in 1743. In the following year the *American Philosophical Society* was founded at Philadelphia, with Thomas Hopkinson as president and Franklin as secretary. With it was united on 2d January, 1769, another Philadelphia society, *The Junto* (1758), the records of which have been preserved. The *American Philosophical Society* is still in vigorous life, and is an exclusively scientific body and the oldest organized society in the United States for the pursuit of philosophical investigation in its broadest sense. It publishes *Transactions* (4to, 1771, etc.) and *Proceedings* (8vo, 1840, etc.). Although not a society in the exact sense of the word, the *Smithsonian Institution*, the most important scientific body in America, must not be overlooked. It was founded at Washington by James Lewis Macie, afterwards called Smithson, a natural son of Hugh Smithson, duke of Northumberland. He died in 1829, leaving by will a sum of money which in 1838 amounted to over half a million dollars, "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." The institution was established by Act of Congress in 1838. The endowment has now been increased to half as much again as the original bequest. The National Museum, founded in 1842, the nucleus of which was the natural history collections brought home by the Wilkes and other exploring expeditions, was given into the custody of the Smithsonian Institution in 1858. It has since been largely increased and is now particularly rich in the ethnology, zoology, and mineralogy of the United States. The chief function of the institution is to assist scientific research and to act as an organized centre for the exchange of books and specimens with scientific bodies and individuals throughout the whole world. The *Annual Reports* date from 1846 (8vo, 1847, etc.), the *Smithsonian Contributions to Knowledge* (4to) from 1848, and the *Miscellaneous Collections* from 1856 (8vo, 1862, etc.). The *Proceedings* and *Bulletin* (1875, etc.) of the National Museum are issued under the authority of the Smithsonian Institution, as well as the publications of the Bureau of Ethnology and the *Bulletin* of the *Philosophical Society of Washington*. Second in point of date comes the *American Academy of Arts and Sciences* of Boston, incorporated in 1780 with the object of furthering the study of the antiquities and natural history of the country. Its *Memoirs* (4to, 1785, etc.) and *Proceedings* (8vo, 1848, etc.) are still published. The *Connecticut Academy of Arts and Sciences* was incorporated at New Haven in 1799. At first only devoted to matters connected with the State of Connecticut, it now embraces the whole field of the sciences and useful arts. It has issued *Memoirs* (1810–16), and now publishes *Transactions* (1866, etc.). One of the leading societies in the United States, the *Academy of Natural Sciences* of Philadelphia, founded in 1812 and incorporated in 1817, possesses the best natural history library (35,000 vols.) in the country and one of the largest natural history museums in the world, being especially rich in conchology. It issues a *Journal* (1817, etc.) and *Proceedings* (1843, etc.). The *American Entomological Society* is merged with it. The *Franklin Institute* of the same city, incorporated in 1824, possesses a library, gives lectures, and issues a *Journal* (1826, etc.). The *Boston Society of Natural History* was founded upon the *Linnean Society* (1814) in 1830 and incorporated in 1831. It possesses a library and a cabinet of specimens. It published the *Boston Journal of Natural History* (8vo, 1837–63), followed by *Memoirs* (4to, 1866, etc.); *Proceedings* (1844, etc.) are also issued. The *Lyceum of Natural History*, New York, was incorporated in 1817 and has published *Annals* from 1823 (1824, etc.) and *Proceedings* (1870, etc.). In 1876 the name was changed to *New York Academy of Sciences*. A number of American naturalists and geologists, having held meetings in various cities between 1840 and 1847, resolved themselves at their Boston congress in the latter year into the *American Association for the Advancement of Science*, which was incorporated in 1874. Its object is "by periodical and migratory meetings to promote intercourse between American scientists." It has published *Proceedings* (1849, etc.). The *National Academy of Science* was incorporated at Washington in 1863 with a view to making the knowledge of specialists available for the service of Government. There are two classes of members, those in mathematics and physics and those in natural history. It has issued *Annals* (Cambridge, 1865, etc.) and *Reports*, as well as *Memoirs* (1866, etc.). The *Academies of Sciences* at San Francisco (1853), St. Louis (1856, incorporated 1857), Chicago (1857, incorporated 1865), and Davenport (1867) deserve special mention.

Among the remaining societies of a general scientific character are—*Albany Inst.* (1828), *Trans.* (1830, etc.), *Proc.* (1870, etc.). Ann Arbor, *Sc. Assoc.* (1875). Baltimore, *Maryland Acad. of Sc. and Lit.*, *Trans.* (1837). Buffalo, *Soc. of Nat. Sc.* (1861), *Bulletin* (1873, etc.). Charleston, *Elliott Soc. of Nat. Hist.* (1853), *Proc.* (1855, etc.), *Journal* (4to, 1859, etc.). Cincinnati, *Soc. of Nat. Hist.* (1870), *Proc.* (1876, etc.). Cleveland, *Acad. of Nat. Sc.* (1852), *Annals* and *Proc.* Dubuque, *Iowa Inst. of Sc. and Arts*, *Trans.* Indianapolis, *Acad. of Sc.*, *Trans.* (1872, etc.). Madison, *Wisconsin Acad. of Sciences, Arts, and Letters* (1870), *Bulletin* (1870, etc.), *Trans.* (1872, etc.). Minneapolis, *Minnesota Acad. of Nat. Sc.* (1873), *Bulletin*. New Orleans, *Acad. of Sc.* (1853), *Proc.* Portland (Maine), *Soc. of Nat. Hist.* (1850), *Proc.* (1862, etc.). Poughkeepsie, *Soc. of Nat. Hist.* (1874), *Proc.* (1874, etc.; 1876, etc.). Rochester, *Acad. of Nat. Sc.* (1881). Salem (Mass.), *Essex County Nat. Hist. Soc.* (1833; now merged in the *Essex Institute*), published the *American Naturalist* (1867–68), afterwards issued by the *Peabody Acad. of Science*, as well as *Proc.* (1856, etc.) and *Bulletin* (1869, etc.). Topeka, *Kansas Acad. of Sc.* (1867), holds meetings in various cities, *Trans.* (1872, etc.).

FRANCE.—The *Institut de France* (see INSTITUTE OF FRANCE), which includes five separate academies, stands at the head of all French societies. The *Société Philotechnique*, founded in 1795 and recognized as of public usefulness by a decree of 11th May, 1861, has for its object the encouragement and study of literature, science, and the fine arts. Two public meetings are held annually. The *Annuaire* (1840, etc.) is its literary organ. The *Société d'Encouragement pour l'Industrie Nationale* was founded in 1801 for the amelioration of all branches of French industry, and was recognized by the state in 1824. Prizes and medals are offered. It publishes a *Bulletin*. The *Académie Nationale, Agricole, Manufacturière, Commerciale* was founded by the duc de Montmorency in 1830, and also offers prizes and medals, and brings out a *Bulletin* (1830, etc.). The *Association Française pour l'Avancement des Sciences* (1871), founded on the model of the British Association, holds migratory meetings and publishes *Comptes Rendus*. The scientific congresses whose origin was due to the initiation of M. A. de Caumont have been noticed at the beginning of the article.

The departmental societies are very numerous and active. The chief are the following: Abbeville, *Soc. d'Émulation* (1797), *Mém.* (1797, etc.). Agen, *Soc. d'Agr., Sc., et Arts* (1784), *Recueil* (1804, etc.). Aix, *Acad. des Sc.*, etc. (1829), based on *Soc. des Amis de la Sc.* (1808), *Mém.* (1819, etc.). Alais, *Soc. Sc. et Litt.* (1868), *Bull.* (1868, etc.). Amiens, *Acad.*, based on *Soc. Litt.* (1746), *Mém.* (1835, etc.); *Soc. Linnéenne* (1838), *Mém.* (1866, etc.). Angers, *Soc. Acad. de Maine et Loire* (1857), *Mém.* (1857, etc.); *Soc. d'Agr., etc.* (1818), *Mém.* (1831, etc.); *Soc. Linn. de M. et L.* (1852), *Annales* (1853, etc.). Angoulême, *Soc. d'Agr., etc., de la Charente* (1803), *Annales* (1819, etc.). Annecy, *Soc. Florimontane* (1851), *Annales* (1851, etc.) and *Rev. Savoisienne* (1860, etc.). Apt, *Soc. Litt., Sc. et Art.*, (1863), *Annales* (1865, etc.). Arras, *Acad.* (1738), *Mém.* (1818, etc.) and other publications. Autun, *Soc. Éduenne* (1836), *Mém.* (1837, etc.) and other publications. Auxerre, *Soc. des Sc.* (1847), *Bull.* (1847, etc.) Bar-le-Duc, *Soc. des Lettres*, etc. (1870), *Mém.* (1871, etc.). Beauvais, *Soc. Acad.* (1847), *Mém.* (1847, etc.). Besançon, *Acad. des Sc., etc.* (1752; suppressed in 1793; re-established 1805), *Séances publ.* (1806, etc.); *Soc. d'Émulation* (1840), *Mém.* (1841, etc.). Béziers, *Soc. Arch., Sc.*, etc. (1834), *Bull.* (1836, etc.). Blois, *Soc. des Sc. et Lettres de Loir-et-Cher* (1832), *Mém.* (1833, etc.). Bordeaux, *Acad.* (1712; suppressed 1793; re-established 1816), *Actes* (1839, etc.); *Soc. Linn.* (1818), *Bull.* (1826–29) and *Actes* (1838, etc.); *Soc. des Sc.* (1850), *Mém.* (1855, etc.). Boulogne, *Soc. Acad.* (1863), *Mém.* (1864, etc.). Bourg, *Soc. d'Émulation* (1783), *Comptes R.* (1802–22) and *Annales* (1868, etc.). Bourges, *Soc. Hist., etc., du Cher* (1849), *Mém.* (1857, etc.). Caen, *Acad. Nat.* (1652), *Mém.* (1754–60 and 1822, etc.); *Soc. Linn.* (1823), *Mém.* (1824, etc.), and *Bull.* (1855, etc.). Cambrai, *Soc. d'Émulation* (1804), *Mém.* (1808, etc.). Cannes, *Soc. des Sc.* (1868), *Mém.* (1869, etc.). Chambéry, *Acad.* (1819), *Mém.* (1825, etc.). Châteaudun, *Soc. Dunoise* (1864), *Bull.* (1864, etc.). Cherbourg, *Soc. Acad.* (1755), *Mém.* (1833, etc.); *Soc. Nat.* (1851), *Mém.* (1852, etc.). Clermont-Ferrand, *Acad.* (1747), *Annales* (1828, etc.) and *Mém.* (1859, etc.). Dijon, *Acad.* (1740; suppressed 1793; re-established 1800), *Mém.* (1769, etc.). Douai, *Soc. d'Agr., etc., du Dép. du Nord* (1799), *Mém.* (1826, etc.). Draguinan, *Soc. d'Études Sc.* (1855), *Bull.* (1856, etc.). Dunkirk, *Soc. Dunkerquoise* (1851), *Mém.* (1853, etc.). Épinal, *Soc. d'Émulation* (1825), *Annales* (1831, etc.). Evreux, *Soc. Libre d'Agr.*, etc. (1807), *Recueil* (1830, etc.). Grenoble, *Acad. Delphinale* (1789), based on *Soc. Litt.* (1772), *Bull.* (1846, etc.). Laon, *Soc. Acad.* (1850), *Bull.* (1852, etc.). La Rochelle, *Acad.* (1732; suppressed 1791; reconstituted in 1808 as *Lycée Rochelais* and in 1853 under its former name), *Annales* (1854, etc.). Le Havre, *Soc. des Sc. et Arts* (1868), *Bull.* (1868, etc.). Le Mans, *Soc. d'Agr.*, etc., *de la Sarthe* (founded in 1761; reorganized on several occasions, and finally in 1839), *Bull.* (1833, etc.). Le Puy, *Soc. d'Agr., Sc.*, etc. (1819), *Annales* (1826, etc.) and *Bull.* (1836, etc.). Lille, *Soc. des Sc.*, etc. (founded 1802 as *Soc. d'Amateurs*), *Mém.* (1819, etc.). Limoges, *Soc. d'Agr., Sc.*, etc., *de la Haute-Vienne* (1759), *Bull.* (1822, etc.). Lons-le-Saunier, *Soc. d'Émulation du Jura* (1817), *Mém.* (1818, etc.). Lyons, *Acad.* (1700), *Mém.* (1845, etc.); *Soc. d'Agr., Hist. Nat.*, etc. (1761), *Comptes R.* (1806, etc.) and *Mém.* (1838, etc.); *Soc. Linn.* (1822), *Annales* (1836, etc.). Mâcon, *Acad.* (1805), *Comptes R.* (1818–47) and *Annales* (1853, etc.). Marseilles, *Acad.* (1726; in 1766 called *Soc. des Sciences*; suppressed in 1793; reorganized in 1799, and finally in 1802), *Recueil* (1727–86) and *Mém.* (1803, etc.). Meaux, *Soc. Libre d'Agr., Sc.*, etc. (1798; reorganized in 1820), *Publ.* (1833, etc.). Mende, *Soc. d'Agr.*, etc., *du Dép. de la Lozère* (1819), *Mém.* (1827, etc.) and *Bull.* (1850, etc.). Montbéliard, *Soc. d'Ém.* (1852), *Mém.* (1852, etc.). Montpellier, *Acad.* (founded in 1706 as *Soc. Royale*; suppressed in 1793; finally reorganized in 1846), *Mém.* (1846, etc.); *Soc. d'Horticult.*, etc., *de l'Hérault* (1860), *Annales* (1860, etc.). Moulins, *Soc. d'Ém. de l'Allier* (1846), *Mém. et Bull.* (1850, etc.). Nancy, *Acad. de Stanislas* (1750), *Mém.* (1754, etc.); *Soc. des Sc.* (1873), founded on *Soc. des Sc. Nat. de Strasbourg* (1828), *Mém.* (1830, etc.) and *Bull.* (1866, etc.). Nantes, *Soc. Acad. de la Loire Inf.* (1848), founded in 1798 as *Institut. Départmental*, *Annales* (1830, etc.). Nevers, *Soc. Nivernaise* (1851), *Bull.* (1851, etc.). Nice, *Soc. des Lettres*, etc., *des Alpes-Marit.* (1861), *Annales* (1865, etc.). Nîmes, *Acad. du Gard* (1682), *Mém.* Niort, *Soc. de Statist. Sc.*, etc., *des Deux-Sèvres* (1836), *Mém.* (1836, etc.) and *Bull.* (1852, etc.). Orleans, *Acad. de Sainte-Croix* (1863), *Lect. et Mém.* (1865, etc.); *Soc. d'Agr., Sc.*, etc. (1809), *Bull.* (1810–18), *Ann.* (1818–37), and *Mém.* (1837, etc.). Pau, *Soc des Sc., Lettres*, etc. (1841), *Bull.* (1841, etc.). Périgueux, *Soc. d'Agr., Sc.*, etc., *de la Dordogne* (1820), *Annales* (1840, etc.). Perpignan, *Soc. Agr.*, etc., *et Litt. des Pyrénées-Or.* (1833), *Bull.* (1834, etc.). Poitiers, *Soc. d'Agr., Belles-Lettres*, etc. (1789), *Bull.* (1818, etc.). Privas, *Soc. des Sc. Nat. et Hist.* (1861), *Bull.* (1861, etc.). Rheims, *Acad. Nat.* (1841), *Séances* (1844, etc.). Rochefort, *Soc. d'Agr., Belles-Lettres*, etc. (1806), *Travaux* (1854, etc.). Rodez, *Soc. des Lettres, Sc.*, etc., *de l'Aveyron* (1836), *Mém.* (1838, etc.) and *Procès-Verb.* (1864, etc.). Rouen, *Acad.* (1744), *Précis Analyt.* (1744, etc.); *Soc. des Amis des Sc. Nat.* (1864), *Bull.* (1865, etc.). Saint-Brieuc, *Soc. d'Ém., Bull. et Mém.* (1861, etc.). Saint-Étienne, *Soc. d'Agr.*, etc., *de la Loire* (1856), *Bull.* Saint-Jean d'Angély, *Soc. Hist. et Sc.* (1863), *Bull.* (1863, etc.). Saint-Quentin, *Soc. Acad.* (1825), *Mém.* (1830, etc.). Semur, *Soc. des Sc. Hist. et Nat.* (1842), *Bull.* (1864, etc.). Soissons, *Soc. Arch., Hist., et Sc.* (1846), *Mém.* (1847, etc.). Tarbes, *Soc. Acad. des Hautes-Pyrénées* (1853), *Bull.* (1854, etc.). Toulon, *Soc. Acad. du Var* (1811), *Mém.* (1832, etc.). Toulouse, *Acad.* (founded in 1640; known to 1704 as *Soc. des Lanternistes* and by other names to 1807, when present title was acquired), *Hist. et Mém.* (1782–90) and *Mém.* (1827, etc.); *Soc. d'Hist. Nat.* (1866), *Bull.* (1867, etc.); *Soc. des Sc.* (1872), *Bull.* (1872, etc.). Tours, *Soc. d'Agr.*, etc., *d'Indre-et-Loire* (founded in 1761 as *Soc. Roy. d'Agr.*), *Recueil* (1763 and 1808–10) and *Annales* (1821, etc.). Troyes, *Soc. Acad.*, based on *Soc. Acad. de l'Aube* (1801), *Mém.* (1801, etc.). Valenciennes, *Soc. d'Agr., Sc., et Arts* (1831), *Mém.* (1833, etc.; 1865, etc.) and *Revue Agricole* (1849, etc.). Vannes, *Soc. Polymathique du Morbihan* (1826), *Comptes R.* (1827, etc.) and *Bull.* (1857, etc.). Vendôme, *Soc. Arch., Sc., et Litt.* (1862), *Bull.* (1862, etc.). Verdun, *Soc. Philomath.* (1822), *Mém.* (1840). Versailles, *Soc. d'Agr. et des Arts* (1798), *Mém.* (1799–1864) and *Bull.* (1866, etc.); *Soc. des Sc Nat. et Méd.* (1832), *Mém.* (1835, etc.). Vesoul, *Soc. d'Agr.*, etc., *de la Haute-Saône* (1801; reorganized in 1819 and 1832), *Recueil Agronom.* (1836, etc.), *Mém.* (1859, etc.), and *Bull.* (1869, etc.). Vitry-le-François, *Soc. des Sc. et Arts* (1861), *Bull.* (1867, etc.).

GERMANY and AUSTRIA-HUNGARY: Agram, *Jugo-slavenska Akademija* or *South Slav. Acad.* (1866), various publications. Altenburg, *Naturforsch. Ges. d. Osterlandes* (1817), *Mittheil.* Augsburg, *Naturforsch. Ver.* (1846), *Ber.* (1848, etc.). Bamberg, *Naturforsch. Ges.* (1834), *Ber.* (1852, etc.). Berlin, *Ges. naturf. Freunde* (1773), *Sitzungsber.* (1862, etc.). Blankenburg, *Naturwiss. Ver. des Harzes* (1831), *Ber.* (1841, etc.). Bonn, *Naturh.-Verein* (1843), *Verhandl.* (1844, etc.); *Görres Ges.* (1876), *Hist. Jahrbüch.* (1880, etc.); *Niederrhein. Ges.* (1818; reorganized 1839). Bremen, *Naturwiss. Ver.* (1864), *Abhandl.* (1868, etc.). Breslau, *Schles. Ges. f. vaterl. Kultur* (1803), *Jahresber.* (1804, etc.). Brünn, *K. k. Mähr.-Schles. Ges.*, *Mittheil.* (1821, etc.). Cassel, *Ver. f. Naturkunde*, *Jahresber.* (1837, etc.). Colmar, *Soc. d'Hist. Nat.* (1859), *Bull.* (1860, etc.) Cracow, *Towarzystwo Naukowe*, afterwards *Akademija Umiejetnosci* or *Acad. of Science*, many publications. Dantzic, *Naturforsch. Ges.*, *Versuche* (1745–57) and *Schriften* (1820, etc.); *Bot.-Zoolog. Ver.* (1878). Donaueschingen, *Ver. f. Gesch. u. Naturgesch.* (1801), *Schriften*. Dresden, *Naturwiss. Ges. Isis* (1833), *Sitzungsber.* (1861, etc.); *Ges. f. Natur- u. Heil-Kunde* (1818). *Jahresber.* (1848, etc.); *Ges. f. Botanik u. Zoologie*, *Nunquam Otiosus* (1870, etc.). Dürkheim, *Pollichia*, *Naturwiss. Ver.*, *Jahresber.* (1843, etc.). Elberfeld, *Naturwiss. Ver.*, *Jahresber.* (1851, etc.). Emden, *Naturforsch. Ges.* (1814), *Jahresber.* (1837, etc.). Frankfort, *Seckenbergische naturforsch. Ges.*, *Museum* (1834–35) and *Abhandl.* (1854, etc.). Freiburg (in Baden), *Naturforsch. Ges.* (1821), *Ber.* (1858, etc.). Fulda, *Ver. f. Naturkunde* (1865), *Ber.* (1870, etc.). Giessen, *Oberhess. Ges. f. Natur- und Heil-Kunde*, *Ber.* (1847, etc.). Görlitz, *Oberlausitzer Ges. d. Wiss.* (1779), *Magazin*; *Naturforsch. Ges.*, *Abhandl.* (1827, etc.). Görz, *Soc. Imp. Reale*, *Mem.* Göttingen, *K. Ges. d. Wissensch.*, *Anzeiger* (1789, etc.), *Abhandl.* (1845, etc.), and *Nachr.* (1845, etc.). Gratz, *Naturwiss. Ver.*, *Mittheil.* (1863, etc.). Greifswald, *Naturwiss. Ver. von Neu-Vorpommern*, *Mittheil.* (1869, etc). Halle, *Naturf. Ges.* (1779), *Abhandl.* (1853, etc.); *Naturwiss. Ver.*, *Zeitschrift* (1853, etc.). Hamburg, *Naturwiss. Ver.*, *Abhandl.* (1846, etc.). Hanau, *Wetterauische Ges.* (1808), *Jahresber.* (1852, etc.). Heidelberg, *Naturhist.-Med. Ver.*, *Verhandl.* (1857, etc.). Hermannstadt, *Siebenbürgisch. med. Ver. f. Naturwiss.*, *Verhandl.* (1849, etc.). Innsbruck, *Ferdinandeum*, *Beiträge* (1825–34) and *Neue Zeitschrift* (1835, etc.). Jena, *K. Leopold.-Carol. Akad.*, *Athenæum* (1875, etc.); *K. Leopold.-Carol. D. Akad. d. Naturf.*, *Leopoldina* (1859, etc.); *Med.-naturwiss. Ges.*, *Jen. Zeitschr.* (1864, etc.). Karlsruhe, *Naturwiss. Ver.*, *Verhandl.* (1864, etc.). Klausenburg, *Siebenbürg. Museum*, *Annalen*. Leipsic, *K. Sächs. Ges. d. Wiss.*, *Ber.* (1846, etc.) and *Abhandl.* (1850, etc.). Lemberg, *Ges. v. Galizien*, *Ber.* Lüneburg, *Naturwiss. Ver. Jahresber.* (1852, etc.). Magdeburg, *Naturwiss. Ver.*, *Abhandl.* (1869, etc.). Mainz, *Rhein. naturforsch. Ges.* (1834). Mannheim, *Ver. f. Naturk.*, *Jahresber.* (1834, etc.). Marburg, *Ges. f. d. Gesch. naturwiss.*, *Schriften* (1823, etc.) and *Sitzungsber.* (1866, etc.). Meissen, *Ver. f. Erdk. Isis* (1845). Metz, *Acad.*, based on *Soc. des Lettres*, etc. (1819), *Mém.* (1828, etc.); *Soc. d'Hist. Nat. Mém.* (1843) and *Bull.* (1844, etc.). Nuremberg, *Naturhist. Ges.* (1801), *Abhandl.* (1852, etc.); *German. Museum*, *Jahresber.* (1854, etc.) and *Anzeig.* (1853, etc.). Pesth, *Magyar Tudományos Akademia* or *Hung. Acad. of Sciences*, many publications; *Királyi Magyar Természett. Társulat* or *R. Hung. Soc. of Nat. Sciences*, many publications. Prague, *K. Böhm. Ges.*, *Abhandl.* (1785, etc.) and *Sitzungsber.* (1859, etc.); *Naturhist. Ver. Lotos*, *Lotos* (1851, etc.). Pressburg, *Ver. f. Naturk. Verhandl.* (1856, etc.). Ratisbon, *Zoolog.-mineralog. Ver.* (1846, since 1883 called *Naturwiss. Ver.*), *Abhandl.* (1849, etc.). Reichenbach (Voigtland, Saxony), *Ver. f. Naturk.* (1859), *Mittheil.* Roveredo, *Imp. Acad.* (1750), *Atti* (1826, etc.). Strasburg, *Soc. des Sc. Agr. et Arts* (1802) *Mem.* (1811, etc.) and *Bull.* (1843, etc.). Stuttgart, *Ver. f. vaterl. Naturk.* (1822), *Jahresber.* (1850, etc.). Thorn, *Copernicus Ver.* (1839). Trieste, *Soc. Adriatica*, *Boll.* Ulm, *Ver. f. Mathem. u. Naturwiss.*, *Verhandl.* Vienna, *K. Akad. d. Wiss.*, *Denkschriften* (1850, etc.), and *Sitzungsber.* (1848, etc.); *K. k. Zoolog.-Bot. Ges.*, *Verhandl.* (1851, etc.); *Verein z. Verb. Naturwiss. Kentnisse*, *Schriften* (1862, etc.). Wiesbaden, *Nassauischer Ver. f. Naturk.* (1829), *Jahrbücher* (1844, etc.). Zweibrücken, *Naturhist. Ver.* (1863), *Jahresber.* (1864, etc.).

Switzerland: Basel, *Naturforsch. Ges.*, *Ber.* (1835, etc.) and *Verhandl.* (1857, etc.). Bern, *Naturforsch. Ges.*, *Mittheil.* (1844, etc.). Chur, *Naturforsch. Ges.*, *Jahresber.* (1856, etc.). Geneva, *Soc. de Phys. et d'Hist. Nat.*, *Mém.* (1821, etc.); *Inst. des Sc., des Lettres*, etc., *Mém.* and *Bull.* Lausanne, *Soc. Vaudoise des Sc. Nat.*, *Bull.* (1842, etc.). Neuchâtel, *Soc. des Sc. Nat.*, *Mém.* (1835, etc.) and *Bull.* (1844, etc.). St. Gall, *Naturwiss. Ges.*, *Ber.* (1860, etc.). Solothurn, *Naturhist. Kantonal-Ges.*, *Jahresber.* (1825, etc.). Zurich, *Naturforsch. Ges.*, *Abhandl.* (1761–66), *Mittheil.* (1846, etc.), and *Vierteljahrschr.* (1856, etc.); *Allg. Schweizer. Ges. f. d. Naturwiss.*, *Verhandl.*, *Anzeiger*, and *Denkschr.* (1829, etc.).

Italy: *Congresso degli Scienziati Italiani*, *Atti* (1844–45); *Riunione degli Sc. Ital.*, *Atti* (1839–47; 1873, etc.). Bologna, *Accad. delle Sc. dell' Istit. di Bologna*, *Rendic.* (1833, etc.), and *Mem.* (1850, etc.). Brescia, *Accad.*, afterwards *Ateneo*, *Comment.* (1808, etc.). Catania, *Accad. Gioenia di Sc. Nat.*, *Atti* (1825, etc.). Florence, *R. Museo di Fis. e Stor. Nat.*, *Annali* (1808, etc.). Lucca, *R. Accad. Lucchese*, *Atti* (1821, etc.). Messina, *R. Accad. Peloritana.* Milan, *Accad. Fis.-Med. Statist.*, *Diario ed Atti* (1846, etc.); *R. Istit. Lombardo*, *Mem.* (1819, etc.), *Giornale* (1840, etc.), *Atti* (1860, etc.), and *Rendic.* (1864, etc.); *Soc. Ital. delle Sc. Nat.*, *Atti* (1860, etc.), and *Mem.* (1865, etc.). Modena, *R. Accad. di Sc.*, etc., *Mem.* (1833, etc.); *Soc. Ital. delle Sc.*, *Mem.* (1782, etc.). Naples, *R. Istit. d'Incoragg. alle Sc. Nat.*, *Atti* (1811, etc.). Padua, *R. Accad. di Sc.*, *Lett.*, *ed Arti*, *Saggi* (1786, etc.) and *Revista* (1851, etc.). Venice, *R. Istit. Veneto di Sc.*, etc., *Atti* (1841, etc.), and *Mem.* (1843, etc.).

Belgium: Brussels, *Acad. Roy. des Sc., des Lettres, et des Beaux Arts* (founded by Maria Theresa in 1772; reorganized in 1845), *Mém.* (1818, etc.), *Bull.* (1832, etc.), and *Annuaire* (1835, etc.); *Soc. Roy. des. Sc. Nat. et Méd.* (1822), *Journ. de Méd.* (1843) and *Journ. de Pharm.* (1845, etc.); *Soc. Roy. Linn.* (1835), *Bull.* (1872, etc.). Liége, *Soc. Roy. des Sc.* (1835), *Mém.* (1843, etc.). Mons, *Soc. Prov. des Sc.*, etc., *du Hainaut* (1833), *Mém.* (1839, etc.).

Holland: Amsterdam, *K. Nederlandsch Instituut*, *Proc.-Verb.* (1808, etc.), *Verhandel.* (1812, etc.), *Tijdschrift* (1847); *Genootschap ter Beford. der Natuur-*, etc., *Kunde*, *Maanblad* (1807, etc.), and *Werken* (1870, etc.); *Hollandsche Maatschappij*, *Werken* (1810, etc.): *K. Akad. van Wetensch.*, *Verslagen* (1853, etc.), *Verhandel.* (1854, etc.), and *Jaarboek* (1857, etc.). Arnheim, *Natuurkundig Genootschap*, *Tijdschrift* (1844, etc.). Bois-le-Duc, *Provinc. Genootschap*, *Handelingen* (1837, etc.). Groningen, *Natuurk. Genootschap*, *Versl.* (1862, etc.). Haarlem, *Hollandsche Maatschappij der Wetensch.*, *Verhandel.* (1754, etc.). The Hague, *K. Zoolog.-Botanisch Genootschap*, *Versl.* (1864, etc.). Luxembourg, *Soc. des Sc. Nat. Publ.* (1853, etc.). Middelburg, *Zeeuwsch Genootschap der Wetensch.*, *Verhandel.* (1769, etc.) and *Archief* (1856, etc.). Utrecht, *Provinc. Genootschap van Kunsten en Wetensch.*, *Verhandel.* (1781, etc.) and *Aanteekeningen* (1845, etc.). Batavia. *Bataviaasch Genootschap van Kunsten en Wetensch.*, *Verhandel.* (1779, etc.), *Tijdschrift* (1852, etc.), and *Notulen* (1864, etc.); *Natuurk. Vereeniging in Nederl. Indië*, *Tijdschrift* (1850, etc.) and *Verhandel* (1856, etc.).

Denmark. Copenhagen, *K. Danske Videnskabernes Selskab*, based on *Kjöbenhavnske Selskab* (1743–1813), *Skrifter* (1781, etc.) and *Afhandlinger* (1824, etc.); *Naturhist. Forening*, *Meddelelser* (1849, etc.).

Sweden: Gottenburg, *K. Vetenskaps och Vitterhets Samhälle*, *Handlingar* (1778, etc.). Stockholm, *K. Svenska Vetenskaps Akademi*, *Handlingar* (1740, etc.) and *Årberättelser* (1820, etc.). Upsala, *K. Vetenskaps Societeten*, *Acta* (1720, etc.).

Norway: Christiania, *Physiographiske Forening*, *Mag. for Naturvidensk* (1832, etc.); *Videnskabs-Selskabet*, *Forhandl.* (1859, etc.). Throndhiem, *K. Norske Vidensk.-Selskab*, *Skrifter* (1817, etc.).

Spain: Madrid, *R. Acad. de Cien. Exactas, Fis., y Nat. Mem.* (1850, etc.); *Soc. Españ. de Hist. Nat. Anales* (1872, etc.). San Fernando, *R. Acad. Mem.*

Russia: *Siezd Russkikh Yestestvoispytately* (*Meeting of Russ. Naturalists*), first meeting at St. Petersburg 1867–68, *Trudy* or *Trans.* (4to, 1868, etc.). Dorpat, *Naturforsch. Ges. Sitzungsber.* (1853, etc.) and *Archiv.* (1854, etc.); *Gelehrte Estnische Ges. Verhandl.* (1846, etc.), *Schriften* (1863, etc.), and *Sitzungsber.* (1866, etc.). Helsingfors, *Soc. Scient. Fennica*, *Acta* (1842, etc.). Kaminietz, *Naturforsch.-Ges.* Kazan, *Soc. of Naturalists at University*, *Protokoly* (1870, etc.) and *Trudy* (1872, etc.). Kharkoff, *Soc. of Scientists at Univ.*, *Trudy* (1870, etc.), and *Protokoly* (1870, etc.). Kieff, *Soc. of Naturalists*, *Zapiski.* Moscow, *Imp. Soc. of the Friends of Nat. Hist.*, *Anthrop.*, etc., *Izviestiya* or *Bull.* (1865, etc.); *Soc. Imp. des Naturalistes*, *Mém.* (4to, 1806) and *Bull.* (8vo, 1829, etc.). Odessa, *Soc. of Naturalists of New Russia*, *Zapiski* (1872, etc.) and *Protokoly* (1874, etc.). Riga, *Naturforsch.-Ver.*, *Corr.-Blatt.* (1846, etc.) and *Arbeiten* (1865, etc.). St. Petersburg, *Soc. of Naturalists*, *Trudy* (1870, etc.). Warsaw, *Soc. of Friends of Sc.*, *Roczniki* (1802–28).

Roumania: Bucharest, *Soc. Acad. Romănă*, *Annalile* (1867, etc.).

Central and South America: Bogotá, *Soc. de Naturalistas Neo-Granadinos*, *Contribuciones* (1860, etc.). Buenos Ayres, *Soc. Cientifica Argentina.* Caracas, *Soc. de Ciencias*, *Boletin* (1868, etc.). Cordova, *Acad. Nacion.*, *Bol.* (1874, etc.). Guatemala, *Instit. Nac.* Havana, *Acad. de Cien.*, *Anales* (1864, etc.). Mexico, *Soc. Méx. de Hist. Nat.*, *La Naturaleza* (1869, etc.). Rio de Janeiro, *Palestra Cient.*, *Archivos* (1858, etc.). Santiago, *Soc. de Hist. Nat.*

II. Mathematics.

Many of the general scientific societies (see class i.) have mathematical and other special sections. Among defunct English societies may be mentioned the *Mathematical Society*, which used to meet in Spitalfields (1717–1845) and possessed a library, and the *Cambridge Analytical Society*, which published *Memoirs* (4to, 1813). The *London Mathematical Society*, *Proc.* (1865, etc.), and the *Edinburgh Mathematical Society* (1883), *Proc.* (1883, etc.), are still flourishing.

France: Paris, *Soc. Mathém. de France* (1872), *Bull.* (1873, etc.). Germany: Berlin, *Mathem. Ver. der Univ.* (1861), *Ber.* (1876, etc.). Cassel, *Geometer-Ver.* (1878). Dresden, *Ver. praktisch. Geometer* (1854), *Jahresber.* (1861, etc.). Essen, *Feldmesser-Ver.* (1869). Frankfort, *Phys. Ver.* (1824). Göttingen, *Mathemat. Ver.* (1868). Hamburg, *Mathemat. Ges.* (1690), *Mittheil.* Königsberg, *Geometer-Ver.* (1872). Strasburg, *Geometer-Ver.* (1881). Stuttgart, *Deutscher Geometer-Ver.*, *Zeitschrift* (1872, etc.). Holland: Amsterdam, *Genootschap der Mathemat. Wetensch. Kunstoeffinengen* (1782–88), *Mengelwerken* (1793–1816), and *Archief* (1856, etc.). Spain: Valladolid, *R. Acad. de Matematicas* (1803, etc.), now dissolved. Russia: Moscow, *Mathemat. Soc.* Japan: *Mathemat. Soc. of Tokio*, *Journal* (1878, etc.).

III. Astronomy.

Astronomical observatories and their publications have been already treated and enumerated in the article Observatory. The *Royal Astronomical Society* was founded in 1820 under the title of *Astronomical Society of London*, and was incorporated on 7th March, 1831. It occupies rooms in Burlington House, and has published *Memoirs* (1822, etc.) and *Monthly Notices* (1831, etc.). There are also societies at Bristol (1869), *Reports*; Liverpool (1881); and Leipsic, *Astronomische Ges.* (1863), *Publ.* (1865, etc.) and *Vierteljahrsschrift* (1866, etc.).

IV. Physics.

The *Physical Society of London* was founded in 1874 and registered under the Companies Act; it has published *Proceedings* (1874, etc.). The *London Electrical Society* (1836) did useful work in its *Transactions* (1837–40, vol. i.) and *Proceedings* (1841–43). Sir W. Siemens was one of the originators of the *Society of Telegraph Engineers and Electricians*, which was founded in 1871 and registered in 1883. It owns the Ronalds library of electricity and magnetism and publishes a *Journal.*

United States: Chicago, *Amer. Electrical Soc.*, *Jour.* (1875). New York, *National Telegr. Union*, *Telegrapher* (1864–70). France: Cambrai, *Soc. Magnétique*, *Archives* (1845). Paris, *Soc. Franç. de Phys.* (recognized as of public utility on 15th January, 1881), *Bull.* Germany: Berlin, *Physikalische Ges.* (1843), *Fortschritte der Physik* (1847, etc.); *Elektrotechnisch. Ver.* (1877), *Ztschr.* (1880, etc.). Breslau, *Physikalischer Ver.* Frankfort, *Physikalischer Ver.*, *Jahresber.* Italy: Naples, *R. Accad. delle Sc. Fis. e Matem.*, *Rendic.* (1856, etc.) and *Atti* (1863). Rome, *Soc. degli Spettroscopisti Ital.* Holland: Rotterdam, *Bataafsch. Genootschap van Proefondervindelijke Wijsbegeerte*, *Verhandel.* (1774, etc.).

V. Chemistry.

Pharmaceutical societies are placed in class xiii. (Medicine, etc.). The *Chemical Society of London* for the promotion of chemistry and the sciences immediately connected with it was instituted on 23d February, 1841; a charter of incorporation was obtained in 1848. It publishes *Memoirs* (1843, etc.) and *Quarterly Journal* (1849, etc.). Chemistry and its connection with the arts, and agricultural and technical matters, form the subjects of the *Institute of Chemistry*, founded on 2d September, 1877, and incorporated on 2d October, 1877. The *Society of Chemical Industry* (1881) is specially devoted to the branch of chemical engineers. The *Society of Public Analysts* publishes the *Analyst* (1876, etc.). The oldest of the numerous photographic societies is the *Photographic Society of Great Britain* (1853), which issues a *Journal.* The *Royal College of Chemistry* was founded in July, 1845, and had a brief career; it published *Reports* (1849). The *Cavendish Society* was instituted in 1846 for the publication and translation of works and papers on chemistry. It came to an end in 1872 after having issued 30 vols.

United States: New York, *American Chemical Soc.* (1876), *Proc.* (1876) and *Journ.* (1879, etc.). France: Paris, *Soc. Chimique*, *Bull.* (1858, etc.). Germany: Berlin, *Deutsche Chemische Ges.* (1867), *Ber.* (1868, etc.). Frankfort, *Chem. Ges.*, Jena, *Chem. Laborat.* Würzburg, *Chemische Ges.* (1872). Bohemia: Prague, *Spolek Chemiku Českých* or *Soc. of Bohemian Chemists*, *Zpravy* or *Trans.* (1872, etc.). Russia: St. Petersburg, *Russ. Chem. and Phys. Soc. at Univ.*, *Journal* (1869, etc.).

VI. Geology, Mineralogy, and Palæontology.

Among these the *Geological Society of London*, founded in 1807 and incorporated in 1826, is the largest and most important; it has published *Proceedings* (1834–46), *Transactions* (1811, etc.), and a *Quarterly Journal* (1845, etc.). The *Geologists' Association* was instituted in 1858, and issues *Proceedings* (1859, etc.). The *Mineralogical Society* (1876) has united with it the *Crystallogical Society*; it issues the *Mineralogical Magazine* (1876, etc.). The *Palæontographical Society* was founded in 1847 for the delineation and description of British fossils; it issues *Publications* (39 vols. 4to, 1847, etc.). The *Cornwall Royal Geological Society* (1814) devotes special attention to the mining interests of the county, and publishes

Transactions (1818, etc.). It holds its meetings at Penzance. In Scotland there are the *Geological Society of Edinburgh* (1834), which has *Transactions* (1870, etc.), and the *Glasgow Geological Society* (1858) which also has *Transactions* (1860, etc.). The *Royal Geological Society of Ireland* (1832) is chiefly directed to the geology of the country. It publishes a *Journal* (1887, etc.). There are also the *Geological Associations* of Leeds (1874) and Liverpool (1880), *Trans.*, the *Societies* of Liverpool (1859), *Proc.*, Manchester (1838), *Trans.*, and Norwich (1864), *Proc.*, and the *Yorkshire Geological and Technological Society*, *Proc.* (1839, etc.).

United States: Louisville, Ky., *Ohio Falls Geolog. Soc.* San Francisco, *California State Geolog. Soc.* (1876). France: Lille, *Soc. Géol. du Nord* (1870), *Annales* (1874, etc.). Havre, *Soc. Géol. de Normandie*, *Bull.* (1873, etc.). Paris, *Soc. Géol. France de* (1830, recognized 1832), awards the Prix Viquesnel (£40) every three years, *Bull.* (1830, etc.), and *Mém.* (1833, etc.); *Soc. Franç. de Minéralogie* (recognized 1886), formerly *Soc. Minéral. de France*, *Bull.* Saint-Étienne, *Soc. d'Ind. Minérale* (1855), *Bull.* (1855, etc.). Germany and Austria-Hungary · Berlin, *Deutsche Geol. Ges.* (1848), *Ztschr.* (1849, etc.). Brünn, *Wernerscher Geol. Ver.*, *Jahresber.* Darmstadt, *Mittelrheinischer Geol. Ver.* (1851), *Mittheil.* (1855, etc.). Dresden, *Gebirgs-Ver.* (1855). Pesth, *Geol. Ver. f. Ungarn.* Switzerland: *Schweizerische Geol. Ges.* (1882), section of *Allg. Schw. Ges.* Zurich, *Schweiz. Paläontol. Ges.* (1874), *Abhandl.* (1875, etc.). Italy: *Soc. Geol. Ital.*, founded at the second International Geological Congress. Belgium: Antwerp, *Soc, Paléontol.* (1857), *Bull.* Charleroi, *Soc. Paléontol.* (1863), *Documents et Rapports* (1866, etc.). Liége, *Soc. Géol. de Belgique*, *Annales* (1874, etc.). Sweden: Stockholm, *Geologiska Förening*, *Förhandlingar* (1872, etc.). Russia: St. Petersburg, *Imp. Russian Mineralog. Soc.*, *Trans.* (1830, etc.). Argentine Republic: Buenos Ayres, *Soc. Paleontol.*

VII. Meteorology.

The *International Meteorological Congress* first met at Vienna in 1873. The *Royal Meteorological Society* (1850) of London was incorporated in 1866; its organ is the *Quarterly Journal* (1873, etc.). To this must be added the *British Rainfall Society* and the *Scottish Meteorological Society*, which holds its meetings at Edinburgh and issues a *Journal* (1866, etc.). Port Louis (Mauritius), *Meteorolog. Soc.*, *Trans.* (1853, etc.). Paris, *Soc. Météorolog. de France*, *Annuaire* (1849, etc.) and *Nouvelles Météorolog.* (1868, etc.). Hamburg, *Deutsche Meteorolog. Ges.* (1883), *Ztschr.* Magdeburg, *Ver. f. landwirthsch. Wetterkunde* (1881). Meissen, *Gesellsch. Isis.* Vienna, *Oesterreich. Ges. f. Meteorol.*, *Zeitschrift* (1866, etc.). Modena, *Soc. Meteorolog. Ital.*

VIII. Microscopy.

The *Royal Microscopical Society* (1839, incorporated 1866), with *Transactions* (1842–68) and *Journal* (1869, etc.); the *Quekett Microscopical Club* (1865), with a *Journal* (1868, etc.); and the *Postal Microscopic Society* (1873), also with a *Journal*, are located in London. There are suburban societies at Ealing (1877), Hackney (1877), Highbury (1878), South London (1871), and Sydenham (1871). Amongst those in the provinces may be mentioned the ones at Bath (1859), Birmingham (1880), Bolton (1877), Bradford (1882), Bristol (1843), Carlisle, Chichester (*Trans.*), Croydon (1870, *Trans.*), Dublin (1840), East Kent (1858), Liverpool (1868, *Trans.*), Manchester (1880), New Cross (1872), and Sheffield (1877). In the United States the *State Microscop. Soc. of Illinois* publishes the *Lens* (1872, etc.); Buffalo, *Amer. Soc. of Microscopists*; New York, *Microscop. Soc.* Brussels, *Soc. Belge de Microscop.* (1875), *Proc.-Verb.* (1875, etc.) and *Annales* (1876, etc.). Berlin, *Ges. f. Mikroskop.* (1877), *Ztschr.* (1878, etc.). Hanover, *Ges. f. Mikroskop.* (1879), *Jahresber.*

IX. Botany and Horticulture.

Linnæan societies, which usually deal with both zoology and botany, are placed in the general class (No. i.). The *Congrès International d'Horticulture* first met at Brussels in 1864 and the *Congrès International de Botanique* at Amsterdam in 1865. The *Royal Botanic Society of London* (incorporated 1839) has gardens in the inner circle of Regent's Park, and issues a *Quarterly Record* (1880, etc.). The *Royal Horticultural Society* (established in 1804, incorporated in 1809) has gardens at Chiswick, and publishes a *Journal* (1846, etc.). The chief provincial societies are—Aberdeen, *North of Scott. Hortic. Assoc.* (1879), *Trans.* Arbroath, *Hortic. Assoc.* (1880). Birmingham, *Bot. and Hortic. Soc.* (1830), gardens. Dublin, *Roy. Hortic. Soc.* (1830). Edinburgh, *Bot. Soc.* (1836), *Proc.* (1837, etc.) and *Trans.* (1844, etc.); *Scottish Arboric. Soc.* (1854), *Trans.*; *Cryptogamic Soc. of Scott.* (1875). Canada: Kingston, *Bot. Soc. of Canada* (1860), *Annals* (1861, etc.).

United States: Boston, *Hortic. Soc.* (1829). New York, *Torrey Botanical Club*, *Bull.* (1870, etc.). San Francisco, *State Hortic. Soc.* France: Beauvais, *Soc. d'Hortic. et de Bot.* (1864), *Bull.* (1864, etc.). Bordeaux, *Soc. d'Hortic.* Chartres, *Soc. d'Hortic. et de Viticulture.* Chauny, *Soc. de Pomologie.* Dijon, *Soc. d'Hortic.* Fontenay-le-Comte, *Soc. d'Hortic.* Lisieux, *Soc. d'Hortic. et de Bot.* (1866), *Bull.* (1866, etc.). Lyons, *Soc. d'Hortic. Pratique* (1844), *Bull.* (1844, etc.); *Soc. Bot.* (1872). *Annales* (1872, etc.); *Soc. Pomologique* (1872). *Bull.* (1872, etc.). Moulins, *Soc. d'Hortic.* Nimes, *Soc. d'Hortic.* Niort, *Soc. d'Hortic.* Orleans, *Soc. d'Hortic.* (1839), *Bull.* (1841, etc.). Paris, *Soc. Nat. d'Hortic.* (1827; declared of public utility 1852), *Journal*; *Soc. Bot. de France*, *Bull.* (1854, etc.). Rouen, *Soc. Centr. d'Hortic.* Saint Germain-en-Laye, *Soc. d'Hortic.* Senlis, *Soc. d'Hortic.* Troyes, *Soc. d'Hortic.* Versailles, *Soc. d'Hortic.* Germany and Austria-Hungary: Berlin, *Bot. Ver.* (1859), *Verhandl.* (1859, etc.); *Deutsche Bot. Ges.* (1882); *Horticult. Ges.* Blankenburg, *Bot. Ver.* Bonn, *Bot. Ver.* (1818), *Jahresber.* (1837, etc.). Dresden, *Flora-Ges. f. Bot.*, *Mittheil.* (1841, etc.). Erfurt, *Gartenbau Ver.* Frankfort, *Gartenbau Ges.* Freiburg, *Bot. Ver.* Görlitz, *Gartenbau Ver.* Gotha, *Thüringer Gartenbau Ver.* Klagenfurt, *Kärntnerische Gartenbau Ges.* Landshut, *Bot. Ver.* (1864). Meiningen, *Ver. f. Pomologie u. Gartenbau.* Munich, *Baierische Gartenbau Ges.* Ratisbon, *K. Baierische Bot. Ges.* (1790), *Flora* (1818, etc.) and *Repertorium* (1864, etc.). Reutlingen, *Pomolog. Inst.* Sondershausen, *Bot. Ver.* Stuttgart, *Gartenbau Ges.*, *Flora.* Vienna, *K. k. Gartenbau Ges.*; *Botan. Ver. Verhandl.* (1851, etc.). Weimar, *Ver. f. Blumistik.* Würzburg, *Bot. Inst. Arbeiten* (1871, etc.). Italy: Milan, *Soc. Crittog. Ital.*, *Atti* (1878, etc.). Belgium: *Fédération des Soc. d'Hortic. de Belgique* (1860), *Bull.* Antwerp, *Soc. Roy. d'Hortic. et d'Agr.*; *Soc. Phytologique*, *Annales* (1864, etc.). Bruges, *Soc. d'Hortic. et de la Bot.* Brussels, *Soc. Roy. de Bot.* (1862), *Bull.* (1862, etc.); *Soc. Roy. de Flore*; *Soc. Centr. d'Arboric.*, *Annales.* Liége, *Soc. Roy. d'Hortic.* Holland: Leyden, *Nederl. Bot. Vereen.* Luxembourg, *Soc. de Bot.*, *Recueil* (1874, etc.). Nimeguen, *Nederl. Bot. Vereen.*, *Archief* (1871, etc.). Denmark: Copenhagen, *Bot. Forening*, *Tidsskrift* (1866, etc.).

X. Zoology.

Societies dealing with natural history in general, or zoology and botany together, are arranged under class i. The *Zoological Society of London* (founded 1826, incorporated 1829) is famous for its collection of live animals in its gardens at Regent's Park. It publishes *Proceedings* (8vo, 1830, etc.) and *Transactions* (4to, 1835, etc.). The other metropolitan societies are—*British Ornithologists' Union* (1859); *Entomological Society of London* (1833), *Trans.* (1834, etc.); *National Fish Culture Association* (1883). The *Marine Biological Association of Great Britain* (1884), for the study of marine food fishes and shell-fish, has a laboratory at Plymouth. The *Royal Zoological Society of Ireland* (1831) has gardens in the Phœnix Park. There is the British *Beekeepers' Association* (1874). Australia and New Zealand. Auckland, *Acclimatization Soc.* Brisbane, *Acclimat. Soc.* Christchurch, *Acclimat. Soc.* Melbourne, *Zoolog. and Acclimat. Soc. of Victoria*, *Report* (1861, etc.). Sydney, *Acclimat. Soc. of N. S. Wales*, *Report* (1862, etc.); *Entomolog. Soc. of N. S. W.*, *Trans.* (1863, etc.). Wellington, *Westland Nat. and Acclimat. Soc.* Africa: Cape Town, *Zoolog. Soc.* Port Louis (Mauritius), *Soc. d'Acclimat.* Canada: Toronto, *Entomolog. Soc.*; *Beekeepers' Assoc.*

United States: Cambridge, *Nuttall Ornitholog. Club*, *Quart. Bull.* (1876, etc.); and *Entomolog. Club*, *Psyche* (1874, etc.). Cincinnati, *Zoolog. Soc.* (1874), *Report* (1875, etc.). *Illinois Central Beekeepers' Association.* Philadelphia, *Zoolog. Soc.* (1873), *Report* (1874, etc.); and *Amer. Entomolog. Soc.*, merged in the *Acad. of Nat. Sc.* Washington, *Biolog. Soc.*; and *Entomolog. Soc.* France: Alais, *Soc. Séricicole*, *Bull.* (1876, etc.). Amiens, *Soc. d'Apiculture*, *Bull.* (1875, etc.). Clermont, *Soc. Centr. d'Apicult.*, *Bull.* (1875, etc.). Lille, *Inst. Zoolog. d Wimereux*, *Travaux* (1877, etc.). Paris, *Soc. Nat. d'Acclimat.* (1854), *Bull. Mensuel* (1854, etc.) and *Chron. Bimens.* (1875, etc.); *Soc. Zoolog. de France*, *Bull.* (1876, etc.); *Soc. Entomolog. de France*; and *Soc. de Biologie*, *Comptes Rendus* (1850, etc.). Germany and Austria-Hungary: *Wanderversammlung Deutscher Bienenzüchter*, *Verhandl.* (1856, etc.). Bendorf, *Akklimat.-Ver.* Berlin, *Akklimat.-Ver.* (1856), *Zeitschr.* (1858, etc.); *Central-Inst. f. Akklimat.*, *Mittheil.* (1859, etc.); *Deutsche Zoolog. Ges.*; *Deutsche Ornithologen-Ges.* (1845), *Ber.* (1850, etc.); *Deutsche Fischerei Ver.*, *Publikat.* (1871, etc.); *Deutsche Entomolog. Ges.* (1856), *Entomolog. Zeitschr.* (1857, etc.); *Ver. zum Beförd. des Seidenbaues*, *Jahresber.* (1869, etc.); *Physiolog. Ges.*, *Verhandl.* (1877, etc.). Breslau, *Physiolog. Inst.*, *Studien* (1861, etc.); *Ver. f. Schles. Insektenkunde*, *Zeitschr.* (1847, etc.). Brunswick, *Deutsche Ornitholog. Ges.* Carlsruhe, *Badischer Ver. f. Geflügelzucht*, *Monatsblatt.* (1872, etc.). Frankenberg, *Bienenwirthschaftl. Haupt-Ver.*, *Sächs*, *Bienenfreund* (1865, etc.). Frankfort, *Zoolog. Ges.*, *Der Zoolog. Garten* (1860, etc.); *Deutsche Malako-zoolog. Ges. Jahrbüch.* (1874, etc.) and *Nachrichtsblatt* (1869, etc.). Halberstadt, *Deutsche Ornitholog. Ges.*; Halle, *Ornitholog. Central-Ver.* Hamburg, *Zoolog. Ges.*, *Ber.* (1862, etc.). Hanover, *Bienenwirthschaftl. Central-Ver.*, *Centralblatt* (1865, etc.). Leipsic, *Sächs. Seidenbau Ver.*, *Zeitschr.* (1868, etc.). Munich, *Entomolog. Ver.* (1876); *Fischerei Ver.*, *Mittheil.* (1876, etc.). Nördlingen, *Ver. Deutscher Bienenwirthe*, *B.-Zeitung* (1845, etc.). Ratisbon, *Zoolog.-Mineralog. Ver.* (see class i.). Stettin, *Ornitholog. Ver.* (1873), *Jahresber.* (1873, etc.); *Entomolog. Ver.* (1837), *Ent. Zeitung* (1840, etc.). Triest, *Zoolog. Inst. u. Zoolog. Station*, *Arbeiten* (1878, etc.). Troppau, *Schles. Bienenzucht-Ver.* (1873). Vienna, *Entomolog. Ver.*; *Embryolog. Inst.*, *Mittheil.* (1871, etc.); *Ornitholog. Ver.* Würzburg, *Zoolog. Zootomisches Inst.* (1872), *Arbeiten* (1874, etc.). Switzerland: Bern, *Schweiz. Entomolog. Ges.* Geneva, *Assoc. Zoolog. du Léman*; *Soc. Ornitholog. Suisse* (1865), *Bull.* (1866, etc.). Italy: Casale, *Soc. Bacologica*, *Boll.* (1866, etc.). Florence, *Soc. Allantina Ital.*, *La Sericicultura* (1865, etc.); *Soc. Entomolog. Ital.*, *Bull.* (1869, etc.). Naples, *Zoolog. Station*, *Mittheil.* (1878). Palermo, *Soc. di Acclimaz.*, *Atti* (1861, etc.). Pisa, *Soc. Malacolog. Ital.*, *Bull.* (1875, etc.). Rome, *Soc. di Piscicolt. Ital.* (1872). Belgium: Antwerp, *Soc. Roy. de Zoologie.* Brussels, *Soc. Roy. de Zoologie*; *Soc. Entomolog. de Belgique* (1855), *Annales* and *Bull.* (1857, etc.); *Soc. Malacolog.* (1863), *Annales* (1863, etc.) and *Procès-Verb.* (1872, etc.). Holland: Amsterdam, *K. Zoolog. Genootschap "Natura Artis Magistra," Jaarboekje* (1852, etc.) and *Tijdschr.* (1863, etc.). The Hague, *Nederl. Entomolog. Vereen.*, *Tijdschr.* (1857, etc.). Rotterdam, *Nederl. Dierkundige Vereen.*, *Tijdschr.* (1874, etc.). Norway: Bergen, *Selskabet for Norges Fiskerier.* Sweden: Stockholm, *Entomolog. Förening.* Russia: Moscow, *Acclimat. Soc.* St. Petersburg, *Russian Entomolog. Soc.* Argentine Republic: Buenos Ayres, *Soc. Zoolog. Argentina*, *Period. Zoolog.* (1875, etc.) · *Soc. Entomolog. Argent.*

XI. Anthropology.

The *Congrès International d'Anthropologie et d'Archéologie Préhistoriques* held its first meeting at Neuchâtel in 1866; it issues *Comptes Rendus* (1866, etc.). The *Anthropological Institute of Great Britain and Ireland* was founded in 1871 upon the *Ethnological Society* (1843), which published a *Journal* (1848–56) and *Transactions* (1859–69), and the *Anthropological Society* (1863), which issued *Memoirs* (1863–69) and the *Anthropological Review* (1864–70). The *Institute* brings out a *Journal* (1871, etc.).

United States: *Ashtabula Anthropolog. Soc.* New York, *Amer. Ethnolog. Soc.*, *Trans.* (1845–53) and *Bull.* (1860–61); *Anthropolog. Inst.*, *Journ.* (1871, etc.). Washington, *Anthropolog. Soc.* France: Paris, *Soc. d'Anthropologie* (1859; recognized 1864), *Bull.* and *Mém.* (1860, etc.); *Soc. d'Ethnogr. Annuaire* (1862, etc.) and *Revue* (1869, etc.); *Soc. des Traditions Populaires* (1886), *Revue.* Germany and Austria-Hungary: Berlin, *Ges. f. Anthropologie*, etc. (1869). *Ztschr.* (1870, etc.) and *Verhandl.* (1871, etc.). Brunswick, *Deutsche Ges. f. Anthropologie*, *Archiv* (1870, etc.) and *Corr.-Blatt.* (1874, etc.). Göttingen, *Anthropolog. Ver. Mittheil.* (1874, etc.). Leipsic, *Ver. f. Anthropolog. Ber.* (1871, etc.), afterwards joined to the *Ver. der Erdk.* Munich, *Ges. f. Anthropolog.* (1870), *Beitr.* (1876, etc.). Stuttgart, *Anthropolog. Ges.* Vienna, *Anthropolog. Ges.*, *Mittheil.* (1870, etc.). Italy: Florence, *Soc. Ital. di Antropologia*, *Archivio* (1873, etc.). Sweden: Stockholm, *Antropologiska Sällskapet*, *Tidskr.* (1875, etc.). **Spain**: Madrid, *Soc. Antropológ. Esp. Revista* (1875, etc.). Havana (Cuba). *Soc. Antropológ.* **Russia**: *Imp. Soc. for friends of Research in Nat. Sc., Anthropology*, etc.

XII. Sociology (Economic Science, Statistics, Law, Education).

The international societies are the *Association Internationale pour le Progrès des Sciences Sociales* and the *Congrès International de Statistique*, which first met at Brussels in 1853. Both have issued *Comptes Rendus*. The *Congrès International de Bienfaisance* may be traced to a suggestion at the *Congrès Pénitentiaire* held at Frankfort in 1847. The first meeting took place at Brussels in 1856. The *National Association for the Promotion of Social Science* (1857) had united with it in 1864 the *Society for Promoting the Amendment of the Law*. It holds a yearly migratory meeting, and publishes *Transactions* (1858, etc.) and *Social Science* (1866, etc.). The *Statistical Society* (1834), with a *Journal* (1839, etc.); *Political Economy Club* (1821); *Cobden Club* (1866), for the diffusion of the political and economical principles with which Cobden's name is associated, having various publications; *Institute of Actuaries; Institute of Chartered Accountants* (1880); and the *Institute of Bankers* (1879) meet in London. There are also the *Manchester Statistical Society* (1833), with *Transactions*; the *Actuarial Society of Edinburgh* (1859); and the *Social and Statistical Society of Ireland* (1847), with a *Journal*, at Dublin. After the **Inns of Court** (*q.v.*), the most important of English legal societies is the *Incorporated Law Society of the United Kingdom* (1827, incorporated 1831); it began courses of lectures for students in 1833, and was appointed registrar of solicitors ten years later, and obtained supplementary charters in 1845 and 1878; it has fifty provincial law societies in association. The *Verulam Society* (1846) published a few books and came to an end. The *Selden Society* for the promotion of the study of the history of law was established in 1887. The headquarters of the *Association for the Reform and Codification of the Law of Nations* are in London, but conferences are held in various Continental towns. The *Institute of Patent Agents* (incorporated 1882) issues *Transactions*. The *Juridical Society of Edinburgh* (1773) has published five editions of a *Complete System of Conveyancing*. The *Ascham Society* was founded in 1879 for the improvement of educational methods; and the *Society for the Development of the Science of Education* (1875) issues *Transactions*.

United States: Boston, *Amer. Assoc. for Promotion of Soc. Sc.; Amer. Statist. Assoc., Collections* (1847, etc.) [*American Institute of Education*]. New York, *Soc. for Polit. Education, Publ.* [Washington, *National Educational Association*; also *American Economic Association* (1886), *Publ.* (1887)]. **France**: Grenoble, *Soc. de Statist.* (1838), *Bull.* (1840, etc.). Marseilles, *Soc. de Statist.* (1827), *Répertoire* (1837, etc.). Paris, *Soc. Int. des Études Pratiques d'Écon.* (1856, recognised 1869); *La Réforme Soc.; Soc. Fran. de Statist. Univ.* (1829), *Journal* issued jointly with *Acad. Nat.* since 1849; *Soc. de Statist. de Paris* (1860, recognized 1869), *Journ.* (1860, etc.); *Soc. de Législation Comparée* (1869 recognized 1873), *Bull.*, *Annuaire de Lég Franç.*, and *Ann. de Lég. Étran.*; *Soc. pour l'Instr. Élément.* (1815, recognized 1831), *Bull.* St. Maixent, *Soc. de Statist. des Deux Sèvres*. **Germany**: Berlin, *Volkswirths. Ges.* (1860), *Volkswirths. Zeitfragen* (1879, etc.); *Ver. f. deutsche Volkswirths.* (1876), *Ztschr.* (1880, etc.); *Ver. f. Förderung d. Handelsfreiheit* (1878), *Mittheil.* (1879, etc.); *Ver. f. d. Statist.; Jurist. Ges.* (1859), *Jahresber.* (1863, etc.). Dresden, *Statistischer Ver.* (1831), *Mittheil.* Frankfort, *Statistische Ges.; Juristische Ges.* (1866), *Rundschau* (1867, etc.). Laibach, *Jurist. Ges.* Leipsic, *Ver. f. wiss. Pädagogik, Jahrbuch* and *Mittheil.* **Belgium**: Brussels, *Ligue de l'Enseignement* (1864), *Bull.; Soc. Centr. des Instituteurs Belges* (1860), *Le Progrès*. **Holland**: Amsterdam, *Ver. voor de Statist. in Nederland, Jaarboekje* (1849, etc.) and *Jaarcijfers* (1882, etc). **Spain**: Madrid, *Junta Estadist.* **Russia**: Moscow, *Juridical Soc.* St. Petersburg, *Pedagogical Soc.* **Egypt**: Cairo, *Bureau Central de Statist.* **Japan**: Tokio, *Statist. Soc.*

XIII. Medicine, Surgery, Etc.

The first meeting of the *Congrès Médical International* was held at Paris in 1867; a *Bulletin* has been issued annually since 1868. The *Proceedings of the British National Veterinary Congress* date from 1881. The Royal Colleges of Physicians and of Surgeons of London, Edinburgh, and Dublin do not come within our scope. The *Medical Society of London* (1773) is the oldest in the metropolis; it has issued *Memoirs* (1787–1805), *Transactions* (1810, etc.), and *Proceedings* (1872, etc.). The other London societies include the *Abernethian Society* (1795), which issues *Proceedings; British Dental Association* (1879), with a *Journal* (1880, etc.); *British Gynæcological Society* (1884); *British Homœopathic Association* (1859), with *Annals* (1860, etc.); *British Medical Association* (1832), which has more than forty home and colonial branches, and publishes *British Medical Journal* (1857, etc.); *Clinical Society* (1867), with *Transactions; Dermatological Society* (1882); *Epidemiological Society* (1850), with *Transactions* (1855, etc.); *Hahnemann Publishing Society* (1852), *Materia Medica* (1852, etc.); *Harveian Society* (1831); *Homœopathic Association* (1845); *Hunterian Society* (1819); *New Sydenham Society* (1858), which publishes *Biennial Retrospect* (1867, etc.), and translations and reprints of books and papers of value, succeeded the *Old Sydenham Society* (1844–57), which issued 40 vols.; *Obstetrical Society* (1858), with *Transactions* (1860, etc.); *Odontological Society* (1856); with *Transactions* (1858, etc.); *Ophthalmological Society* (1880); *Parkes Museum* (1876), founded in memory of the services of Dr. E. A. Parkes to sanitary science; *Pathological Society* (1846) *Transactions: Pharmaceutical Society* (1841), with museum, which has a branch at Edinburgh, *Pharmaceutical Journal* (1842, etc.); *Physiological Association* (1876), *Journ. of Physiology* (1878, etc.); *Royal Medical and Chirurgical Society* (1805; charter 1834), with library, and *Transactions* (1809, etc.) and *Proceedings* (1857, etc); *Sanitary Institute* (1876), the council of which appoint examiners; *Society of Medical Officers of Health* (1856), *Transactions*. The provincial societies are very numerous and include—Birmingham, *Midland Med. Soc.* (1848). Dublin *Acad. of Med. in Ireland* (1882), *Trans.* (1883, etc.). Edinburgh, *Roy. Med. Soc.* (1737; charter 1778); *Harveian Soc.* (1752); *Medico-Chirurg. Soc.* (1821), *Trans.* 1824, etc.); and *Obstetrical Soc.* (1840). Glasgow, *Medico-Chirurg. Soc.* (1866), based upon *Med. Soc.* and *Med.-Chirurg. Soc.* (both 1814). Manchester, *Med. Soc.* (1834).

Australia: Melbourne, *Med. Soc. of Victoria, Austr. Med. Journ.* (1856, etc.). **Canada**: Montreal, *Union Méd. du Canada, Revue* (1872, etc.); *Canada Med. Assoc. Trans.* (1877, etc.) **India**: Bombay *Med. and Physical Soc., Trans.* (1838, etc.). Calcutta, *Méd. Soc. Trans.* (1883, etc.).

United States: *Amer. Pub. Health Assoc., Reports* (1873, etc.); *Amer. Dental Assoc., Trans.* (1860, etc.); and *Amer. Inst. of Homœop., Trans.* (1878, etc.). The state medical associations include those of Alabama, *Trans.* (1869, etc.); Georgia, *Trans.* (1873, etc.); Maine, *Trans.* (1853, etc.); Missouri, *Trans.* (1851, etc.); and South Carolina, *Trans.* The State medical societies include those of Arkansas, *Trans.* (1877, etc.); California, *Trans.* (1870, etc.); Illinois, *Trans.* (1851, etc.); Kansas, *Trans.* (1867, etc.); Michigan, *Trans.* (1869, etc.); Minnesota, *Trans.* (1874, etc.); Nebraska, *Trans.* (1869, etc.); New Jersey, *Trans.* (1859, etc.); Pennsylvania, *Trans.* (1851, etc.); Rhode Island, *Trans.* (1877, etc.); Texas, *Trans.* (1874), and Wisconsin *Trans.* (1880, etc.). To these have to be added the following town associations: Albany, *Med. Soc. Trans.* (1807, etc.) Baltimore, *Med. and Chirurg. Faculty of Maryland, Trans.* 1856, etc.); Boston, *Amer. Gynæcolog. Soc., Trans.* (1876, etc.); *Mass. Medico-Legal Soc. Trans.* (1878, etc.); New York, *Acad. of Med., Trans.* (1847, etc.), and *Bull.* (1860, etc.; *Med. Soc., Trans.* (1815, etc.); *Medico-Chirurg. Soc., Trans.* (1878, etc.; *Amer. Surg. Assoc., Trans.* (1883, etc.); *Medico-Legal Soc., Sanitarian* (1873, etc.); *Amer. Ophthalmolog. Soc., Trans.* (1865, etc.). Philadelphia, *Amer. Med. Assoc., Trans.* (1848, etc.); *Med. Soc., Trans.* (1850, etc.); *Obstet. Soc., Trans.* (1869, etc.); *Amer. Pharm. Assoc., Proc.*: *Patholog. Soc.* Richmond, *Med. Soc., Trans.* (1871, etc.).[1]

France: Besançon, *Soc. de Méd.* (1845), *Bull.* (1845, etc.). Bordeaux, *Soc. de Méd.* (1798), *Journ.* (1829, etc.): *Soc. de Pharm.* (1834), *Bull.* (1860, etc.): *Soc. de Méd. et de Chirurg.* Caen, *Soc. de Méd.* (1799, known by its present name since 1875), *Année Méd.* (1876, etc.). Chambéry, *Soc. Méd.* (1848), *Comptes Rend.* (1848, etc.) and *Bull.* (1859, etc.). Grenoble, *Soc. de Méd. et de Pharm.* Havre, *Soc. de Pharm.* (1858), *Mém.* Lille, *Soc. Centr. de Méd.* (1845), *Bull.* (1846, etc.). Lyons, *Soc. Nat. de Méd.* (1789, etc.), *Le Lyon Méd.* (1869, etc.). Marseilles, *Soc. de Méd.* (1800), *Comptes Rend.* (1826–53) and *Le Mars. Méd.* (1869, etc.); *Soc. Méd. Chirurg.* (1872). Paris, *Soc. de Méd. Pratique* (1808), *Bull.; Acad. Nat. de Méd.* (1820); *Soc. de Chirurg.* (1843, reorganized 1859), *Mém.* (1847, etc.), and *Bull.* (1848, etc.); *Soc. Anat. Bull.* (1826, etc.); *Soc. Clinique, Bull.* (1877, etc.); *Soc. Méd. des Hôpitaux, Bull.* (1849, etc.); *Soc. Méd Légale; Soc. de Pharm., Journ.* (1815, etc.): *Soc. de Thérapeutique; Soc. Fran. de Hygiène; Soc. Centr. de Méd. Vétérinaire.* Rouen, *Soc. de Méd.* (1821), *Union Méd.* (1861), etc.); *Soc. Libre des Pharmaciens* (1802), *Bull.* Toulouse, *Soc de Méd.* (1804), *Bull.* and *Revue* (1867, etc). Tours, *Soc. Méd.* (1801). **Germany and Austria-Hungary**; *Deutscher Aerztevereinsbund* (1872), *Verhandl.; Central Ver. d. Zahnärzte* (1859) *Mittheil.; D. Veterinärrath* (1874); *D. Apotheker-Ver.* (1820), *Archiv.* (1822, etc.). Berlin, *Ver. f. Heilkunde* (1823), *Magazin* (1835, etc.); *Ges. f. Gebertshülfe u. Gynækologie* (1876), *Ztschr.* (1877 etc.), *Ges. f. Heilkunde* (1855): *Berl. Med. Ges.* (1860), *Verhandl.* (1865, etc.); *Physiolog. Ges.* (1860), *Verhandl.* (1877, etc.) *D. Ver. f. Med. Statistik* (1868); *Ver Homöop. Aerzte* (1871), *Ztschr.* (1882, etc.); *D. Ges. f. Chirurgie* (1872), *Verhandl.* Bonn, *Verband der Aerztl. Verein* (1865). Breslau *Ver. f. Physiolog. Heilkunde* (1848), *Ztschr.* (1850, etc.); *Verband d. Schles. Aerzte-Ver.* (1878). Cologne, *Rhein. Med. Chirurg.-Ver.* (1848), *Organ* (1852, etc). Darmstadt, *Aerztl. Kreisver.* (1844). Dresden, *Ges. f. Natur-u. Heil-Kunde* (1818), *Jahresber* (1848, etc.). Erlangen, *Physik.-Med. Soc.* (1808), *Sitzungsber* (1870 etc.). Frankfort, *Aerztl. Ver.* (1845), *Jahresber* (1857, etc.). Hamburg, *Aerztl. Ver.* (1816). Hanover, *Ver. Analyt. Chemiker* (1878). Heidelberg, *Ophthal. Ges.* (1857), Königsberg, *Ver. f. wiss. Heilkunde* (1851). Leipsic *Med. Ges.* (1829); *Ges. f. Geburtshülfe* (1854), *Mittheil.; Homöop. Central-Ver.* (1829). Magdeburg, *D. Chirurgen-Ver.* (1844), *Ztschr.* (1847, etc.). Munich, *Aerztl. Ver.* (1833), Int.-Blatt (1854, etc.). Strasburg, *Soc. de Méd.* (1842), *Mém.* (1850, etc.); *Soc. Vétérin* (1864). Stuttgart, *Württemb. Aerztl. Ver.* (1831), *Corr.-Blatt.* (1832, etc.); *Hahnemannia* (1868), *Mittheil.* (1873, etc.); *Apotheker.-Ver.* (1822). *Pharm. Wochenblatt* (1861), etc.). Vienna, *K. k. Ges. der Aerzte, Ztschr.* (1844, etc.). Weimar, *Med.-Naturwiss. Ver.* (1863). Würzburg, *Physikal.-Méd. Ges.* (1849), *Verhandl.* (1850, etc.). **Switzerland**: Geneva, *Soc. Méd.* Zurich, *Soc. de Méd.; Schweiz. Apotheker Ver.* **Italy**: Bologna, *Soc. Med. Chirurg.* Genoa, *Accad. Med. Chirurg.* Milan, *Soc. Ital. d'Igiena.* Modena, *Soc. Med.-Chirurg.* Naples, *Real. Accad. Med. Chirurg.* Rome, *R. Istit. Fisico-Patologico.* Turin, *Accad. Real. Med. Chirurg.* **Belgium**: Antwerp, *Soc. de Méd.* (1839), *Annales*. Brussels, *Acad. Roy. de Méd.* (1841), *Bull.* (1841, etc.) and *Mém.; Soc. Roy. de Pharm.* (1856), *Bull.; Soc. Anat. Patholog.* (1857), *Annales; Soc. Belge. de Méd. Homœop.* Ghent, *Soc. de Méd.* (1834), *Annales*. Liége, *Soc. Méd. Chirurg.* **Holland**: Amsterdam, *Genootschap ter Bevordering der Genees- en Heel-Kunde, Verhandel.* (1841, etc.); *Nederl. Maatschappij ter Bevord der Pharmacie.* Batavia (Java), *Geneeskundige Vereeniging.* **Denmark**: Copenhagen, *K. Med. Selskab; Veterinaer Selskab.* **Norway**: Christiania, *Med. Selskab.* **Sweden**: Stockholm, *Farmaceutiska Inst.* **Spain and Portugal**: Lisbon, *Soc. de Sc. Med.; Soc. Pharm. Lusitana.* **Russia**: Dorpat, *Pharm. Soc.* Moscow, *Phys.-Med. Soc.* Riga, *Soc. of Practical Physicians.* St. Petersburg, *Soc. of Practical Physicians; Imp. Pharm. Soc.* Warsaw, *Med. Chirurg. Soc.* **Greece**: Athens, *Soc. Méd.* **Turkey**: Constantinople, *Soc. Imp. de Méd.; Soc. de Pharm.* **Central and South America**: Buenos Ayres, *Asoc. Med.* Caracas, *Escuela Med.* Guadalajara (Mexico), *Soc. Med.* Merida (Mexico), *Soc. Med.* Mexico, *Acad. de Med.; Soc. Med.* Monte Video, *Soc. de Med.* Santiago, *Soc. Med.* **Japan**: *Tokio Soc. for Adv. of Med. Sc., Trans* (1885, etc.).

XIV. Engineering and Architecture.

The principal English society dealing with mechanical science is the *Institution of Civil Engineers* (established in 1818, incorporated in 1828), which publishes *Transactions* (4to, 1836–42) and *Minutes of Proceedings* (8vo, 1837, etc.). George Stephenson was the first president of the *Institution of Mechanical Engineers*, which was founded at Birmingham in 1847, removed to London in 1877, and registered under the Companies Act in 1878. It holds migratory meetings and publishes *Proceedings*. The *Society of Engineers* (1854), with *Transactions* (1861, etc.); the *Civil and Mechanical Engineers' Society* (1854); the *Iron and Steel Institute* (1869), with *Transactions*; the *Surveyors' Institution* (1868, incorporated in 1881).

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[1] [General *Societies of Dental Surgeons* in Baltimore, Richmond, Philadelphia, and Cincinnati.—Am. Ed.]

which publishes *Transactions* and holds professional examinations; and the *Aeronautical Society of Great Britain* (1866) also meet in London. There are institutions in the provinces at Cardiff (1857, incorporated in 1861), Chesterfield (1871), Dublin (1835, incorporated in 1857), Glasgow (1857, with *Transactions*), Middlesborough (1864), and Newcastle-on-Tyne (1852, incorporated in 1876, with *Transactions*).

The leading architectural society is the *Royal Institute of British Architects*, founded in 1834, incorporated in 1837, and granted a new charter in 1887. It appoints examining professional boards and publishes *Transactions* (1836; 1879, etc.) and *Proceedings* (1879, etc.). There are also the associations of Birmingham (1874), Edinburgh (1850), Exeter (1843), Glasgow (1868), Leeds (1876), Leicestershire (1855), Liverpool (1848), Manchester (1875), Newcastle-on-Tyne, and the societies of Manchester (1865) and Oxford (1837). The *Architectural Association* of London publishes a *Sketch Book* (1870, etc.). The *Architectural Publishing Society* (1848) has published *Essays* (1848-52), and since 1852 has been bringing out a *Dictionary of Architecture*. There is also a *Society of Architects*.

UNITED STATES: Easton, Pa., *Inst. of Mining Engineers*. New York, *Amer. Soc. of Civ. Eng., Trans.; Amer. Inst. of Min. Eng.; Amer. Inst. of Architects*. FRANCE: Lyons, *Soc. Acad. d'Arch.* (1830), *Annales* (1867, etc.). Paris, *Soc. des Ingénieurs Civils; Mém.* (1848, etc.); *Soc. Cent. des Architectes, Bull.* (1851, etc.) and *Annales* (1875, etc.); it has held a congress since 1875. Saint-Étienne, *Soc. de l'Industrie Min.* (1855), *Bull.* GERMANY and AUSTRIA-HUNGARY: Berlin, *Ver. Deutscher Ingenieure, Ztschr.* (1857) and *Wochenschrift* (1877, etc.); *Ver. f. Eisenbahnkunde; Akad. des Bauwesens; Architekten-Ver., Ztschr.* Breslau, *Ver. f. Ges. der Bild. Künste* (1862). Constance, *Münsterbau Ver.* (1881). Dresden, *Sächs. Ingen.- u. Architekten-Ver., Protok.* Hanover, *Arch.- u. Ingen.-Ver., Ztschr.* Klagenfurt, *Berg- und Hutten-Mannischen Ver.* Leoben, *K. k. Berg-Akad.* Munich, *Bayr. Arch.- u. Ingen.-Ver., Ztschr.* Prague, *Arch.- und Ingen.-Ver.* Vienna, *Oesterr. Ingen.- u. Arch.-Ver., Ztschr.; Ges. f. Bild. Künste*. SWITZERLAND: Lausanne, *Soc. Vaudoise des Ingén. et des Arch.* Zurich, *Ver. Schweiz. Ingen. u. Arch.* ITALY: Turin, *Soc. degli Ingeneri, Atti* (1868-70). BELGIUM: Brussels, *Assoc. des Ingén.* Liége, *Assoc. des Ingén.* (1847), *Annuaire* (1851, etc.). HOLLAND: Amsterdam, *Maatschappij tot Bevordering der Bouwkunst, Bouwkundige Bijdragen* (1843, etc.). The Hague, *Kon. Inst. van Ingen., Verslag* (1848, etc.), *Verhandel.* (1848, etc.), and *Tijdschr.* (1870, etc.). SPAIN and PORTUGAL: Lisbon, *Assoc. dos Engenheiros Civ. Port.; Soc. dos Architectos e Archeologos*. Madrid, *Soc. Central de Arquitectos*.

XV. NAVAL AND MILITARY SCIENCE.

The *Royal United Service Institution*, first known as the *Naval and Military Library and Museum* (1831), took the name of the *United Service Institution* in 1839, and was incorporated in 1860; it has a professional museum and publishes a *Journal* (1857, etc.). The home of the society is in London, as is also that of the *Institution of Naval Architects* (1860), which publishes *Transactions* (4to, 1860, etc.). The *Royal Artillery Institution* (1838), which issues *Minutes of Proceedings* (1858, etc.), is at Woolwich, and the *Royal Engineers Institute* (1875), which issues *Royal Engineers Professional Papers*, at Chatham. CANADA: Toronto, *Military Inst.* INDIA: Simla, *United Service Institution*.

UNITED STATES: New York, *Military Service Inst., Journal* (1879, etc.) [*U. S. Naval Lyceum* (1833); Annapolis, *U. S. Naval Institute* (1873)]. FRANCE: Paris, *Réunion des Officiers*, now *Cercle Militaire, Bull.* (1871, etc.). GERMANY and AUSTRIA-HUNGARY: Munich, *Militär. Ges.* (1868), *Jahrbüch.* (1871, etc.); Vienna, *K. k. Milit.-Geogr. Inst., Arbeiten* (1871, etc.). HOLLAND: Utrecht, *Vereen. tot Verspreiding van Kennis aangaande s' Lands Verdediging, Jaarsverslag* (1872, etc.) and *Werken*. NORWAY: Christiania, *Militære Samfund, Nordsk Milit. Tidsskrift* (1848, etc.). DENMARK: Copenhagen, *Krigsvidenskabelige Selskab, Milit. Tidsskrift* (1872, etc.).

XVI. AGRICULTURE AND TRADES.

The *Royal Agricultural Society of England* began as the *English Agricultural Society* in 1838 and was incorporated in 1840. It holds annually one migratory meeting in some part of England or Wales and two meetings in London, where are its headquarters; it publishes a *Journal* (1840, etc.). The leading provincial agricultural societies and associations are—Aberdeen, *Roy. Northern Agr. Soc.* (1843). Arbroath, *Angus Agr. Assoc.* Banbury (1834). Basingstoke, *Roy. Counties Agr. Soc.* (1859). Bath, *Bath and West of Engl. Soc. and Southern Counties Assoc.* (founded in 1777, enlarged in 1852, and reorganized in 1866), *Letters and Papers* (1780-1816) and *Journal* (1852, etc.). Belfast, *Chemico-Agr. Soc. of Ulster* (1845), *Proc.; N. E. Agr. Assoc. of Ireland*. Birkenhead, *Wirrel and Birkenhead Agr. Soc.* (1842). Brecknock (1855). Carluke (1833). Chelmsford, *Essex Agr. Soc.* (1858). Chertsey (1833). Doncaster (1872). Dublin, *Roy. Agr. Soc. of Ireland* (1841). Edinburgh, *Highland and Agr. Soc. of Scotland* (1784, incorporated in 1787), *Trans.* (1799, etc.). Halifax (1839, enlarged in 1858). Ipswich, *Suffolk Agr. Assoc.* (1831). Otley, *Wharfedale Agr. Soc.* Paisley, *Renfrewshire Agr. Soc.* (1802). Warwick. Worcester (1838). AFRICA: Cape Town, *Agr. Soc.* AUSTRALIA: Sydney, *Agr. Soc. of N. S. Wales*. BRITISH GUIANA: Georgetown, *Roy. Agr. and Commercial Soc.* CANADA: Montreal, *Soc. d'Agr.* INDIA: Calcutta, *Agr. and Hortic. Soc., Journ.* (1842, etc.).

UNITED STATES: Albany, *State Agr. Soc., The Cultivator* and *Journal*. Atlanta, *State Agr. Soc.* Boston, *Inst. of Technology*. Hoboken, *Stevens Inst. of Technol.* Madison, *State Agr. Soc., Trans.* (1852, etc.). Sacramento, *Soc. of Agr. and Hortic.* San Francisco, *Agr. and Hort. Soc.* Troy, *Rensselaer Polytechnic Inst.* Worcester, *Free Inst. of Industry*.[1]

FRANCE: Algiers, *Soc. d'Agr.* (1840), *Bull.* Amiens, *Soc. Industrielle* (1861), *Bull.* Angers, *Soc. Industr. et Agr.* (1830), *Bull.* Bordeaux, *Soc. d'Agr.* Boulogne, *Soc. d'Agr.* Caen, *Assoc. Normande pour l'Agr., l'Industrie*, etc. (1831), *Annuaire* (1835, etc.); *Soc. d'Agr. et de Commerce* (1762), *Mém.* (1853-58) and *Bull.* (1858, etc.). Châlons-sur-Marne, *Soc. d'Agr.*, etc. (1798), *Mém.* (1807, etc.). Elbeuf, *Soc. Industr.* (1858), *Bull.* Grenoble, *Soc. d'Agr. et d'Hortic.* (1835), *Sud.-Est* (1855, etc.). Le Mans, *Soc. du Matériel Agr.* (1857), *Bull.* Lyons, *Soc. des Sc. Industr.* (1862), *Annales*. Montpellier, *Soc. d'Agr.* (1799), *Bull.* (1808, etc.). Nancy, *Soc. Centr. d'Agr.* Paris, *Soc. Nat. d'Agr. de France* (1761; reconstructed in 1878 with a view of instructing Government on agricultural matters), *Mém.* and *Bull.* Rheims, *Soc. Industr.* (1833), *Bull.* (1858, etc.). Rouen, *Soc. Industr.* (1872), *Bull.; Soc. du Commerce et de l'Ind.* Saint-Jean-d'Angély, *Soc. d'Agr.* (1819), *Bull.* (1833, etc). St. Quentin, *Soc. Industr.* (1868), *Bull.* Toulouse, *Soc. d'Agr.* GERMANY and AUSTRIA-HUNGARY: The migratory *Congress Deutscher Volkswirthe* first met at Gotha in 1858. Agram, *Kroatisch-Slav. Landwirths. Ges., Blätter*. Augsburg, *Landwirths. Ver., Landw. Blätter*. Berlin, *Vereinigt. Berlinerkaufleute u. Industr.; Ver. f. Beförd. des Gewerbefleisses*. Bonn, *Landwirthsch. Central-Ver.* Bremen, *Landwirths. Ver.* Breslau, *Landwirths. Central-Ver.; Schles. Central. Gewerbe-Ver.* Cassel, *Landwirths. Central-Ver., Mittheil.* Cracow, *Akerbau Ges., Annalen*. Dantzic, *Volkswirths. Ges.* (1850). Darmstadt, *Landwirths. Ver., Ztschr.* Dresden, *K. Oekonomie Ges.; K. Sächs. Polytechnicum*. Fürth, *Gewerbe-Ver.* Gratz, *K. k. Steiermarkische Landwirths. Ges.* Greifswald, *Baltischer Central-Ver.* Halle, *Landwirths. Central-Ver.* Hanover, *Gewerbe-Ver.* Innsbruck, *K. k. Landwirths. Ges. Wochenschr.; Kärnt. Industrie- u. Gewerbe-Ver.* Jena, *Landwirths. Inst.* Königsberg, *Ostpreuss. Landwirths. Central-Ver.* Leipsic, *Landwirths. Kreis-Ver.; Polytechn. Ges.* Linz, *K. k. Landwirths. Ges.* Lübeck, *Landwirths. Ver., Mittheil.* Mühlhausen, *Soc. Industr., Bull.* Munich, *Landwirths. Kreis-Ver.; Polytechn. Ver.* Nuremberg, *Polytechn. Ver.* Pesth, *Ungar. Akerbau Ges., Mittheil.; Industrielle Ges.* Prague, *Böhmischer Gewerbe-Ver.; Industrie Ges., Mittheil.* and *Annalen*. Ratisbon, *Landwirths. Kreis.-Ver., Bauernfreund*. Stuttgart, *K. Württemb. Central-Stelle, Wochenblatt*. Trieste, *Akerbau Ges.* Tübingen, *Landwirths. Ver.* Vienna, *K. k. Reichs Landwirths. Ges., Ztschr.* Wiesbaden, *Gewerbe-Ver.* SWITZERLAND: Bern, *Oekonom. Ges.* Lausanne, *Soc. d'Agr. de la Suisse Romande*. Zurich, *Ver. f. Landwirths. u. Gartenbau*. ITALY: Bologna, *Soc. Agraria, Annali*. Cagliari, *Soc. Agr. ed. Econom.* Florence, *Soc. Econom. ed. Agr., Rendiconti*. Milan, *Soc. Agr. di Lombardia; Soc. Gen. degli Agricolt. Ital.; Soc. d'Incoragg. di Arti e Mestieri, Discorsi*. Perugia, *Soc. Econom. ed Agr., Atti*. Turin, *Accad. Reale di Agricolt.; Assoc. Agr. Ital., Esercitazioni*. Verona, *Accad. d'Agricolt.* BELGIUM: *Soc. Centr. d'Agricult.* (1854), *Bull.* Ghent, *Soc. Roy. d'Agr. et de Bot.* Liége, *Soc. d'Agr., Journ.* (1850, etc.). Verviers, *Soc. Industr. et Commerc.* (1863), *Bull.* HOLLAND: Amsterdam, *Aardrijkskundig Genootschap; Vereeniging voor Volksvlijt*. DENMARK: Copenhagen, *K. Landhuusholdnings Selskab; Det Statist. Tabelværk*. NORWAY: Christiania, *Polytekniske Forening*. SWEDEN: *K. Landtbruks Akademien*. SPAIN and PORTUGAL: Barcelona, *Soc. Econom., Actas*. Lisbon, *Inst. Real de Agric.; Soc. Promotora de Industr.* Madrid, *Soc. Econom. Matritense, Anales*. Oporto, *Acad. Polytechn.* RUSSIA: Dorpat, *K. Livländische Oekonom. Ges. Jahrbuch*. Kazan, *Imp. Econom. Soc., Monthly Reports*. Moscow, *Imp. Soc. of Agriculturalists*. Odessa, *Imp. Agronom. Soc. of S. Russia*. Riga, *Technical Soc.* St. Petersburg, *Imp. Econom Soc., Trans.; Technical Soc.* ROUMANIA: Bucharest, *Soc. Roumaine d'Agr.*

XVII. LITERATURE, HISTORY, AND ARCHÆOLOGY.

The *Congrès International des Orientalistes* first met at Paris in 1873; it issues *Comptes Rendus* (1874, etc.). The *Congrès Bibliographique International* held its first meeting in 1878, and the *Congrès des Américanistes* its first meeting in 1875. The *Royal Society of Literature* (1823, incorporated in 1826), with *Transactions* (4to, 1829-39; 8vo, 1843, etc.), and the *Royal Asiatic Society* (1823), with *Journal* (1834, etc.), have their headquarters in London, as well as the following literary societies and printing clubs, all of which issue publications: *Aristotelian* (1879), *Authors* (1884), *Ballad* (1868), *Browning* (1881), *Carlyle* (1879), *Chaucer* (1868), *Early English Text* (1864), *East India Association* (1866) *English Dialect* (1873), *Gaelic*, *Hebrew Literature* (1872), *Hellenic Studies* (1879), *Index* (1877), *Library Association* (1877), *London Dialectical* (1865), *New Shakspere* (1873), *Oriental Translation Fund* (1828), *Pali Text*, *Philobiblon* (1853), *Philological* (1842), *Roxburghe Club* (1812), *Shorthand*, *Wordsworth* (1880), *Wyclif* (1882). The *Cambridge Philological Society*, the *Glasgow Hunterian Club* (1871), the *Lancashire and Cheshire Historical Society* (1828), at Liverpool, the *Manchester Literary Club*, with *Transactions and Papers* (1874, etc.), and the *Manx Society* (1858), at Douglas, may also be mentioned.

The oldest and most important society in England dealing with history and archæology is the *Society of Antiquaries of London*, which enthusiasts trace to an association founded by Archbishop Parker in 1572. The meetings were not publicly recommenced until 1707; the present body was incorporated in 1751; it publishes *Vetera Monumenta* (fol., 1747, etc.), *Archæologia* (4to, 1770, etc.), and *Proceedings* (8vo, 1849, etc.). The *Royal Archæological Institute* (1843), issuing the *Archæological Journal* (1845, etc.); the *British Archæological Association* (1843), with *Journal* (1846, etc.); the *Numismatic Society* (1836), issuing the *Numismatic Chronicle* (1838, etc.); and the *Royal Historical Society* (1868), with *Transactions*, belong to London, as well as the following historical and antiquarian societies, all of which issue publications: *Arundel* (1848), *Camden* (1838), *Cymmrodorion* (1751-73, revived in 1820), *Dilettanti* (1784), *Folk Lore* (1877), *Harleian* (1869), *Holbein*, *Huguenot* (1885), *London and Middlesex Archæol.* (1855), *Medallists* (1885), *Middlesex County Records* (1884), *Palæographical*, *Pipe Roll* (1883), *Rabelais Club* (1879), *Seal* (1883), *Soc. Bibl. Archæol.* (1870), *Soc. for Prot. Anc. Buildings* (1877), *Topographical* (1880). The *Society of Antiquaries of Scotland* (1790), at Edinburgh, and the *Irish Archæology and Celtic Society*, at Dublin, are the leading associations outside London. Among others are—Aberdeen, *New Spalding Club* (1886); *Bedfordshire Archæol. and Architect. Soc.* (1844); Bristol, *Bristol and Gloucester Arch. Soc.* (1876); *Cambrian Arch. Assoc.* (1846); *Cambridge Antiq. Soc.* (1840); Dublin, *Roy. Hist. and Arch. Soc.;* Durham, *Surtees Soc.* (1834); *Essex Arch. Soc.* (1852); Exeter, *Diocesan Arch. Soc.* (1841); *Glasgow Arch. Soc.* (1856); *Kent Arch. Soc.* (1857); *Lanc. and Cheshire Antiq. Soc.* (1883); Manchester, *Chetham Soc.* (1843); *Newcastle-on-Tyne Soc. of Antiq.* (1813); Norwich, *Norfolk and Norwich Arch. Soc.* (1846); Oxford, *Architect. and Hist. Soc.* (1839) and *Hist. Soc.* (1883); *Purbeck Soc.; Sussex Arch. Soc.* (1846); Welshpool, *Powys Land Club* (1867); and *Yorkshire Arch. and Topogr. Assoc.* (1863).

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[1] [Efficient Agricultural Societies exist in nearly every northern and northwestern State, besides which there are many local and specialized organizations. The technical schools named in this paragraph are not societies, but chartered educational institutions.—AM. ED.]

CANADA: Montreal, *Soc. Hist.*, *Mém.* (1859, etc.); *Numism. and Antiq. Soc.*, *Journ.* (1872, etc.). Quebec, *Lit. and Hist. Soc.*, *Trans.* (1837, etc.). Toronto, *Lit. and Hist. Soc.* CHINA: Hong Kong, *Roy. Asiatic Soc.* Shanghai, *Roy. Asiatic Soc.*, *Journ.* (1858, etc.). INDIA: Bombay, *Roy. Asiatic Soc.* (1841), *Journ.* (1844, etc.). Calcutta, *Asiatic Soc. of Bengal*, *Journ.* (1832, etc.) and *Proc.* (1865, etc.). Colombo, *Roy. Asiatic Soc.*, *Journ.* (1844, etc.). Singapore, *Roy. Asiatic Soc.*

UNITED STATES: Baltimore, *Hist. Soc.* Boston, *Mass. Hist. Soc.*, *Collections* (1792, etc.) and *Proc.* (1859, etc.); *New Engl. Hist.-Gen. Soc.* (1846), *Proc.*; *Amer. Oriental Soc.* (1843), *Journ.* (1849, etc.). Brunswick [Me]., *Hist. Soc.* Chicago, *Hist. Soc.* Concord, *Hist. Soc.*, *Coll.* (1824, etc.). Hartford, *Amer. Philolog. Soc.*; *Hist. Soc.*, *Coll.* (1860, etc.). Madison [Wis.], *Hist. Soc.*, *Coll.* (1855, etc.). Minneapolis, *Hist. Soc.*, *Coll.* (1869, etc.). Montpelier, *Hist. Soc. of Vermont*, *Coll.* (1869, etc.). [New Haven, *American Oriental Society*]. New York, *Hist. Soc.*, *Coll.* (1811, etc.); *Genealog. Soc.*; *Amer. Library Assoc.* (1876), *Libr. Journ.* Philadelphia, *Hist. Soc.*, *Mem.* (1826, etc.); *Numism. and Arch. Soc.* (1865). Portland, *Maine Hist. Soc.*, *Coll.* (1831, etc.). Providence, *Hist. Soc.*, *Coll.* (1827, etc.). Richmond, *Virg. Hist. and Phil. Soc.*, *Publ.* (1874, etc.). St. Louis, *Missouri Hist. Soc.* Savannah, *Hist. Soc.*, *Coll.* (1840, etc.). Topeka, *Hist. Soc.*, *Trans.* (1881, etc.). Worcester, *Amer. Antiq. Soc.*, *Proc.* and *Arch. Amer.* (1820, etc.).

FRANCE: The *Congrès Archéologique de la France* first met in 1834. Algiers, *Soc. Hist.* (1856), *Revue* (1856, etc.). Amiens, *Soc. des Antiq.* (1836), *Mém.* (1838, etc.) and *Bull.* Angoulême, *Soc. Arch. et Hist.* (1841), *Bull.* Bordeaux, *Soc. Archéol.* (1873). Caen, *Soc. des Antiq. de Normandie* (1824), *Mém.* (1825, etc.) and *Bull.* (1860, etc.); *Soc. Fran. d'Arch.* (1834), *Comptes Rend.* (1834, etc.) and *Bull. Mens.* (1835, etc.). Constantine, *Soc. Arch.* (1852), *Recueil.* Dijon, *Comm. des Antiquités* (1830), *Mém.* (1832, etc.). Limoges, *Soc. Hist. et Arch.* (1845), *Bull.* Lyons, *Soc. Hist., Litt., et Arch.* (1807), *Mém.* (1861, etc.). Montpellier, *Soc. Arch.*, *Mém.* (1835, etc.). Nancy, *Soc. d'Arch. de Lorraine* (1848), *Mém.* (1850, etc.) and *Journ.* (1852, etc.). Nantes, *Soc. Arch.* (1845), *Bull.* (1859, etc.). Orleans, *Soc. Arch. et Hist.* (1849), *Mém.* (1851, etc.) and *Bull.* Paris, *Soc. Nat. des Antiq. de Fr.* (based on the *Académie Celtique*), *Mém.* (1817, etc.) and *Bull.* (1857, etc.); *Soc. de l'Hist. de France* (1833), has published about 270 vols.; *Soc. de l'École Nat. des Chartes* (1854), *Bibliothèque*; *Soc. Asiatique* (1822), *Journal Asiat.* (1822, etc.), etc.; *Soc. Fran. d'Arch. et de Numism.*; *Soc. de l'Hist. du Prot. Fran.*; *Soc. de Linguistique*; *Soc. bibliogr.* (1868), *Polybiblion.* Poitiers, *Soc. des Antiq.* (1834), *Mém.* Rouen, *Soc. de l'Hist. de Norm.* (1869), *Publ.* Toulouse, *Soc. Arch.* (1831), *Mém.* Tours, *Soc. Arch.* (1840), *Mém.* (1842, etc.). GERMANY and AUSTRIA-HUNGARY: *Gesam. Ver. d. D. Gesch. u. Alt. Vereine* (1852). Agram, *Ges. f. Süd-Slav. Alterth.* Altenburg, *Gesch. u. Alterthums Ges.* (1838), *Mittheil.* (1841, etc.). Augsburg, *Hist. Ver.* (1820, reorganized in 1834), *Jahresber.* (1835, etc.). Baden, *Alterthums-Ver.* (1844), *Schriften.* Bamberg, *Hist. Ver.* (1830), *Ber.* (1834, etc.). Berlin, *Ver. f. Gesch. d. Mark Brandenb.* (1836), *Forschungen* (1841, etc.); *Ver. f. d. Gesch. Berlins* (1865), *Schriften*; *Hist. Ges.* (1872), *Mittheil.*; *Archäolog. Ges.* (1841), *Archäol. Zeitung*; *Numism. Ges.* (1843), *Jahresber.* (1845, etc.), *Herold* (1869); *Phil. Ges.* (1843), *Der Gedanke* (1861, etc.); *Ges. f. D. Philologie* (1877), *Jahresber.* (1879, etc.). Bonn, *Ver. f. Alterth.* (1841), *Jahresber.*; *Soc. Philologa* (1854). Brandenburg, *Hist. Ver.* (1868), *Jahresber.* (1870, etc.). Braunsberg, *Hist. Ver.* (1856), *Ztschr.* (1858, etc.). Breslau, *Ver. f. Gesch. u. Alt. Schl.* (1846), *Ztschr.* (1856, etc.); *Breslauer Dichterschule* (1860). Cassel, *Ver. f. Hess. Gesch.* (1834), *Ztschr.* (1837, etc.). Cologne, *Hist. Ver.* (1854), *Annalen* (1855, etc.). Darmstadt, *Hist. Ver.* (1834), *Archiv* (1835, etc.). Dresden, *K. Sächs. Alt. Ver.* (1824), *Jahresber.* (1835, etc.) and *Mittheil* (1835, etc.). Frankfort, *Ges. f. Deutschlands ält. Geschichtskunde* (1819; since 1875 under guidance of *Central-Dir. d. Mon. Germ.*), *Mon. Germ.* (1826, etc.); *Ges. f. Gesch. u. Kunst* (1837), *Mittheil.* (1858, etc.); *Freies D. Hochstift in Goethe's Vaterhaus* (1859). Halle, *Thür.-Sächs. Ver.* (1819), *Mittheil.* (1822, etc.); *D. Morgenl. Ges.* (1844), *Ztschr.* (1847, etc.) and *Abhandl.* (1859, etc.). Hanover, *Hist. Ver.* (1835), *Ztschr.* Kiel, *Ges. f. Gesch. Schl.-Holst.* (1833, reorganized in 1873), *Archiv* (1833, etc.) and *Ztschr.* (1870, etc.). Leipsic, *D. Ges z. Erforschung vaterl. Spr. u. Alterth.* (1697, reorganized in 1824), *Jahresber.* (1825, etc.) and *Mittheil.* (1856, etc.); *Fürstlich Jablonowski's Ges.* (1768), *Acta* (1772, etc.); *Börsenver. d. D. Buchhändler* (1825), *Börsenblatt* (1834, etc.); *Hist. Theolog. Ges.* (1814). Lübeck, *Hansischer Ges. Ver.* (1870). Munich, *Hist. Ver.* (1837), *Archiv* (1839, etc.): *Alterthums-Ver.* (1864). Nuremberg, *Pegnesischer Blumenorden* (1644), had united with it in 1874 the *Lit. Ver.* (1839). Prague, *Ver. f. Gesch.* Ratisbon, *Hist. Ver.* (1830), *Verhandl.* (1832, etc.). Schwerin, *Ver. f. Meckl. Gesch. u. Alterthumsk.* (1835), *Jahrbuch* (1836, etc.) and other publications. Stuttgart, *Lit. Ver.* (1839), *Bibliothek* (1843, etc.); *Württemb. Alterth. Ver.* (1843). Vienna, *K. k. Orient. Akad.* Weimar, *D. Shakespeare Ges.* (1864), *-Jahrbuch* (1865, etc.). Wiesbaden, *Ver. f. Nass. Alterth.* (1821), *Annalen* (1830, etc.). Würzburg, *Hist. Ver.* (1830), *Archiv* (1833). SWITZERLAND: Basel, *Hist. u. Antiq. Ges* Bern, *Schweiz. Hist. Ges.* Freiburg, *Soc. d'Hist.* Geneva, *Soc. d'Hist. et d'Arch.* Lausanne, *Soc. d'Hist.* Zurich, *Soc. d'Hist.*; *Antiq. Ges.* ITALY: Genoa, *Soc. di Storia Patria.* Naples, *R. Accad.*; *R. Accad. Ercolanese.* Rome, *Accad. Rom. di Arch.*; *Soc. Rom. di Storia Patria*; *Inst. di Corr. Arch.*; *Brit. and Amer. Arch. Soc.*; *K. Deutsch. Archäolog. Inst.*, *Arch. Ztng.* (1843–85) and *Jahrb.* Turin, *Real Deputaz. di Stor. Patr.* BELGIUM: Antwerp, *Acad. d'Archéol.* (1842), *Bull.* (1865, etc.). Bruges, *Soc. pour l'Hist. et les Antiq. de la Flandre* (1839), *Publ.* Brussels, *Soc. de l'Hist. de Belgique* (1858), *Publ.*; *Soc. Roy. de Numism.* (1841), *Revue*; *Soc. des Bibliophiles* (1865). Ghent, *Soc. Roy. des Beaux-Arts et de la Litt.* (1808), *Annales* (1844, etc.); *Willems Fond* (1851). Liége, *Inst. Archéol.* (1852), *Bull.* (1852, etc.). Louvain, *Soc. Litt.* (1839), *Mém.* and *Publ.* Mons, *Cercle Archéol.* (1856), *Annales* (1857, etc.). Tournai, *Soc. Hist. et Litt.* (1846), *Bull.* (1849, etc.). Verviers, *Soc. Arch.* Ypres, *Soc. Hist.* (1861). HOLLAND: Leyden, *Acad. Lugduno-Batava.* Luxembourg, *Inst. Archéol.* (1846, reorganized in 1862), *Annales* (1849, etc.). Utrecht, *Hist. Genootschap.* DENMARK: Copenhagen, *Island. Litt. Selskab*; *K. Danske Selskab*; *K. Nordisk Oldskrift Selskab.* Reykjavik (Iceland), *Fornleifafelag.* NORWAY: Christiania, *Norske Hist. Forening*; *Norske Oldskrift Selskab.* SWEDEN: *K. Vitterhets Hist. och Antiq. Akad.*; *Svenska Akad.* SPAIN: Barcelona, *R. Acad. de Buenas Letras*; Madrid, *R. Acad. de Cienc. Mor. y Pol.*; *R. Acad. Esp. Arq.*; *R. Acad. de la Hist.* GREECE: Athens, *Soc. Archéol.* RUSSIA: Helsingfors, *Finska Litt. Sällskapet.* Mitau, *Courland Soc. of Lit. and Art.* Moscow, *Imp. Russ. Soc. of Hist. and Antiq.*; *Archæolog. Soc.* Narva, *Archæolog. Soc.* Odessa, *Hist. and Antiq. Soc.* Riga, *Lett. Lit. Ges.*; *Hist. and Antiq. Soc.* St. Petersburg, *Russ. Hist. Soc.* TURKEY: Constantinople, *Soc. for Adv. of Turkish Lit.*; *Hellenic Philolog. Soc.* JAPAN: Yokohama, *Asiatic Soc. of Japan*, *Trans.* (1874, etc.).

XVIII. GEOGRAPHY.

The *Congrès International pour les Progrès des Sciences Géographiques* first met in 1871. The *Royal Geographical Society of London*, founded in 1830, had joined to it in the following year the *African Association* (1788), the successor of the *Saturday Club*; the *Palestine Association* (1805) became merged with it in 1834. It publishes *Journal* (1832, etc.) and *Proceedings* (1857, etc.). The *Hakluyt Society* (1846) has printed more than 70 vols. of rare voyages and travels. The *Alpine Club* (1858), whose publications are *Peaks, Passes, and Glaciers* (1859–62) and *Journal* (1863, etc.), and the *Palestine Exploration Fund* (1865), publishing *Quarterly Statement* (1869, etc.) and *Memoirs*, meet in London. The *Scottish Geographical Society* (1884) has its centre at Edinburgh, and issues the *Scottish Geographical Magazine.* Manchester has also a *Geographical Society.* AUSTRALIA: Melbourne, *Geogr. Soc.* Sydney, *Geogr. Inst.* CANADA: Quebec, *Geogr. Soc.* INDIA: Bombay, *Geogr. Soc.*, *Trans.* (1836, etc.).

UNITED STATES: New York, *Amer. Geogr. (and Statist.) Soc.*, *Bull.* (1852, etc.), *Journ.* (1859, etc.), and *Proc.* (1862, etc.); *Palestine Exploration Soc.* (1870). FRANCE: Bordeaux, *Soc. de Géogr. Commerciale* (1874), *Bull.* Lyons, *Soc. de Géogr.* (1873), *Bull.* Marseilles, *Soc. de Géogr.* (1876), *Bull.* Paris, *Soc. de Géogr.* (1821, reorganized in 1827), *Bull.* (1822, etc.). GERMANY and AUSTRIA-HUNGARY: *D. Geographentag* (1881), *Verhandl.*; *D. Alpen-Ver.* (1869), *Ztschr. u. Jahrb.* (1869, etc.). Berlin, *Ges. f. Erdkunde* (1828), *Ztschr.* (1853, etc.) and *Verhandl.* (1873, etc.); *Ges zur Erforschung Aequat. Afrikas* (1873), *Corr.-Blatt.*; *Afrik. Ges.* (1878), *Mittheil.* Bremen, *Geograph. Ges.* (1877), *Geogr. Blätter.* Carlsruhe, *Badische Geogr. Ges.* (1880), *Verhandl.* Cassel, *Ver. f. Erdk.* (1882). Darmstadt, *Ver. f. Erdk.* (1845), *Notizblatt* (1854, etc.). Dresden, *Ver. f. Erdk.* (1863), *Jahresber.* Frankfort, *Ver. f. Geogr. u. Statist.* (1836), *Jahresber.* Halle, *Ver. f. Erdk.* (1873). Hamburg, *Geogr. Ges.* (1873), *Jahresber.* Hanover, *Geogr. Ges.* (1878), *Jahresber.* Jena, *Geogr. Ges.* (1880), *Mittheil.* Leipsic, *Ver. f. Erdk.* (1861), *Jahresber.* Lübeck, *Geogr. Ges.* (1880). Munich, *Geogr. Ges.* (1869), *Jahresber.* Pesth, *Hung. Geogr. Soc.* (1873). Vienna, *K. k. Geogr. Ges.*, *Mitth.* (1857, etc.); *Ver. der Geogr.* Weimar, *Geogr. Inst.* SWITZERLAND: Bern, *Inst. Geogr.*; *Schweiz. Alpen-Club.* Geneva, *Soc. de Géogr.*, *Mém.* (1860, etc.). Zurich, *Karten-Ver.* ITALY: Rome, *Soc. Geogr. Ital.*, *Bull.* (1868, etc.). Turin, *Circolo Geogr. Ital.* (1868). BELGIUM: Antwerp, *Soc. Belge de Géogr.* (1870), *Bull.* Brussels, *Soc. Belge de Géogr.* HOLLAND: Amsterdam, *Het Aardrijkskundig Genoot.*, *Tijdschrift* (1874, etc.); *Landkundige Genootschap.* DENMARK: Copenhagen, *Geogr. Selskab.* SPAIN and PORTUGAL: Lisbon, *Soc. de Geogr.*, *Bol.* (1876, etc.). Madrid, *Soc. Geogr.*, *Bol.* (1876, etc.). RUSSIA: Irkutsk, *Geogr. Soc.*, *Bull.* (1871, etc.). St. Petersburg, *Imp. Russ. Geogr. Soc.*, *Mem.* (1849, etc.) and *Bull.* (1865, etc.). Tiflis, *Geogr. Soc.*, *Mem.* (1852, etc.). EGYPT: Cairo, *Soc. Khédiviale de Géogr.*, *Bull.* (1876, etc.). JAPAN: Tokio, *Geogr. Soc.* CENTRAL and SOUTH AMERICA: Buenos Ayres, *Inst. Geogr. Argent.* Mexico, *Soc. de Geogr. ed Estad.*, *Bol.* (1861, etc.). Rio Janeiro, *Roy. Geogr. Soc.*

BIBLIOGRAPHY.—The *Catal. of Printed Books in the British Museum* (1841), folio, *s.v.* "Academies," contains a list of all the publications of societies at that time in the museum. This has been re-arranged and greatly enlarged as *Academies* (1885–86), 5 parts folio. See also *Annuaire des Soc. Sav. de la France et de l'Étranger* (1846), 8vo; A. d'Héricourt, *Annuaire*, 1863–66, 3 pts. 8vo; *Cat. of Periodicals in Bodleian Lib.*, pt. iii. *Foreign*, 1880, 8vo; S. H. Scudder, *Cat. of Scientific Serials*, 1633–1876, Camb. (U. S.), 1879, 8vo, very complete; P. E. Richter, *Periodica im Besitze des k. öff. Bibl. zu Dresden*, 1880, 8vo; *Cat. of Trans., etc., in Radcliffe Lib.*, 1884, 8vo; *List of Foreign Corr. of the Smithsonian Inst.* 1886, 8vo. British societies are now well represented in the *Year Book of the Scientific and Learned Societies of Great Brit. and Ireland*, 1884, etc. See also Hume's *Learned Societies and Printing Clubs of the U. K.*, 1853, 8vo; E. Mailly, *Inst. Sc. de la Grande Bret.*, 1861-67, 6 pts.; H. G. Bohn, *App. to Bibliographer's Manual*, 1864, 8vo; *Engl. Catal. of Books*, 1864-82, 3 vols. 8vo; and "Sc. Societies and Field Clubs," in *Nature*, v., viii. For France, see U. Robert, *Bibl. des Soc. Sav. de la France*, pt. i., 1878; F. Bouillier, *L'Institut et les Acad. de Province*, 1879, 8vo; *Bibliogr. des Travaux Hist. et Arch. publ. par les Soc. Sav. de la France*, 1885, etc., 4to (in prog.). For Germany and Austria-Hungary, see H. A. Stöhr, *Allg. Deutsches Vereinshandbuch*, 1873, etc., 8vo; J. Müller, *Die wiss. Vereine u. Ges. Deutschlands im 19ten Jahrh.*, 1883, 4to (in prog.); J. Winckler, *Die period. Presse Oesterreichs*, 1875, 8vo; and P. A. F. Walther for German historical societies (1845). F. Huth, *Verzeichniss*, Berlin, 1887, etc. (in prog.), describes publications of societies relating to natural science. See also "Les Congrès Scientifiques," by Count de Marsy, in *Compte Rendu du Congrès Bibliogr.*, 1879. For Belgium, see *Introd. à la Bibl. de la Belgique*, 1875. For Italy, see G. Ottino, *La Stampa Periodica in Italia*, 1875, 8vo. For Russia, consult C. Woldemar, *Gesch. d. russ. Gelehrten- und Schul-Anstalten*, St. Petersburg, 1865, 8vo, and Kawall, *Die neuen russ. Naturforschergesellschaften*, Riga, 1872–74. (H.R.T.)

SOCIETY ISLANDS. See TAHITI ARCHIPELAGO.

SOCINUS, the Latinized form of the Italian Soccini, Sozini, or Sozzini.

I. LELIO FRANCESCO MARIA SOZINI (1525–1562), theological inquirer, was born at Siena on 29th January, 1525. His family descended from Sozzo, a banker at Percena, whose second son, Mino Sozzi, settled as a notary at Siena in 1304. Mino Sozzi's grandson, Sozzino (d. 1403), was the ancestor of a line of patrician jurists, of whom Mariano Sozzini, senior (1397–1467), was the first and the most famous. Lelio was the sixth son of Mariano Sozzini, junior (1482–1556), by his wife Camilla Salvetti. The family name is variously spelled (usually "Soccini" by modern writers); Lelio invariably uses the form "Sozini," Latinizing it "Sozinus"; his nephew **Fausto** (see below) writes "Sozzini" and "Socinus." Sozini was educated as a jurist under his father's eye at Bologna. According to Melanchthon, it was his desire to reach the *fontes juris* which led him to Biblical studies and hence to the rejection of "the idolatry of Rome." Later on he acquired some knowledge of Hebrew and Arabic (he gave to Bibliander a manuscript of the Koran) as well as Greek, but he was never a laborious student. His father supplied him with means, and on coming of age he went to Venice, the headquarters of the evangelical movement in Italy. A tradition first published by Sand in 1678, and amplified by subsequent writers, makes Sozini the leading spirit in certain alleged theological conferences at Vicenza, about 1546, which are said to have forecast the main positions of the Unitarian heresy; but the whole account, including the story of the flight of Sozini, must be rejected as mythical. At this period the standpoint of Sozini was that of evangelical Protestantism; his mental temper presents a singular union of enthusiastic piety with a love for the subtleties of theological speculation. It was at Chiavenna in 1547 that he came under the influence of a gentle mystic, Camillo of Sicily, surnamed "Renato," whose teaching anticipated at many points that of the early Quakers. Pursuing his religious travels, Sozini visited Switzerland, France, England, and Holland, returning to Switzerland at the close of 1548. He had commendatory letters to the Swiss churches from Nicolas Meyer, envoy from Wittenberg to Italy; but his family name was a sufficient passport, and wherever he went his personal charm won friends. We find him in 1549–50 at Geneva and Basel (with Sebastian Münster), but chiefly at Zurich, where he lodges with Pellican. He spends eleven months (July, 1550, to June, 1551) at Wittenberg, at first under Melanchthon's roof, then with Johann Forster for the improvement of his Hebrew. From Wittenberg Sozini returned to Zurich (end of 1551) after visiting Prague, Vienna, and Cracow. Political events attracted him back to Italy in June, 1552. Two visits to Siena (where freedom of speech was for the moment possible, owing to the shaking off of the Spanish yoke) brought him into fruitful contact with his young nephew Fausto. He was at Padua (not at Geneva, as is often said) at the date of Servetus's execution (27th October, 1553). Thence he made his way to Basel (January, 1554), Geneva (April), and Zurich (May), where he took up his abode.

Calvin, as well as Melanchthon, received Sozini with open arms. Melanchthon (though a phrase in one of his letters has been strangely misinterpreted) never regarded him with theological suspicion. To Calvin's keen glance Sozini's over-speculative tendency and the genuineness of his religious nature were equally apparent. A passage often quoted from one of Calvin's letters to Sozini (1st January, 1552) has been construed as a breaking off of amicable intercourse; but, while more than once uneasy apprehensions arose in Calvin's mind, there was no breach of correspondence or of friendship. Of all the Reformers Bullinger was Sozini's closest intimate, his warmest and wisest friend. Sozini's theological difficulties turned upon the resurrection of the body, predestination, the ground of salvation (these were the points on which he corresponded with Calvin), the doctrinal basis of the original gospel (queries addressed to Bullinger), the nature of repentance (to Rudolph Gualther), the sacraments (to Johann Wolff). Not till the fate of Servetus had directed his mind to the question of the Trinity did he throw out any doubts upon this subject. At Geneva, in April, 1554, he had uttered incautious remarks on the common doctrine, emphasized in a subsequent letter to Martinengo, the Italian pastor. Bullinger, warned by several correspondents (including Calvin), questioned Sozini as to his faith, and received from him an explicitly orthodox confession, afterwards reduced to writing (15th July, 1555), with a frank reservation of the right of further inquiry. A month before this Sozini had been sent with Martino Muralto to Basel to secure Ochino as pastor of the Italian church at Zurich. There can be little doubt that the minds of Sozini and Ochino (a thinker of the same order as Camillo, but with finer dialectic skill) acted powerfully on each other in the radical discussion of theological problems. Sozini lost his father in 1556, an event which involved him in pecuniary anxieties. To what property he was entitled does not appear; he got nothing under his father's will. Fortified with the most influential introductions (including one from Calvin), he visited in 1558 the courts of Vienna and Cracow to obtain support for his appeal to the reigning duke of Florence. His object was to realize his own estate and secure that of his family. It is a sufficiently curious circumstance that Melanchthon's letter introducing Sozini to Maximilian II. invokes the historic parallel of the emperor Constans rendering a hospitable reception to Athanasius, when he fled from Egypt to Treves. Well received out of Italy, Sozini (who does not appear to have got beyond Venice) found he could do nothing at home. The Inquisition had its eye on his family: his brother Cornelio was imprisoned at Rome; his brothers Celso and Camillo and his nephew Fausto were "reputati Luterani" at Siena, and Camillo had taken refuge in flight. In August, 1559, Sozini returned to Zurich, and we hear little more of him. His brief career ended on 14th May, 1562, at his lodging in the house of Hans Wyss, silk-weaver.

The news of his death reached his nephew at Lyons through Antonio Maria Besozzo. Fausto repaired to Zurich and got his uncle's papers, comprising very little connected writing, but a good many notes. Fausto has so often been regarded as a plagiarist from Lelio that it may be well here to state that his debt to Lelio, somewhat over-estimated by himself, was two-fold. (1) He derived from him in conversation (1552–53) the germ of his theory of salvation; (2) Lelio's paraphrase (1561) of ἀρχή in John i. 1 as "the beginning of the gospel" gave Fausto a hint of Biblical exegesis by help of which he constructed a new Christology. Apart from these suggestions, Fausto owed nothing to Lelio except a curiously far-fetched interpretation of John viii. 58, and the stimulating remembrance of his pure character and brilliant gifts. The two men were of totally different genius. Lelio, impulsive and inquisitive, was in quest of the spiritual ground of religious truth; the drier mind of Fausto sought in external authority a basis for the ethical teaching of Christianity.

Sozini's extant writings are (1) *De Sacramentis Dissertatio*, four parts, 1560, and (2) *De Resurrectione*, a fragment. Both were first printed in *F. et L. Socini, item E. Soneri Tractatus*, Amsterdam, 1654, 16mo. To these may be added his *Confession*, 1555 (printed in Hottinger, *Hist. Eccles. N. T.*, vol. ix., sec. 16, part 5, 1667), and about twenty-four letters, some still unprinted; but the most important will be found in Illgen and Trechsel, and (the earliest) in the edition of Calvin's works by Baum, Cunitz, and Reuss. Sand adds a *Rhapsodia in Esaiam Prophetam*, of which nothing is known. Beza suspected that Sozini had a hand in the *De Hæreticis, an sint persequendi*, 1553, and to him has also been assigned the *Contra Libellum Calvini*, 1554; but these ascriptions were not made till his nephew had identified his name with active heresy, and are not supported by internal evidence. To Lelio also Beza assigned (in 1567) an anonymous *Explicatio* (1562) of the proem of St. John's Gospel, which was the work of Fausto. This error, adopted by Zanchi, has been the chief source of the misconception which represents Lelio as a heresiarch. In Franc. Guinio's *Defensio Cath. Doct. de S. Trin.*, 1590–91, is an anonymous *enumeratio* of motives for adhering to the doctrine of the Trinity, by some ascribed to Lelio, by others, with somewhat more probability, to Fausto.

For the life of L. Sozini the best guide is Trechsel, *Die Prot. Antitrin. vor F. Socin*, vol. ii., 1844; but there are valuable materials in

Illgen, *Vita L. Socini*, 1814, and especially *Symbolæ ad Vitam et Doctrinam L. Soc.*, etc., 1826. Wallace (*Antitrin. Biog.*, 1850, ii. 68) gives the ordinary Unitarian view, relying on Bock, Da Porta, and Lubienecki; see also Bonet-Maury's *Early Sources of English Unit. Christ.*, 1884, chap. 9. Use has been made above of unprinted sources.

II. FAUSTO PAOLO SOZZINI (1539–1604), theological writer, was born at Siena on 5th December 1539, the only son of Alessandro Sozzini, "princeps subtilitatum," by Agnese, daughter of Borghese Petrucci. He was thus descended on the one side from the long line of great lawyers, of whom Mariano the elder is traditionally said to have been the first heretic of the family, on the other from Pandolfo Petrucci, the Cromwell of Siena. His father died in 1541 at the early age of thirty-one. Fausto received no regular education; he was brought up at home with his sister Fillide. The influence of the able women of his family communicated a strong moral impress to his thought. His youth was spent in desultory reading at Scopeto, the country seat of his family. His early intellectual stimulus came from his uncle Celso, an *esprit fort*, though always nominally a Catholic, and the founder of the Accademia dei Sizienti (1554), of which Fausto was a member. In 1556 his grandfather's will made him independent by leaving him one-fourth of the family estates. Next year he was enrolled in the famous Accademia degli Intronati, the centre of the intellectual life of Siena. His academic name was "Il Frastagliato"; he took as his badge "un mare turbato da venti," with the motto "turbant sed extollunt." About this time Panzirolo (*De Claris Legg. Interpp.*, not published till 1637) describes him as a young man of fine talent, and bespeaks for him a legal career. But Fausto despised the law, and preferred the writing of sonnets. He was suspected of Lutheranism in 1558–59; soon after he came of age (1561) he went to Lyons, being probably employed there in mercantile business; he revisited Italy after his uncle Lelio's death; we next find him enrolled for a short time in 1562 as a member of the Italian church at Geneva; he returned to Lyons next year. The evangelical position was not radical enough for him. His *Explicatio* (1562) of the proem to St. John's Gospel shows that already he attributed to our Lord an official instead of an essential deity; a letter of 1563 rejects the natural immortality of man (a position developed long after in his disputation with Pucci). Towards the end of 1563 he conformed again to the Catholic Church, and spent the next twelve years in Italy, partly at court. Przypkowski, regardless of chronology, places him in the service of Francesco, grand-duke of Tuscany. His unpublished letters show that he was in the service only of Isabella de' Medici, Francesco's sister. This portion of his life is obscure, and he afterwards regarded it as wasted. Till 1567 he continued to give some attention to legal studies. He found time to write (1570) his treatise *De Auctoritate S. Scripturæ*. In 1571 he was in Rome, perhaps with his patroness. At the end of 1575 he left Italy, and after Isabella's death (strangled by her husband in 1576) declined the overtures of Francesco, who pressed him to return. Francesco was probably aware of the motives which led Sozzini to quit Italy; for there is every reason to believe the statement of Przypkowski that the grand-duke agreed to protect him in the enjoyment of the income of his property so long as he published nothing in his own name. Sozzini now fixed himself at Basel, where he gave himself to close study of the Bible, began a poetic version of the Psalms, edited posthumous dialogues of Castellio, and, in spite of his increasing deafness, became a recognized centre of theological discussion. One of these discussions was on the doctrine of salvation, with Jacques Couet. It resulted in a bulky treatise, *De Jesu Christo Servatore* (finished 12th July, 1578), the circulation of which in manuscript appears to have commended his powers to the notice of Giorgio Biandrata (1515–1588), court physician in Transylvania, and an unscrupulous ecclesiastical wire-puller.[1]

Transylvania had for a short time (1559–71) enjoyed religious liberty under an antitrinitarian prince, John Sigismund. But the existing ruler, Christopher Báthori, favored the Jesuits, and it was an object with Biandrata to limit the "Judaic" tendencies of the antitrinitarian bishop, Francis Dávid (1510–1579), with whom he had previously acted. By the alleged discovery of a stain upon Biandrata's morals of the gravest sort his influence with Dávid was destroyed. Now Sozzini's scheme of doctrine encouraged the use of seemingly orthodox language in an heretical sense. Christ was to be called God, and invoked with divine honors, though without any inherent title to such homage, but as "un Dio subalterno, al quale in un dato tempo il Dio supremo cedette il governo del mondo" (Cantù). It occurred to Biandrata that, if Sozzini could convert the eloquent Dávid to this view, all would be well. Accordingly in November, 1578, Sozzini reached Kolozsvár (Klausenburg), and did his best, during a visit of four months and a half under Dávid's roof, to teach him the doctrine of the invocation of Christ. Though Sozzini did not (as Biandrata desired) urge the absolute necessity of this invocation, the result was a public explosion on Dávid's part against the cultus of Christ in any shape or form. His trial followed, on a charge of innovation. Sozzini hurried off to Poland before it began. He cannot be accused of a guilty complicity with what he calls the rage of Biandrata, for he was no party to the incarceration of Dávid at Déva, where the old man miserably perished in prison. But he was willing that Dávid should be prohibited from preaching pending the decision of the controversy by a general synod; and his references to the case show that (as in the later instances of Jacobo Paleologo, Christian Franken, and Martin Seidel) theological aversions, though they never made him uncivil, froze up his kindness and blinded his perceptions of character. Biandrata ultimately conformed to the Catholic Church; yet as late as 1584 Sozzini, always constant to the leanings of friendship, sought his patronage for his treatise *De Jesu Christi Natura*, in reply to the Calvinist Andrew Wolan. The remainder (1579–1604) of Sozzini's life was spent in Poland. Excluded at first by his views on baptism from the Minor or Antitrinitarian Church (anabaptist in its constitution), he acquired by degrees a predominant influence in its synods. He converted the Arians from their avowal of our Saviour's pre-existence and their refusal to honor Him by invocation; he repressed the semi-Judaizers whom he could not convince. Through correspondence with his friends in official places he ruled also the policy of the Antitrinitarian Church of Transylvania. Forced to leave Cracow in 1583, he found a home with a Polish noble, Christopher Morsztyn, whose daughter Elizabeth he married (1586). She died in the following year, a few months after giving birth to a daughter, Agnes, afterwards the wife of Stanislau Wiszowaty. In 1587 the grand-duke Francesco died, and to this event Sozzini's biographers attribute the loss of his Italian property. But he was on good terms with Francesco's successor, and might have continued to receive his rents had not family disputes arisen respecting the intepretation of his grandfather's will. The holy office at Siena disinherited him in October, 1590; but he was allowed a pension, which does not seem to have been paid. The failure of supplies from Italy dissolved the compact under which his works were to remain anonymous. He began to publish under his own name. The consequence was that in 1598 a mob expelled him from Cracow, wrecking his house and grossly ill-using his person. Friends gave him a ready welcome at Luslawice, 30 miles east from Cracow; and here, having long been troubled with colic and the stone, he died on 4th March, 1604. A limestone block, with illegible inscriptions, marks his grave.[1]

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[1] Biandrata was Sozzini's evil genius. Born of an old family in Piedmont and educated in France, Biandrata had attached himself to the left wing of Protestantism, and had moved here and there among the upper circles of the Reformed, depending for professional advancement on a special knowledge of the diseases of women. Driven eastwards a second time in 1558 (after fomenting antitrinitarian heresy in the Italian church of Geneva), he had for twenty years been the confidential adviser of ladies of the reigning house, first in Poland and then in Transylvania. In both countries he was a dexterous meddler in church affairs; his policy was the establishment of a kind of broad church, with a confession nakedly Scriptural in its terms, and a resolute suppression of all compromising extremes.

Sozzini's works, as edited by his grandson Andrew Wiszowaty and the learned printer F. Kuyper, are contained in two closely printed folios, Amsterdam, 1668. They are usually reckoned the first two volumes of the *Bibliotheca Fratrum Polonorum*, but in fact the works of Crell and Schlichting preceded them in the series. They include all Sozzini's extant theological writings, except his essay *On Predestination* (in which he denies that God foresees the actions of free agents), prefixed to Castellio's *Dialogi IV.*, 1578 (reprinted 1613), and his revision of a school manual, *Instrumentum Doctrinarum Aristotelicum*, 1586. His pseudonyms, easily interpreted, were Felix Turpio Urbevetanus, Prosper Dysidæus, Gratianus Prosper, and Gratianus Turpio Gerapolensis (= Senensis). Some of his early poetry will be found in Ferentilli's *Scielta di Stanze di Diversi Autori Toscani*, 1579 (reprinted 1594); other specimens are given in Cantù, and in the *Athenæum*, 11th August, 1877. Sozzini himself considered that his *Contra Atheos*, which perished in the riot at Cracow, was his ablest work. In later life he began, but left incomplete, more than one work intended to exhibit his system as a whole. His reputation as a thinker must rest on (1) his *De Auctoritate S. Scripturæ*, and (2) his *De Jesu Christo Servatore*. The former was first published at Seville (1588) by Lopez, a Jesuit, who claimed it as his own, but prefixed a preface in which, contrary to a fundamental position of Sozzini, he maintains that man by nature has a knowledge of God. A French version (1592) was approved by the ministers of Basel; and the English translation (1731) by Edward Coombe was undertaken in consequence of the commendation of the work in a charge (1728) by Bishop Smalbroke, who observes that Grotius had laid it under contribution in his *De Veritate Christ. Rel.* In a small compass it anticipates the whole argument of the "credibility" writers; but in trying it by modern tests it should be remembered that Sozzini regarded it (in 1581) as not adequately meeting the cardinal difficulties attending the proof of the Christian religion, and subsequently began to reconstruct its argument in his unfinished *Lectiones Sacræ*. His treatise on salvation constitutes his main service to theology, placing orthodoxy and heresy in new relations of fundamental antagonism, and narrowing the conflict to the central interest of religion. Of the person of Christ in this treatise he says nothing; he deals exclusively with the work of Christ, which in his view operates upon man alone; and it is by the persistency with which this idea tends to recur that we must estimate the theological sagacity of Sozzini. Though his name has been attached to a school of opinion (Socinianism), he disclaimed the rôle of a heresiarch, and declined to give his unreserved adhesion to any one sect. The confidence with which he relied upon the conclusions of his own mind has gained him the repute of a dogmatist; but it was his constant aim to reduce and simplify the fundamentals of Christianity, and it is not without ground that the memorial tablet at Siena (inscription by Brigidi, 1879) characterizes him as a vindicator of human reason against the supernatural. Of his non-theological doctrines the most important is his assertion of the unlawfulness not only of war, but of the taking of human life in any circumstances. Hence the comparative mildness of his proposals for dealing with religious offenders; but it cannot be said that he had grasped the full idea of toleration. Hence too his contention that magisterial office is unlawful for a Christian.

For the biography of Sozzini the best materials are his letters. There is a collection in his works; others are given by Cantù; some are unpublished. In his correspondence he delineates himself freely, not sparing his weak points of character or of attainment. The earliest life, prefixed (with engraved portrait) to the works, is by Przypkowski (1636), translated into English by Bidle (1653). This is the foundation of the article by Bayle, the *Memoirs* by Toulmin (1777), and the *Life* by Wallace (*Antitrin. Biog.*, 1850), ii. 306). The sketch by Cantù in *Gli Eretici d'Italia*, 1866, vol. ii., gives a genealogy of the Sozzini (needing some correction). The best defence of Sozzini in his relations with Dávid is by James Yates, in *Christ. Pioneer*, February, 1834; a less favorable view is taken by the Hungarian biographer of Dávid (Jakab, *Dávid F. Emléke*, 1879). Of his system, most generally known through the *Racovian Catechism*, 1605 (planned by Sozzini, but chiefly carried out by others, principally Schmalz; translated by Rees, 1818), there is a special study by Fock, *Der Socinianismus*, 1847. See also "The Sozzini and their School," in *Theol. Rev.*, 1879 (corrected in *Christ. Life*, 25th August, 1883). Use has been made above of unpublished papers in the archives at Florence, with others in the archives, communal library, and collection of Padre Toti at Siena. (A. GO.)

SOCORRO, a town of the United States, in a county of the same name in New Mexico, 76 miles south of Albuquerque junction on the Atchison, Topeka, and Santa Fé Railroad, is beautifully situated in the Rio Grande valley. It is the centre of a silver and lead mining district, and has a stamp mill and smelting-works. Fruit-growing and cattle-breeding are prosecuted in the vicinity. The population, including old and new town, was about 5000 in 1887.

SOCOTRA, or **SOCOTORA** (Arabic *Sokoṭrá*), an island of the Indian Ocean, 150 miles from Cape Gardafui and about 220 from the Arabian coast. Its length from east to west is 71 miles, its greatest breadth 22. A plain 2 to 4 miles wide skirts the greater part of the coast, while the interior is mountainous. The granite peaks behind Tamarída (a village on the north coast and the chief place in the island, but now much decayed) rise to a height of 4000 feet, and a limestone chain connected with these runs north and south with an average height of about 1900 feet. The climate is moist, but not unhealthy, with much rain, especially during the southwest monsoon. At this season the temperature rises to 80° or even 95°, but on the whole the heat is not excessive. The scenery of the island is very striking, with bare rocky heights and fertile valleys; but there is little cultivation, the inhabitants living mainly by their vast flocks of sheep and goats, or on dates, home-grown and imported. Milch cows are numerous near Tamarída. The population is about 5000, of two distinct types. The nomad inhabitants of the uplands are a peculiar race, well built, with good features and long curling but not woolly hair; they resemble neither the Arabs nor the Somál. In Tamarída and other villages and towards the eastern end of the island the population is a mixture of Arab, African, and other elements, even including Portuguese. The native speech is not intelligible to ordinary Arabs, but Wellsted says that it can sometimes be made out by Arabs from the opposite (Mahra) coast. In fact, according to Ibn Mojáwir and Hamdání, the Socotrans in the middle Ages were regarded as Mahra and spoke the Mahra dialect. Their way of life is rude and simple in the extreme, but they are hospitable and generally well behaved, though they have almost no government; they are nominally dependent on the sultan of Keshín. A certain dependence (at least of places on the coast) on some sovereign of the Arabian coast has endured for many centuries, except during the short Portuguese occupation of Tamarída by Albuquerque. From 1876 to 1886 the sultan of Keshín was bound by treaty not to cede the island to a foreign power or allow settlements on it without the consent of England. In 1886 it was formally annexed by Great Britain.

The fauna and flora of Socotra are peculiar. As regards mammalia the civet cat is found, but the ordinary wild beasts of Arabia are unknown. The flora was studied by Professor Bailey Balfour in 1880, and his account of it is about to be published by the Royal Society of Edinburgh. The most valuable vegetable products are now, as in the Middle Ages, aloes and dragon's-blood. The Socotran aloes (the French *chicotin*) is esteemed the best in the world when unadulterated. In old times the ambergris of Socotra was also famous.

Socotra was known to the ancients as the isle of Dioscorides; this name, and that by which the island is now known, are usually traced back to a Sanskrit form, Dvípa-Sakhádhára, "the island abode of bliss," which again suggests an identification with the νῆσοι εὐδαίμονες of Agatharchides (§ 103). The *Periplus* of the Erythræan Sea speaks of the island as peopled only in one part by a mixed race of Arab, Indian, and Greek traders. It was subject to the king of the Incense Country, and was a meeting place of Arabian and Indian ships. Cosmas in the 6th century says that the people spoke Greek and were largely Christian, with a bishop sent from Persia. The Arab geographers also had a tradition of an early Greek settlement (which they naturally ascribe to Alexander), but also of later Persian influence, followed by a settlement of Mahra tribes, who partly adopted Christianity. The Socotrans remained Nestorian Christians, with a bishop under the metropolitan of Persia, through the Middle Ages (Assemani, *B.O.*, ii. 459; comp. Mohallebí, in Abulfeda, p. 371); but in their isolated position they have gradually lost all trace of Christianity except reverence for the cross, and practice the old South Arabian moon worship. There was much more at least of the forms of Christianity when Europeans first visited the island in the 16th century. In the Middle Ages Socotra was a station of the Indian corsairs who harrassed the Arab trade with the far East. The population seems then to have been much larger; Arabian writers estimate the fighting men at 10,000.

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[1] No trace is discoverable on the stone of the alleged epitaph—
"Tota ruit Babylon: destruxit tecta Lutherus,
Calvinus muros, sed fundamenta Socinus."

See, for the history of Socotra, Yule, *Marco Polo*, ii. 400 *sq.*, and, besides the authorities there cited, Yákút, *s.v.;* Hamdání, p. 52; Kazwíní, ii. 54. For the state of the island at the beginning of the 18th century, see the account of the French expedition to Yemen in 1708(*Viaggio nell' Arabia Felice*, Venice, 1721); and, for the present century, Wellsted, *City of the Caliphs*, vol. ii. (1840). For the topography, etc., see *Red Sea Pilot*, 2d ed., 1882.

SOCRATES, son of the statuary Sophroniscus and of the midwife Phænarete, was born at Athens, not earlier than 471 nor later than May or June 469 B.C. As a youth he received the customary instruction in gymnastic and music; and in after years he made himself acquainted with geometry and astronomy and studied the methods and the doctrines of the leaders of Greek thought and culture. He began life as a sculptor: and in the 2d century A.D. a group of the Graces, supposed to be his work, was still to be seen on the road to the Acropolis. But he soon abandoned art and gave himself to what may best be called education, conceiving that he had a divine commission, witnessed by oracles, dreams, and signs, not indeed to teach any positive doctrine, but to convict men of ignorance mistaking itself for knowledge, and by so doing to promote their intellectual and moral improvement. He was on terms of intimacy with some of the most distinguished of his Athenian contemporaries, and, at any rate in later life, was personally known to very many of his fellow-citizens. His domestic relations were, it is said, unhappy. The shrewishness of his wife Xanthippe became proverbial with the ancients, as it still is with ourselves. Aristotle, in his remarks upon genius and its degeneracy (*Rhet.*, ii. 15), speaks of Socrates's sons as dull and fatuous; and in Xenophon's *Memorabilia*, one of them, Lamprocles, receives a formal rebuke for undutiful behavior towards his mother.

Public life.

Socrates served as a hoplite at Potidæa (432–429), where on one occasion he saved the life of Alcibiades, at Delium (424), and at Amphipolis (422). In these campaigns his bravery and endurance were conspicuous. But while he thus performed the ordinary duties of a Greek citizen with credit, he neither attained nor sought political position. His "divine voice," he said, had warned him to refrain from politics, presumably because office would have entailed the sacrifice of his principles and the abandonment of his proper vocation. Yet in 406 he was a member of the senate; and on the first day of the trial of the victors of Arginusæ, being president of the prytanes, he resisted—first, in conjunction with his colleagues, afterwards, when they yielded, alone—the illegal and unconstitutional proposal of Callixenus, that the fate of the eight generals should be decided by a single vote of the assembly. Not less courageous than this opposition to the "civium ardor prava jubentium" was his disregard of the "vultus instantis tyranni" two years later. During the reign of terror of 404 the Thirty, anxious to implicate in their crimes men of repute who might otherwise have opposed their plans, ordered five citizens, one of whom was Socrates, to go to Salamis and bring thence their destined victim Leon, Socrates alone disobeyed. But, though he was exceptionally obnoxious to the Thirty,—as appears, not only in this incident, but also in their threat of punishment under a special ordinance forbidding "the teaching of the art of argument,"—it was reserved for the reconstituted democracy to bring him to trial and to put him to death. In 399, four years after the restoration and the amnesty, he was indicted as an offender against public morality. His accusers were Meletus the poet, Anytus the tanner, and Lycon the orator, all of them members of the democratic or patriot party who had returned from Phyle with Thrasybulus. The accusation ran thus: "Socrates is guilty, firstly, of denying the gods recognized by the state and introducing new divinities, and secondly, of corrupting the young." In his unpremeditated defence, so far from seeking to conciliate his judges, Socrates defied them. He was found guilty by 280 votes, it is supposed, against 220. Meletus having called for capital punishment, it now rested with the accused to make a counter-proposition; and there can be little doubt that, had Socrates without further remark suggested some smaller but yet substantial penalty, the proposal would have been accepted. But to the amazement of the judges and the distress of his friends, Socrates proudly declared that for the services which he had rendered to the city he deserved, not punishment, but the reward of a public benefactor, maintenance in the Prytaneum at the cost of the state; and, although at the close of his speech he professed himself willing to pay a fine of one mina, and upon the urgent entreaties of his friends raised the amount of his offer to thirty minas, he made no attempt to disguise his indifference to the result. His attitude exasperated the judges, and the penalty of death was decreed by an increased majority. Then in a short address Socrates declared his contentment with his own conduct and with the sentence. Whether death was a dreamless sleep or a new life in Hades, where he would have opportunities of testing the wisdom of the heroes and the sages of antiquity, in either case he esteemed it a gain to die. In the same spirit he refused to take advantage of a scheme arranged by his friend Crito for an escape from prison. Under ordinary circumstances the condemned criminal drank the cup of hemlock on the day after the trial; but in the case of Socrates the rule that during the absence of the sacred ship sent annually to Delos no one should be put to death caused an exceptional delay. For thirty days he remained in imprisonment, receiving his intimates and conversing with them in his accustomed manner. How in his last conversation he argued that the wise man will regard approaching death with a cheerful confidence Plato relates in the *Phædo*; and, while the central argument—which rests the doctrine of the soul's immortality upon the theory of ideas—must be accounted Platonic, in all other respects the narrative, though not that of an eye-witness, has the air of accuracy and truth.

But what were the personal characteristics which won for this man, poor in worldly goods, the affectionate regard of the best of his contemporaries? Why was it that the Athenians, forgetting his loyal performance of civic duties, his virtuous life, and his disinterested anxiety for their welfare, brought him to trial, condemned him, put him to death? What were the principles upon which his teaching rested, and what was the message which, instant in season, out of season, he carried to his countrymen? How were his principles interpreted by his followers, and what influence did his teaching exert upon subsequent speculation? These are the questions which demand consideration in the present article.

Authorities.

Happily, though Socrates left no writings behind him, and indeed, as will hereafter appear, was by his principles precluded from dogmatic exposition, we have in the 'Απομνημονεύματα or *Memoirs* and other works of Xenophon records of

Socrates's conversation, and in the dialogues of Plato refined applications of his method. Xenophon, having no philosophical views of his own to develop, and no imagination to lead him astray,—being, in fact, to Socrates what Boswell was to Johnson,—is an excellent witness. The 'Απομνημονεύματα or *Memorabilia* are indeed confessedly apologetic, and it is easy to see that nothing is introduced which might embitter those who, hating Socrates, were ready to persecute the Socratics; but the plain, straightforward narrative of Socrates's talk, on many occasions, with many dissimilar interlocutors, carries with it in its simplicity and congruity the evidence of substantial justice and truth. Plato, though he understood his master better, is a less trustworthy authority, as he makes Socrates the mouthpiece of his own more advanced and even antagonistic doctrine. Yet to all appearance the *Apology* is a careful and exact account of Socrates's habits and principles of action; the earlier dialogues, those which are commonly called "Socratic," represent, with such changes only as are necessitated by their form, Socrates's method; and, if in the later and more important dialogues the doctrine is the doctrine of Plato, echoes of the master's teaching are still discoverable, approving themselves as such by their accord with the Xenophontean testimony. In the face of these two principal witnesses other evidence is of small importance.

Personal appearance.

Moral qualities.

Personal Characteristics.—What, then, were the personal characteristics of the man? Outwardly his presence was mean and his countenance grotesque. Short of stature, thick-necked, and somewhat corpulent, with prominent eyes, with nose upturned and nostrils outspread, with large mouth and coarse lips, he seemed the embodiment of sensuality and even stupidity. Inwardly he was, as his friends knew, "so pious that he did nothing without taking counsel of the gods, so just that he never did an injury to any man, whilst he was the benefactor of his associates, so temperate that he never preferred pleasure to right, so wise that in judging of good and evil he was never at fault,—in a word, the best and the happiest of men." "His self-control was absolute; his powers of endurance were unfailing; he had so schooled himself to moderation that his scanty means satisfied all his wants." "To want nothing," he said himself, "is divine; to want as little as possible is the nearest possible approach to the divine life;" and accordingly he practiced temperance and self-denial to a degree which some thought ostentatious and affected. Yet the hearty enjoyment of social pleasures was another of his marked characteristics; for to abstain from innocent gratification from fear of falling into excess would have seemed to him to imply either a pedantic formalism or a lack of real self-control. In short, his strength of will, if by its very perfection it led to his theoretical identification of virtue and knowledge, secured him in practice against the ascetic extravagances of his associate Antisthenes.

Intellectual gifts.

The intellectual gifts of Socrates were hardly less remarkable than his moral virtues. Naturally observant, acute, and thoughtful, he developed these qualities by constant and systematic use. The exercise of the mental powers was, he conceived, no mere occupation of leisure hours, but rather a sacred and ever-present duty; because, moral error being intellectual error translated into act, he who would live virtuously must first rid himself of ignorance and folly. He had, it may be conjectured, but little turn for philosophical speculation; yet by the careful study of the ethical problems which met him in himself and in others he acquired a remarkable tact in dealing with questions of practical morality; and in the course of the lifelong war which he waged against vagueness of thought and laxity of speech he made himself a singularly apt and ready reasoner.

Philanthropy.

While he regarded the improvement, not only of himself but also of others, as a task divinely appointed to him, there was in his demeanor nothing exclusive or pharisaical. On the contrary, deeply conscious of his own limitations and infirmities, he felt and cherished a profound sympathy with erring humanity, and loved with a love passing the love of women fellow-men who had not learnt, as he had done, to overcome human frailties and weaknesses. Nevertheless great wrongs roused in him a righteous indignation which sometimes found expression in fierce and angry rebuke. Indeed it would seem that Plato, in his idealized portrait gives his hero credit, not only for a deeper philosophical insight but also for a greater urbanity than facts warranted. Hence, whilst those who knew him best met his affection with a regard equal to his own, there were, as will be seen hereafter, some who never forgave his stern reproofs, and many who regarded him as an impertinent busybody.

Patriotism.

He was a true patriot. Deeply sensible of his debt to the city in which he had been born and bred, he thought that in giving his life to the spread of sounder views in regard to ethical and political subjects he made no more than an imperfect return; and, when in the exercise of constitutional authority that city brought him to trial and threatened him with death, it was not so much his local attachment, strong though that sentiment was, as rather his sense of duty which forbade him to retire into exile before the trial began, to acquiesce in a sentence of banishment when the verdict had been given against him, and to accept the opportunity of escape which was offered him during his imprisonment. Yet his patriotism had none of the narrowness which was characteristic of the patriotism of his Greek contemporaries. His generous benevolence and unaffected philanthropy taught him to overstep the limits of the Athenian demus and the Hellenic race, and to regard himself as a "citizen of the world."

Humor.

He was blest with an all-pervading humor, a subtle but kindly appreciation of the incongruities of human nature and conduct. In a less robust character this quality might have degenerated into sentimentality or cynicism; in Socrates, who had not a trace of either, it showed itself principally in what his contemporaries knew as his "accustomed irony." Profoundly sensible of the inconsistencies of his own thoughts and words and actions, and shrewdly suspecting that the like inconsistencies were to be found in other men, he was careful always to place himself upon the standpoint of ignorance and to invite others to join him there, in order that, proving all things, he and they might hold fast that which is good. "Intellectually the acutest man of his age," says W. H. Thompson in a brilliant and instructive appendix to his edition of Plato's *Phædrus*, "he represents himself in all companies as the dullest person present. Morally the purest, he affects to be the slave of passion, and borrows the language of gallantry to describe a benevolence too exalted for the comprehension of his contemporaries. He is by turns an ἐραστής, a προαγωγός, a μαστροπός, a μαιευτικός, disguising the sanctity of his true vocation by names suggestive of vile or ridiculous images. The same spirit of whimsical paradox leads him, in Xenophon's *Banquet*, to argue that his own satyr-like visage was superior in beauty to that of the handsomest man present. That this irony was to some extent calculated is more than probable; it disarmed ridicule by anticipating it; it allayed jealousy and propitiated envy; and it possibly procured him admission into gay circles from which a more solemn teacher would have been excluded. But it had for its basis a real greatness of soul, a hearty and unaffected disregard of public opinion, a perfect disinterestedness, an entire abnegation of self. He made himself a fool that others by his folly might be made wise; he humbled himself to the level of those among whom his work lay that he might raise some few among them to his own level; he was 'all things to all men, if by any means he might win some.'" It would seem that this humorous depreciation of his own great qualities, this pretence of being no better than his neighbors, led to grave misapprehension amongst his contemporaries. That it was the foundation of the slanders of the Peripatetic Aristoxenus can hardly be doubted.

Piety.

Socrates was further a man of sincere and fervent piety. "No one," says Xenophon, "ever knew of his doing or saying anything profane or unholy." There was indeed in the popular mythology much which he could not accept. It was incredible, he argued, that the gods should have committed acts which would be disgraceful in the worst of men. Such stories, then, must be regarded as the inventions of lying poets. But, when he had thus purified the contemporary polytheism, he was able to reconcile it with his own steadfast belief in a Supreme Being, the intelligent and beneficent Creator of the universe, and to find in the national ritual the means of satisfying his religious aspirations. For proof of the existence of "the divine," he appealed to the providential arrangement of nature, to the universality of the belief, and to the revelations and warnings which are given to men through signs and oracles. Thinking that the soul of man partook of the divine, he maintained the doctrine of its immortality as an article of faith, but not of knowledge. While he held that, the gods alone knowing what is for man's benefit, man should pray, not for particular goods, but only for that which is good, he was regular in prayer and punctual in sacrifice. He looked to oracles and signs for guidance in those matters, and in those matters only, which could not be resolved by experience and judgment, and he further supposed himself to receive special warnings of a mantic character through what he called his "divine sign" (*δαιμόνιον, δαιμόνιον σημεῖον*).

Divine sign.

Socrates's frequent references to his "divine sign" were, says Xenophon, the origin of the charge of "introducing new divinities" brought against him by his accusers, and in early Christian times, amongst Neoplatonic philosophers and fathers of the church, gave rise to the notion that he supposed himself to be attended by a "genius" or "dæmon." Similarly in our own day spiritualists have attributed to him the belief—which they justify—in "an intelligent spiritual being who accompanied him through life,—in other words, a guardian spirit" (A. R. Wallace). But the very precise testimony of Xenophon and Plato shows plainly that Socrates did not regard his "customary sign" either as a divinity or as a genius. According to Xenophon, the sign was a warning, either to do or not to do which it would be folly to neglect, not superseding ordinary prudence, but dealing with those uncertainties in respect of which other men found guidance in oracles and tokens; Socrates believed in it profoundly, and never disobeyed it. According to Plato, the sign was a "voice" which warned Socrates to refrain from some act which he contemplated; he heard it frequently and on the most trifling occasions; the phenomenon dated from his early years, and was, so far as he knew, peculiar to himself. These statements have been variously interpreted. Thus it has been maintained that, in laying claim to supernatural revelations, Socrates (1) committed a pious fraud, (2) indulged his "accustomed irony," (3) recognized the voice of conscience, (4) indicated a general belief in a divine mission, (5) described "the inward voice of his individual tact, which in consequence partly of his experience and penetration, partly of his knowledge of himself and exact appreciation of what was in harmony with his individuality, had attained to an unusual accuracy," (6) was mad ("était fou"), being subject not only to hallucinations of sense but also to aberrations of reason. Xenophon's testimony that Socrates was plainly sincere in his belief excludes the first and the second of these theories; the character of the warnings given, which are always concerned, not with the moral worth of actions, but with their uncertain results, warrants the rejection of the third and the fourth; the fifth, while it sufficiently accounts for the matter of the warning, leaves unexplained its manner, the vocal utterance; the sixth, while it plausibly explains the manner of the warning, goes beyond the facts when it attributes to it irrationality of matter. It remains for us, then, modifying the fifth hypothesis, that of Diderot, Zeller, and others, and the sixth, that of Lélut and Littré, and combining the two, to suppose that Socrates was subject, not indeed to delusions of mind, but to hallucinations of the sense of hearing, so that the rational suggestions of his own brain, exceptionally valuable in consequence of the accuracy and delicacy of his highly cultivated tact, seemed to him to be projected without him, and to be returned to him through the outward ear. It appears that, though in some of the best known instances—for example, those of Cowper and Sidney Walker—hallucinations of the sense of hearing, otherwise closely resembling Socrates's "divine sign," have been accompanied by partial derangement of reason, cases are not wanting in which "the thoughts transformed into external sensorial impressions" are perfectly rational.

Mode of life.

The eccentricity of Socrates's life was not less remarkable than the oddity of his appearance and the irony of his conversation. His whole time was spent in public,—in the market-place, the streets, the gymnasia. Thinking with Dr. Johnson that "a great city is the school for studying life," he had no liking for the country, and seldom passed the gates. "Fields and trees," Plato makes him say, 'won't teach me anything; the life of the streets will." He talked to all comers,—to the craftsman and the artist as willingly as to the poet or the politician,—questioning them about their affairs, about the processes of their several occupations, about their notions of morality, in a word, about familiar matters in which they might be expected to take an interest. The ostensible purpose of these interrogatories was to test, and thus either refute or explain, the famous oracle which had pronounced him the wisest of men. Conscious of his own ignorance, he had at first imagined that the God was mistaken. When, however, experience showed that those who esteemed themselves wise were unable to give an account of their knowledge, he had to admit that, as the oracle had said, he was wiser than others, in so far as, whilst they, being ignorant, supposed themselves to know, he, being ignorant, was aware of his ignorance. Such, according to the *Apology*, was Socrates's account of his procedure and its results. But it is easy to see that the statement is colored by the accustomed irony. When in the same speech Socrates tells his judges that he would never from fear of death or any other motive disobey the command of the god, and that, if they put him to death, the loss would be, not his, but theirs, since they would not readily find any one to take his place, it becomes plain that he conceived himself to hold a commission to educate, and was consciously seeking the intellectual and moral improvement of his countrymen. His end could not be achieved without the sacrifice of self. His meat and drink were of the poorest; summer and winter his coat was the same; he was shoeless and shirtless. "A slave whose master made him live as you do," says a sophist in the *Memorabilia*, "would run away." But by the surrender of the luxuries and the comforts of life Socrates secured for himself the independence which was necessary that he might go about his appointed business, and therewith he was content.

Contemporary judgments.

His message was to all, but it was variously received. Those who heard him perforce and occasionally were apt to regard his teaching either with indifference or with irritation,—with indifference if, as might be, they failed to see in the elenchus anything more than elaborate trifling; with irritation if, as was probable, they perceived that, in spite of his assumed ignorance, Socrates was well aware of the result to which their enforced answers tended. Amongst those who deliberately sought and sedulously cultivated his acquaintance there were some who attached themselves to him as they might have attached themselves to any ordinary sophist, conceiving that by temporary contact with so acute a reasoner, they would best prepare themselves for the logomachies of the law courts, the assembly, and the senate. Again, there were others who saw in Socrates at once master, counsellor, and friend, and hoped by associating with him "to become good men and true, capable of doing their duty by house and household, by relations and friends, by city and fellow-citizens" (Xenophon). Finally, there was a little knot of intimates who, having something of Socrates's enthusiasm, entered more deeply than the rest into his principles, and, when he died, transmitted them to the next generation. Yet even those who belonged to this inner circle were united, not by any common doctrine, but by a common admiration for their master's intellect and character.

Plato's panegyric.

For the paradoxes of Socrates's personality and the eccentricity of his behavior, if they offended the many, fascinated the few. "It is not easy for a man in my condition," says the intoxicated Alcibiades in Plato's *Symposium*, "to describe the singularity of Socrates's character. But I will try to tell his praises in similitudes. He is like the piping Silenes in the statuaries' shops, which, when you open them, are found to contain images of gods. Or, again, he is like the satyr Marsyas, not only in outward appearance—that, Socrates, you will yourself, allow—but in other ways also. Like him, you are given to frolic,—I can produce evidence to that; and, above all, like him, you are a wonderful musician. Only there is this difference,—what he does with the help of his instrument you do with mere words; for whatsoever man, woman, or child hears you, or even a a feeble report of what you have said, is struck with awe and possessed with admiration. As for myself, were I not afraid that you would think me more drunk than I am, I would tell you on oath how his words have moved me,—ay, and how they move me still. When I listen to him my heart beats with a more than Corybantic excitement; he has only to speak and my tears flow. Orators, such as Pericles, never moved me in this way,—never roused my soul to the thought of my servile condition; but this Marsyas makes me think that life is not worth living so long as I am what I am. Even now, if I were to listen, I could not resist. So there is nothing for me but to stop my ears against this siren's song and fly for my life, that I may not grow old sitting at his feet. No one would think that I had any shame in me; but I am ashamed in the presence of Socrates."

Popular prejudices.

The Accusation and its Causes.—The life led by Socrates was not likely to win for him either the affection or the esteem of the vulgar. Those who did not know him personally, seeing him with the eyes of the comic poets, conceived him as a "visionary" (μετεωρολόγος) and a "bore" (ἀδολέσχης). Those who had faced him in argument, even if they had not smarted under his rebukes, had at any rate winced under his interrogatory, and regarded him in consequence with feelings of dislike and fear. But the eccentricity of his genius and the ill-will borne towards him by individuals are not of themselves sufficient to account for the tragedy of 399. It thus becomes necessary to study the circumstances of the trial, and to investigate the motives which led the accusers to seek his death and the people of Athens to acquiesce in it.

The accusation.

Socrates was accused (1) of denying the gods recognized by the state and introducing instead of them strange divinities (δαιμόνια), and (2) of corrupting the young. The first of these charges rested upon the notorious fact that he supposed himself to be guided by a divine visitant or sign (δαιμόνιον). The second, Xenophon tells us, was supported by a series of particular allegations,—(*a*) that he taught his associates to despise the institutions of the state, and especially election by lot; (*b*) that he had numbered amongst his associates Critias and Alcibiades, the most dangerous of the representatives of the oligarchical and democratical parties respectively; (*c*) that he taught the young to disobey parents and guardians and to prefer his own authority to theirs; (*d*) that he was in the habit of quoting mischievous passages of Homer and Hesiod to the prejudice of morality and democracy.

Strength of the defence.

It is plain that the defence was not calculated to conciliate a hostile jury. Nevertheless, it is at first sight difficult to understand how an adverse verdict became possible. If Socrates rejected portions of the conventional mythology, he accepted the established faith and performed its offices with exemplary regularity. If he talked of a δαιμόνιον, the δαιμόνιον was no new divinity, but a mantic sign divinely accorded to him, presumably by the gods of the state. If he questioned the propriety of certain of the institutions of Athens, he was prepared to yield an unhesitating obedience to all. He had never countenanced the misdeeds of Critias and Alcibiades, and indeed, by a sharp censure, had earned the undying hatred of one of them. Duty to parents he inculcated as he inculcated other virtues; and, if he made the son wiser than the father, surely that was not a fault. The citation of a few lines from the poets ought not to weigh against the clear evidence of his large-hearted patriotism; and it might be suspected that the accuser had strangely misrepresented his application of the familiar words.

Its weakness.

To the modern reader Xenophon's reply, of which the foregoing paragraph is in effect a summary, will probably seem sufficient, and more than sufficient. But it must not be forgotten that Athenians of the old school approached the subject from an entirely different point of view. Socrates was in all things an innovator,—in religion, inasmuch as he sought to eliminate from the theology of his contemporaries "those lies which poets tell"; in politics, inasmuch as he distrusted several institutions dear to Athenian democracy; in education, inasmuch as he waged war against authority, and in a certain sense made each man the measure of his own actions. It is because Socrates was an innovator that we, who see in him the founder of philosophical inquiry, regard him as a great man; it was because Socrates was an innovator that old-fashioned Athenians, who saw in the new-fangled culture the origin of all their recent distresses and disasters, regarded him as a great criminal. It is, then, after all in nowise strange that a majority was found first to pronounce him guilty, and afterwards, when he refused to make any submission and professed himself indifferent to any mitigation of the penalty, to pass upon him the sentence of death. That the verdict and the sentence were not in any way illegal is generally acknowledged.

Occasion of the attack.

But, though the popular distrust of eccentricity, the irritation of individuals and groups of individuals, the attitude of Socrates himself, and the prevalent dislike of the intellectual movement which he represented go far to account for the result of the trial, they do not explain the occasion of the attack. Socrates's oddity and brusquerie were no new things; yet in the past, though they had made him unpopular, they had not brought him into the courts. His sturdy resistance to the demus in 406 and to the Thirty in 404 had passed, if not unnoticed, at all events unpunished. His political heresies and general unorthodoxy had not caused him to be excluded from the amnesty of 403. Why was it, then, that in 399, when Socrates's idiosyncrasies were more than ever familiar, and when the constitution had been restored, the toleration hitherto extended to him was withdrawn? What were the special circumstances which induced three members of the patriot party, two of them leading politicians, to unite their efforts against one who apparently was so little formidable?

For an answer to this question it is necessary to look to the history of Athenian politics. Besides the oligarchical party, properly so called, which in 411 was

Political reasons for it.

represented by the Four Hundred and in 404 by the Thirty, and the democratical party, which returned to power in 410 and in 403, there was at Athens during the last years of the Peloponnesian War a party of "moderate oligarchs," antagonistic to both. It was to secure the co-operation of the moderate party that the Four Hundred in 411 promised to constitute the Five Thousand, and that the Thirty in 404 actually constituted the Three Thousand. It was in the hope of realizing the aspirations of the moderate party that Theramenes, its most prominent representative, allied himself, first with the Four Hundred, afterwards with the Thirty. In 411 the policy of Theramenes was temporarily successful, the Five Thousand superseding the Four Hundred. In 404 the Thirty outwitted him; for, though they acted upon his advice so far as to constitute the Three Thousand, they were careful to keep all real power in their own hands. But on both occasions the "polity"—for such, in the Aristotelian sense of the term, the constitution of 411–410 was, and the constitution of 404–403 professed to be—was insecurely based, so that it was not long before the "unmixed democracy" was restored. The programme of the "moderates"—which included (1) the limitation of the franchise, by the exclusion of those who were unable to provide themselves with the panoply of a hoplite and thus to render to the city substantial service, (2) the abolition of payment for the performance of political functions, and, as it would seem, (3) the disuse of the lot in the election of magistrates—found especial favor with the intellectual class. Thus Alcibiades and Antiphon were amongst its promoters, and Thucydides commends the constitution established after the fall of the Four Hundred as the best which in his time Athens had enjoyed. Now it is expressly stated that Socrates disliked election by lot; it is certain that, regarding paid educational service as a species of prostitution, he would account paid political service not a whit less odious; and the stress laid by the accuser upon the Homeric quotation (*Iliad*, ii. 188–202)—which ends with the lines *δαιμόνι', ἀτρέμας ἧσο, καὶ ἄλλων μῦθον ἄκουε οἳ σέο φέρτεροί εἰσι· σὺ δ' ἀπτόλεμος καὶ ἄναλκις, οὔτε ποτ' ἐν πολέμῳ ἐναρίθμιος οὔτ' ἐνὶ, βουλῇ*—becomes intelligible if we may suppose that Socrates, like Theramenes, wished to restrict the franchise to those who were rich enough to serve as hoplites at their own expense. Thus, as might have been anticipated, Socrates was a "moderate," and the treatment which he received from both the extreme parties suggests—even if with Grote we reject the story told by Diodorus (xiv. 5), how, when Theramenes was dragged from the altar, Socrates attempted a rescue—that his sympathy with the moderate party was pronounced and notorious. Even in the moment of democratic triumph the "moderates" made themselves heard, Phormisius proposing that those alone should exercise the franchise who possessed land in Attica; and it is reasonable to suppose that their position was stronger in 399 than in 403. These considerations seem to indicate an easy explanation of the indictment of Socrates by the democratic politicians. It was a blow struck at the "moderates," Socrates being singled out for attack because, though not a professional politician, he was the very type of the malcontent party, and had done much, probably more than any man living, to make and to foster views which, if not in the strict sense of the term oligarchical, were confessedly hostile to the "unmixed democracy." His eccentricity and heterodoxy, as well as the personal animosities which he had provoked, doubtless contributed, as his accusers had foreseen, to bring about the conviction; but, in the judgment of the present writer, it was the fear of what may be called "philosophical radicalism" which prompted the action of Meletus, Anytus, and Lycon. The result did not disappoint their expectations. The friends of Socrates abandoned the struggle and retired into exile; and, when they returned to Athens, the most prominent of them, Plato, was careful to confine himself to theory, and to announce in emphatic terms his withdrawal from the practical politics of his native city.

Method and Doctrine.—Socrates was not a "philosopher," nor yet a "teacher," but rather an "educator," having for his function "to rouse, persuade, and rebuke" (Plato, *Apology*, 30 E). Hence, in examining his life's work, it is proper to ask, not What was his philosophy? but What was his theory, and what was his practice, of education? It is true that he was brought to his theory of education by the study of previous philosophies, and that his practice led to the Platonic revival; but to attribute to him philosophy, except in that loose sense in which philosophy is ascribed to one who, denying the existence of such a thing, can give an account of his disbelief, is misleading and even erroneous.

Theory of education.

Socrates's theory of education had for its basis a profound and consistent skepticism; that is to say, he not only rejected the conflicting theories of the physicists,—of whom "some conceived existence as a unity, others as a plurality; some affirmed perpetual motion, others perpetual rest; some declared becoming and perishing to be universal, others altogether denied such things,"—but also condemned, as a futile attempt to transcend the limitations of human intelligence, their *φιλοσοφία*, their "pursuit of knowledge for its own sake." Unconsciously, or more probably consciously, Socrates rested his skepticism upon the Protagorean doctrine that man is the measure of his own sensations and feelings; whence he inferred, not only that knowledge such as the philosophers had sought, certain knowledge of nature and its laws, was unattainable, but also that neither he nor any other person had authority to overbear the opinions of another, or power to convey instruction to one who had it not. Accordingly, whereas Protagoras and others, abandoning physical speculation and coming forward as teachers of culture, claimed for themselves in this new field power to instruct and authority to dogmatize, Socrates, unable to reconcile himself to this inconsistency, proceeded with the investigation of principles until he found a resting-place, a *ποῦ στῶ*, in the distinction between good and evil. While all opinions were equally true, of those opinions which were capable of being translated into act some, he conceived, were as working hypotheses more serviceable than others. It was here that the function of such a one as himself began. Though he had neither the right nor the power to force his opinions upon another, he might by a systematic interrogatory lead another to substitute a better opinion for a worse, just as a physician by appropriate remedies may enable his patient to substitute a healthy sense of taste for a morbid one. To administer such an interrogatory and thus to be the physician of souls was, Socrates thought, his divinely appointed duty; and, when he described himself as a "talker" or "converser," he not only negatively distinguished himself from those who, whether philosophers or sophists, called themselves "teachers" (*διδάσκαλοι*), but also positively indicated the method of question and answer (*διαλεκτική*) which he consistently preferred and habitually practiced.

Dialectical method.

That it was in this way that Socrates was brought to regard "dialectic," "question and answer," as the only admissible method of education is, in the opinion of the present writer, no matter of mere conjecture. In the review of theories of knowledge which has come down to us in Plato's *Theætetus* mention is made (172 B) of certain "incomplete Protagoreans," who held that, while all impressions are equally true, one impression is better than another, and that the "wise man" is one who by his arguments causes good impressions to take the place of bad ones, thus reforming the soul of the individual or the laws of a state by a process similar to that of the physician or the farmer (166 D *sq.*); and these "incomplete Protagoreans" are identified with Socrates and the Socratics by their insistence (167 D) upon the characteristically Socratic distinction between disputation and dialectic, as well as by other familiar traits of Socratic converse. In fact, this passage becomes intelligible and significant if it is supposed to refer to the historical Socrates; and by teaching us to regard him as an "incomplete Protagorean" it supplies the link which connects his philosophical skepticism with his dialectical theory of education. It is no doubt possible that Socrates was unaware of the closeness of his relationship to Protagoras; but the fact, once stated, hardly admits of question.

Its two processes.

In the application of the "dialectical" or "maieutic" method two processes are distinguishable,—the destructive process, by which the worse opinion was eradicated, and the constructive process, by which the better opinion was induced. In general it was not mere "ignorance" with which Socrates had to contend, but "ignorance mistaking itself for knowledge" or "false conceit of wisdom,"—a more stubborn and a more formidable foe, who, safe so long as he remained in his entrenchments, must be drawn from them, circumvented, and surprised. Accordingly, taking his departure from some apparently remote principle or proposition to which the respondent yielded a ready assent, Socrates would draw from it an unexpected but undeniable consequence which was plainly inconsistent with the opinion impugned. In this way he brought his interlocutor to pass judgment upon himself, and reduced him to a state of "doubt" or "perplexity" (ἀπορία). "Before I ever met you," says Meno in the dialogue which Plato called by his name (79 E), "I was told that you spent your time in doubting and leading others to doubt; and it is a fact that your witcheries and spells have brought me to that condition; you are like the torpedo: as it benumbs any one who approaches and touches it, so do you. For myself, my soul and my tongue are benumbed, so that I have no answer to give you." Even if, as often happened, the respondent, baffled and disgusted by the ἔλεγχος or destructive process, at this point withdrew from the inquiry, he had, in Socrates's judgment, gained something; for, whereas formerly, being ignorant, he had supposed himself to have knowledge, now, being ignorant, he was in some sort conscious of his ignorance, and accordingly would be for the future more circumspect in action. If, however, having been thus convinced of ignorance, the respondent did not shrink from a new effort, Socrates was ready to aid him by further questions of a suggestive sort. Consistent thinking with a view to consistent action being the end of the inquiry, Socrates would direct the respondent's attention to instances analogous to that in hand and so lead him to frame for himself a generalization from which the passions and the prejudices of the moment were, as far as might be, excluded. In this constructive process, though the element of surprise was no longer necessary, the interrogative form was studiously preserved, because it secured at each step the conscious and responsible assent of the learner.

Maieutic in Plato and Xenophon.

Of the two processes of the dialectical method, the ἔλεγχος or destructive process attracted the more attention, both in consequence of its novelty and because many of those who willingly or unwillingly submitted to it stopped short at the stage of "perplexity." But to Socrates and his intimates the constructive process was the proper and necessary sequel. It is true that in the dialogues of Plato the destructive process is not always, or even often, followed by construction, and that in the *Memorabilia* of Xenophon construction is not always, or even often, preceded by the destructive process. There is, however, in this nothing surprising. On the one hand, Xenophon, having for his principal purpose the defence of his master against vulgar calumny, seeks to show by effective examples the excellence of his positive teaching, and accordingly is not careful to distinguish, still less to emphasize, the negative procedure. On the other hand, Plato's aim being not so much to preserve Socrates's positive teaching as rather by written words to stimulate the reader to self-scrutiny, just as the spoken words of the master had stimulated the hearer, he is compelled by the very nature of his task to keep the constructive element in the background, and, where Socrates would have drawn an unmistakable conclusion, to confine himself to enigmatical hints. For example, when we compare Xenophon's *Memorabilia*, iv. 6, 2–4, with Plato's *Euthyphro*, we note that, while in the former the interlocutor is led by a few suggestive questions to define "piety" as "the knowledge of those laws which are concerned with the gods," in the latter, though on a further scrutiny it appears that "piety" is "that part of justice which is concerned with the service of the gods," the conversation is ostensibly inconclusive. In short, Xenophon, a mere reporter of Socrates's conversations, gives the results, but troubles himself little about the steps which led to them; Plato, who in early manhood was an educator of the Socratic type, withholds the results that he may secure the advantages of the elenctic stimulus.

Induction and definition.

What, then, were the positive conclusions to which Socrates carried his hearers? and how were those positive conclusions obtained? Turning to Xenophon for an answer to these questions, we note (1) that the recorded conversations are concerned with practical action, political, moral, or artistic; (2) that in general there is a process from the known to the unknown through a generalization, expressed or implied; (3) that the generalizations are sometimes rules of conduct, justified by examination of known instances, sometimes definitions similarly established. Thus, in *Memorabilia*, iv. 1, 3, Socrates argues from the known instances of horses and dogs that the best natures stand most in need of training, and then applies the generalization to the instance under discussion, that of men; and in iv. 6, 13–14, he leads his interlocutor to a definition of "the good citizen," and then uses it to decide between two citizens for whom respectively superiority is claimed. Now in the former of these cases the process—which Aristotle would describe as "example" (παράδειγμα), and a modern might regard as "induction" of an uncritical sort—sufficiently explains itself. The conclusion is a provisional assurance that in the particular matter in hand a certain course of action is, or is not, to be adopted. But it is necessary to say a word of explanation about the latter case, in which, the generalization being a definition, that is to say, a declaration that to a given term the interlocutor attaches in general a specified meaning, the conclusion is a provisional assurance that the interlocutor may, or may not, without falling into inconsistency, apply the term in question to a certain person or act. Moral error, Socrates conceived, is largely due to the misapplication of general terms, which, once affixed to a person or to an act, possibly in a moment of passion or prejudice, too often stand in the way of sober and careful reflection. It was in order to exclude error of this sort that Socrates insisted upon τὸ ὁρίζεσθαι καθόλου with ἐπακτικοὶ λόγοι for its basis. By requiring a definition and the reference to it of the act or person in question, he sought to secure in the individual at any rate consistency of thought, and, in so far, consistency of action. Accordingly he spent his life in seeking and helping others to seek "the what" (τὸ τί), or the definition, of the various words by which the moral quality of actions is described, valuing the results thus obtained, not as contributions to knowledge, but as means to right action in the multifarious relations of life.

Virtue is knowledge.

While, however, Socrates sought neither knowledge, which in the strict sense of the word he held to be unattainable, nor yet, except as a means to right action, true opinion, the results of observation accumulated until they formed, not perhaps a system of ethics, but at any rate a body of ethical doctrine. Himself blessed with a will so powerful that it moved almost without friction, he fell into the error of ignoring its operations, and was thus led to regard knowledge as the sole condition of well-doing. Where there is knowledge,—that is to say, practical wisdom (φρόνησις), the only knowledge which he recognized,—right action, he conceived, follows of itself; for no one knowingly prefers what is evil; and, if there are cases in which men seem to act against knowledge, the inference to be drawn is, not that knowledge and wrongdoing are compatible, but that in the cases in question the supposed knowledge was after all ignorance. Virtue, then, is knowledge, knowledge at once of end and of means irresistibly realizing itself in act. Whence it follows that the several virtues which are commonly distinguished are essentially one. "Piety," "justice," "courage," and "temperance" are the names which "wisdom" bears in different spheres of action: to be pious is to know what is due to the gods; to be just is to know what is due to men; to be courageous is to know what is to be feared and what is not; to be temperate is to know how to use what is good and avoid what is evil. Further, inasmuch as virtue is knowledge, it can be acquired by education and training, though it is certain that one soul has by nature a greater aptitude than another for such acquisition.

Theory of the Good.

But, if virtue is knowledge, what has this knowledge for its object? To this question Socrates replies, Its object is the Good. What, then, is the Good? It is the useful, the advantageous. Utility, the immediate utility of the individual, thus becomes the measure of conduct and the foundation of all moral rule and legal enactment. Accordingly, each precept of which Socrates delivers himself is recommended on the ground that obedience to it will promote the pleasure, the comfort, the advancement, the wellbeing of the individual; and Prodicus's apologue of the Choice of Heracles, with its commonplace offers of worldly reward, is accepted as an adequate statement of the motives of virtuous action. Of the graver difficulties of ethical theory Socrates has no conception, having, as it would seem, so perfectly absorbed the lessons of what Plato calls "political virtue" that morality has become with him a second nature, and the scrutiny of its credentials from an external standpoint has ceased to be possible. His theory is indeed so little systematic that, whereas, as has been seen, virtue or wisdom has the Good for its object, he sometimes identifies the Good with virtue or wisdom, thus falling into the error which Plato (*Republic*, vi. 505 C), perhaps with distinct reference to Socrates, ascribes to certain "cultivated thinkers." In short, the ethical theory of Socrates, like the rest of his teaching, is by confession unscientific; it is the statement of the convictions of a remarkable nature, which statement emerges in the course of an appeal to the individual to study consistency in the interpretation of traditional rules of conduct. For a critical examination of the ethical teaching which is here described in outline, see ETHICS.

The Socratics.

Socratic schools.

It has been seen that, so far from having any system, physical or metaphysical, to enunciate, Socrates rejected "the pursuit of knowledge for its own sake" as a delusion and a snare,—a delusion, inasmuch as knowledge, properly so called, is unattainable, and a snare, in so far as the pursuit of it draws us away from the study of conduct. He has therefore no claim to be regarded as the founder of a philosophical school. But he had made some tentative contributions to a theory of morality; he had shown both in his life and in his death that his principles stood the test of practical application; he had invented a method having for its end the rectification of opinion; and, above all, he had asserted "the autonomy of the individual intellect." Accordingly, not one school but several schools sprang up amongst his associates, those of them who had a turn for speculation taking severally from his teaching so much as their pre-existing tendencies and convictions allowed them to assimilate. Thus Aristippus of Cyrene interpreted hedonistically the theoretical morality; Antisthenes the Cynic copied and caricatured the austere example; Euclides of Megara practiced and perverted the elenctic method; Plato the Academic, accepting the whole of the Socratic teaching, first developed it harmoniously in the skeptical spirit of its author, and, afterwards conceiving that he had found in Socrates's agnosticism the germ of a philosophy, proceeded to construct a system which should embrace at once ontology, physics, and ethics. From the four schools thus established sprang subsequently four other schools,—the Epicureans being the natural successors of the Cyrenaics, the Stoics of the Cynics, the Skeptics of the Megarians, and the Peripatetics of the Academy. In this way the teaching of Socrates made itself felt throughout the whole of the post-Socratic philosophy. Of the influence which he exercised upon Aristippus, Antisthenes, and Euclides, the "incomplete Socratics," as they are commonly called, as well as upon the "complete Socratic" Plato, something must now be said.

Incomplete Socratics.

The "incomplete Socratics" were, like Socrates, skeptics; but, whereas Aristippus, who seems to have been in contact with Protagoreanism before he made acquaintance with Socrates, came to skepticism, as Protagoras had done, from the standpoint of the pluralists, Antisthenes, like his former master Gorgias, and Euclides, in whom the ancients rightly saw a successor of Zeno, came to skepticism from the standpoint of Eleatic monism. In other words, Aristippus was skeptical because, taking into account the subjective element in sensation, he found himself compelled to regard what are called "things" as successions of feelings, which feelings are themselves absolutely distinct from one another; while Antisthenes and Euclides were skeptical because, like Zeno, they did not understand how the same thing could at the same moment bear various and inconsistent epithets, and consequently conceived all predication which was not identical to be illegitimate. Thus Aristippus recognized only feelings, denying things; Antisthenes recognized things, denying attributions; and it is probable that in this matter Euclides was at one with him. For, though since Schleiermacher many historians, unnecessarily identifying the εἰδῶν φίλοι of Plato's *Sophist* with the Megarians, have ascribed to Euclides a theory of "ideas," and on the strength of this single passage thus conjecturally interpreted have added a new chapter to the history of Megarianism, it is difficult, if not impossible, to see how, if the founder of the school had broken loose from the trammels of the Zenonian paradox, his successors, and amongst them Stilpo, should have reconciled themselves, as they certainly did, to the Cynic denial of predication.

While the "incomplete Socratics" made no attempt to overpass the limits which Socrates had imposed upon himself, within those limits they occupied each his department. Aristippus, a citizen of the world, drawn to Athens by the fame of Socrates, and retained there by the sincere affection which he conceived for him, interpreted the ethical doctrine of Socrates in accordance with his own theory of pleasure, which in its turn came under the refining influence of Socrates's theory of φρόνησις. Contrariwise, Antisthenes, a rugged but not ungenerous nature, a hater of pleasure, troubled himself little about ethical theory and gave his life to the imitation of his master's asceticism. Virtue, he held, depended upon "works," not upon arguments or lessons; all that was necessary to it was the strength of a Socrates (Diog. Laert., vi. 11). Yet here too the Socratic theory of φρόνησις had a qualifying effect; so that Cyrenaic hedonism and Cynic asceticism sometimes exhibit unexpected approximations. The teaching of Euclides, though the Good is still supposed to be the highest object of knowledge, can hardly be said to have an ethical element: and in consequence of this deficiency the dialectic of Socrates degenerated in Megarian hands, first into a series of exercises in fallacies, secondly into a vulgar and futile eristic. In fact, the partial Socraticisms of the incomplete Socratics necessarily suffered, even within their own narrow limits, by the dismemberment which the system had undergone. Apparently the maieutic theory of education was not valued by any of the three; and, however this may be, they deviated from Socratic tradition so far as to establish schools, and, as it would seem, to take fees like the professional educators called Sophists.

Plato's metaphysical theories.

Of the relations in which the metaphysic of Plato stood to the Socratic search for definitions there are of necessity almost as many theories as there are interpretations of the Platonic system. Hence in this place the writer must content himself with a summary statement of his own views. Initiated into philosophical speculation by the Heraclitean Cratylus, Plato began his intellectual life as an absolute skeptic, the followers of Heraclitus having towards the end of the 5th century pushed to its conclusion the unconscious skepticism of their master. There would have been then nothing to provoke surprise, if, leaving speculation, Plato had given himself to politics. In 407, however, he became acquainted with Socrates, who gave to his thoughts a new direction. Plato now found an occupation for his intellectual energies, as Socrates had done, in the scrutiny of his beliefs and the systematization of his principles of action. But it was not until the catastrophe of 399 that Plato gave himself to his life's work. An exile, cut off from political ambitions, he came forward as the author of dialogues which aimed at producing upon readers the same effect which the voice of the master had produced upon hearers. For a time he was content thus to follow in the steps of Socrates, and of this period we have records in those dialogues which are commonly designated Socratic. But Plato had too decided a bent for metaphysics to linger long over propædeutic studies. Craving knowledge—not merely provisional and subjective knowledge of ethical concepts, such as that which had satisfied Socrates, but knowledge of the causes and laws of the universe, such as that which the physicists had sought—he asked himself what was necessary that the "right opinion" which Socrates had obtained by abstraction from particular instances might be converted into "knowledge" properly so called. In this way Plato was led to assume for every Socratic universal a corresponding unity, eternal, immutable, suprasensual, to be the cause of those particulars which are called by the common name. On this assumption the Socratic definition or statement of the "what" of the universal, being obtained by the inspection of particulars, in some sort represented the unity, form, or "idea" from which they derived their characteristics, and in so far was valuable; but, inasmuch as the inspection of the particulars was partial and imperfect, the Socratic definition was only a partial and imperfect representation of the eternal, immutable, suprasensual idea. How, then, was the imperfect representation of the idea to be converted into a perfect representation? To this question Plato's answer was vague and tentative. By constant revision of the provisional definitions which imperfectly represented the ideas he hoped to bring them into such shapes that they should culminate in the definition of the supreme principle, the Good, from which the ideas themselves derive their being. If in this way we could pass from uncertified general notions, reflections of ideas, to the Good, so as to be able to say, not only that the Good causes the ideas to be what they are, but also that the Good causes the ideas to be what we conceive them, we might infer, he thought, that our definitions, hitherto provisional, are adequate representations of real existences. But the Platonism of this period had another ingredient. It has been seen that the Eleatic Zeno had rested his denial of plurality upon certain supposed difficulties of predication, and that they continued to perplex Antisthenes as well as perhaps Euclides and others of Plato's contemporaries. These difficulties must be disposed of if the new philosophy was to hold its ground; and accordingly, to the fundamental assertion of the existence of eternal immutable ideas, the objects of knowledge, Plato added two subordinate propositions, namely, (1) "the idea is immanent in the particular," and (2) "there is an idea wherever a plurality of particulars is called by the same name." Of these propositions the one was intended to explain the attribution of various and even inconsistent epithets to the same particular at the same time, whilst the other was necessary to make this explanation available in the case of common terms other than the Socratic universals. Such was the Platonism of the *Republic* and the *Phædo*, a provisional ontology, with a scheme of scientific research, which, as Plato honestly confessed, was no more than an unrealized aspiration. It was the non-Socratic element which made the weakness of this the earlier theory of ideas. Plato soon saw that the hypothesis of the idea's immanence in particulars entailed the sacrifice of its unity, whilst as a theory of predication that hypothesis was insufficient, because applicable to particulars only, not to the ideas themselves. But with clearer views about relations and negations the paradox of Zeno ceased to perplex; and with the consequent withdrawal of the two supplementary articles the development of the fundamental assumption of ideas, eternal, immutable, suprasensual, might be attempted afresh. In the more definite theory which Plato now propounded the idea was no longer a Socratic universal, perfected and hypostatized, but rather the perfect type of a natural kind, to which type its imperfect members were related by imitation, whilst this relation was metaphysically explained by means of a "thoroughgoing idealism" (R. D. Archer-Hind). Thus, whereas in the earlier theory of ideas the ethical universals of Socrates had been held to have a first claim to hypostatization in the world of ideas, they are now peremptorily excluded, whilst the idealism which reconciles plurality and unity gives an entirely new significance to so much of the Socratic element as is still retained.

Plato's ethical theories.

The growth of the metaphysical system necessarily influenced Plato's ethical doctrines; but here his final position is less remote from that of Socrates. Content in the purely Socratic period to elaborate and to record ethical definitions such as Socrates himself might have propounded, as soon as the theory of ideas offered itself to Plato's imagination he looked to it for the foundation of ethics as of all other sciences. Though in the earlier ages both of the individual and of the state a sound utilitarian morality of the Socratic sort was useful, nay valuable, the morality of the future should, he thought, rest upon the knowledge of the Good. Such is the teaching of the *Republic*. But with the revision of the metaphysical system came a complete change in the view which Plato took of ethics and its prospects. Whilst in the previous period it had ranked as the first of sciences, it was now no longer a science; because, though Good absolute still occupied the first place, Good relative and all its various forms—justice, temperance, courage, wisdom—not being ideas, were incapable of being "known." Hence it is that the ethical teaching of the later dialogues bears an intelligible, though perhaps unexpected, resemblance to the simple practical teaching of the unphilosophical Socrates.

Yet throughout these revolutions of doctrine Plato was ever true to the Socratic theory of education. His manner indeed changed; for, whereas in the earlier dialogues the characteristics of the master—

> "The soft and intricate discourse,
> The wit that makes us tolerant perforce,
> The mystic legend, and the verse that drops
> As snowflakes shower on wintry forest tops,
> The questions working wedge-like to the proof,
> The threads of prayer from old religion's woof,
> The courteous skill of keen rebukes that chide
> The learner's folly and the sophist's pride"—

are studiously and skilfully preserved, in the later dialogues Socrates first becomes metaphysical, then ceases to be protagonist, and at last disappears from the scene. But in the later dialogues, as in the earlier, Plato's aim is the aim which Socrates in his conversation never lost sight of, namely, the dialectical improvement of the learner.

Bibliography.—Of the histories of Greek philosophy enumerated in the article PARMENIDES the most important for the study of Socrates's life and work is Zeller's *Philosophie d. Griechen*. The part in question has been translated into English under the title of *Socrates and the Socratic Schools*, London, 1877. Schwegler's *Geschichte d. griechischen Philosophie* will also be found instructive. It is plainly impossible to supply here such a list of special treatises as is given by Ueberweg in his *Grundriss d. Geschichte d. Philosophie*, and still more so to provide a complete bibliography. But the following sources of information may be mentioned: F. Schleiermacher, "Ueber d. Werth d. Sokrates als Philosophen," in *Abh. d. Berliner Akad. d. Wissensch.*, 1818, and *Werke*, iii., 2, 287-308, translated into English by C. Thirlwall, in the *Philosophical Museum*, Cambridge, 1833, ii. 538-555; L. F. Lélut, *Du Démon de Socrate*, Paris, 1836, 1856, reviewed by E. Littré in *Médecine et Médecins*, Paris, 1872; G. Grote, *History of Greece*, ch. lxviii., and *Plato and the other Companions of Sokrates*, London, 1865; C. F. Hermann, *De Socratis accusatoribus*, Göttingen, 1854; W. H. Thompson, *The Phædrus of Plato*, London, 1868, Appendix I.; T. Wildauer, *D. Psychologie d. Willens bei Sokrates*, etc., Innsbruck, 1877. For the view taken in the present article with regard to the *δαιμόνιον*, see the writer's paper "On the *δαιμόνιον* of Socrates," in the *Journal of Philology*, v.; and comp. Chr. Meiners, *Vermischte philosophische Schriften*, Leipsic, 1776—"in moments of 'Schwärmerei' Socrates took for the voice of an attendant genius what was in reality an instantaneous presentiment in regard to the issue of a contemplated act." For a fuller statement of the writer's view of Plato's relations to Socrates, see a paper on Plato's *Republic*, vi. 509 D *sq.*, in the *Journal of Philology*, x., and a series of papers on "Plato's later Theory of Ideas," in vols. x., xi., xiii., xiv. of the same periodical. Comp. SOPHISTS and (by all means) ETHICS. (H. JA.)

SOCRATES, church historian. In the course of the last twenty-five years (425–450) of the reign of Theodosius II. (the first thoroughly Byzantine emperor) at least six church histories were written in Greek within the limits of the Eastern empire,—those, namely, of Philostorgius the Arian, of Philippus Sidetes, of Socrates, of Sozomen, of Theodoret, and of Hesychius. Of these the first, no longer extant except in fragments, seems to have been the most important. Those of Philip and of Hesychius (the former an untrustworthy and dreary performance) have also perished. The remaining three are now our main sources for church history from Constantine to Theodosius II. None of them has ventured upon a fresh treatment of the period dealt with by Eusebius; all three begin their narratives about the point where his closes. In the West the *Church History* of that author had already been continued by Rufinus and his *Chronicle* by Jerome, and the work of Rufinus was certainly known to the Byzantines. Nor did these write independently of each other, for SOZOMEN (*q.v.*) certainly had before him the work of Socrates, and THEODORET (*q.v.*) knew one or both of them. The three histories together became known in the West from the 6th century through the selection which Cassiodorus caused to be made from them, and it is to this selection (if we leave Rufinus and Jerome out of account) that the Middle Ages were mainly indebted for all they knew of the Arian controversies, and of the period generally between the councils of Nice and Ephesus.

The 'Εκκλεσιαστική 'Ιστορία of Socrates, still complete, in several books, embracing the period from 306 to 439, was written about, or at all events not later than, 440. He was born and brought up at Constantinople; the date of his birth is uncertain, but it can hardly have been before 385. Of the facts of his life we know practically nothing, except that he was not a cleric but a "scholasticus" or advocate. Of the occasion, plan, and object of his work he has himself informed us in the prologues to his first, second, fifth, and sixth books. It is dedicated to one Theodorus, who had urged him to write such a history. He had no thorough preparation for the task, and for the period down to the death of Constantius (361) was practically dependent on Rufinus. His work finished, he became a student of Athanasius and came to see how untrustworthy his guide had been. He accordingly re-wrote his first two books, and it is only this revision that has reached us. The chief sources from which he drew were—(1) the *Church History*, the *Life of Constantine*, and the theological works of Eusebius; (2) the *Church History* of Rufinus; (3) the works of Athanasius; (4) the no longer extant *Συναγωγὴ τῶν Συνοδικῶν* of the Macedonian and semi-Arian Sabinus,—a collection with commentaries of acts of councils, brought down to the reign of Theodosius I. (this was a main source); (5) collections of letters by members of the Arian and orthodox parties; (6) the *Ancoratus* of Epiphanius; (7) works of Archelaus, Gregory of Laodicea, Evagrius, Palladius, orations of Nestorius, etc. Theological literature proper,—as, for example, the writings of the Cappadocians—he quite neglected. On the other hand, he appears to have known some of Origen's work, and the *Apologia pro Origene* of Pamphilus. It is to Origen and Origen's immediate disciples that he refers when he speaks of "the old church writers," or of "the Christian philosophers"; the last designation, however, also includes the monks. Jeep alleges, but does not adduce any adequate proof, that

Socrates made use of Philostorgius. As regards profane history his materials were exceedingly defective. Thus, for example, he confesses his reason for not relating the political history of Constantine to be that he has been unable to ascertain anything about it. Jeep has instituted an examination into the *fasti*, containing historical notes, made use of by our author with the following results. His chronological data with the facts he appends to them are of the highest value, especially in those cases where, as sometimes happens, data are preserved which are less precisely given in other fasti and chronicles. Somewhere about the year 395–400 his use of these precisely dated records of profane history comes to an end. From this point his information is purely ecclesiastical (dates of ordination and death of bishops and the like); that is to say, he makes use of church fasti. The secular fasti of Socrates come down precisely to the same point as those which lay in the first rank before Idatius.[1] His reckonings by Olympiads are generally wrong, the error arising not from any systematic source but merely from carelessness. It is not altogether impossible, however, after all that Socrates may have taken the historical data of his fasti at second hand from the profane historians. He certainly made use of Eutropius; but that he had any recourse to Eunapius and Olympiodorus is more doubtful, and indeed would be quite improbable if it could be proved that he had Philostorgius before him. There is no evidence of his having known the works of Dexippus and Zosimus. But he is greatly indebted to oral tradition and to the testimony of eye-witnesses, especially of members of the Novatian community in Constantinople; something also he has set down from personal knowledge. The contents of the closing books are for the most part derived from oral tradition, from the narratives of friends and countrymen, from what was still generally known and current in the capital about past events, and from the ephemeral literature of the day.

The theological position of Socrates, so far as he can be said to have had one, is at once disclosed in his unlimited admiration for Origen. All the enemies of the great Alexandrian he regards merely as empty and vain obscurantists; for the orthodoxy of his hero he appeals to Athanasius. Closely connected with his high regard for Origen are his appreciation of science generally and the moderation of his judgment on all dogmatic questions. According to him, ἑλληνικὴ παιδεία is quite indispensable within the church; many Greek philosophers were not far from the knowledge of God, as is proved by their triumphant arguments against atheists and gainsayers of divine providence. The apostles did not set themselves against the study of Greek literature and science; Paul had even made a thorough study of them himself. The Scriptures, it is true, contain all that appertains to faith and life, but give no clue to the art of confuting gainsayers. Greek science, therefore, must not be banished from the church, and the tendency within the church so to deal with it is wrong. This point of view was the common one of the majority of educated Christians at that period, and is not to be regarded as exceptionally liberal. The same holds true of the position of Socrates in regard to dogmatic questions. On the one hand, indeed, orthodoxy and heresy are symbolized to his mind by the wheat and the tares respectively; he clings to the naive opinion of Catholicism, that contemporary orthodoxy has prevailed within the church from the first; he recognizes the true faith only in the mystery of the Trinity; he judges heretics who have been already condemned as interlopers, as impudent innovators, actuated by bad and self-seeking motives; he apologizes for having so much as treated of Arianism at all in his history of the church; he believes in the inspiration of the ecclesiastical councils as much as in that of the Scriptures themselves. But, on the other hand, he takes absolutely no interest in dogmatical subtleties and clerical disputes; he regards them as the source of great evils, and expresses his craving for peace: "one ought to adore the ineffable mystery in silence." This attitude, which was that of most educated Byzantine laymen, has in particular cases made it possible for him to arrive at very free judgments. Even granting that some feeble remains of antique reserve may have contributed to this, and even although some of it is certainly to be set down to his disposition and temperament, still it was his religious passivity that here determined the character of Socrates and made him a typical example of the later Byzantine Christianity. If Socrates had lived about the year 325, he certainly would not have ranked himself on the side of Athanasius, but would have joined the party of mediation. But—the ὁμοούσιος has been laid down, and must be recognized as correctly expressing the mystery; only one ought to rest satisfied with that word and with the repudiation of Arianism. Anything more, every new distinction, is mischievous. The controversy in its details is a νυκτομαχία to him, full of misunderstandings. Sometimes he gives prominence, and correctly, to the fact that the disputants partially failed to understand one another, because they had separate interests at heart,—those on the one side desiring above everything to guard against polytheism, those on the other being most afraid of Sabellianism. He did not fail, however, to recognize also that the controversies frequently had their root in mere emulation, slander, and sophistry. Not unfrequently he passes very sharp judgments on whole groups of bishops. In the preface to his fifth book he excuses his trenching on the region of political history on the ground of his desire to spare his readers the disgust which perusal of the endless disputes of the bishops could not fail to excite, and in that to his sixth book he prides himself on never having flattered even the orthodox bishops. This attitude of his has given him a certain measure of impartiality. Constantius, and even Julian—not Valens, it is true—are estimated very fairly. The Arian Goths who died for their religion are recognized as genuine martyrs. His characterizations of Cyril and Nestorius, and his narrative and criticism of the beginnings of the Christological controversy, are models of candor and historical conscientiousness. In frequent instances, moreover, he acknowledges his own incompetency to give an opinion and hands the question over to the clergy. For the clergy as a whole, in spite of his criticism of individuals, he has the very highest respect, as also for the monks, without himself making any inordinate religious professions. In a special excursus of considerable length he has paid a tribute of the highest order to monachism, and in his characterization of Theodosius II. also (where he has made use of the brightest colors) he does not fail to point out that in piety the emperor could almost compete with the monks. But, apart from these two chapters (iv. 23, vii. 22), it is but seldom that one could learn from the pages of Socrates that there was such a thing as monasticism in those days. To his mind the convent is not far removed from the church, and as a layman he is not at all inclined to accept the principles of monachism as applying to himself or to square his views of history in accordance with them. He has even gone so far as formally to express his sympathy with Paphnutius, the champion of the right of bishops to marry.

As a source for the period within which he wrote, the work of Socrates is of the greatest value, but as "history" it disappoints even the most modest expectations. Eusebius, after all, had some conception of what is meant by "church history," but Socrates has none. "As long as there is peace there is no material for a history of the church"; but, on the other hand, neither do heresies by rights come into the story. What, then, is left for it? A collection of anecdotes and a series of episodes. In point of fact this is the view actually taken by Socrates. His utter want of care and consistency appears most clearly in his vacillation as to the relations between ecclesiastical and political history. At one time he brings in politics, at another he excuses himself from doing so. He has not failed to observe that church and state act and react upon each other; but he has no notion how the relation ought to be conceived. Nevertheless his whole narrative follows the thread of political—that is to say, of imperial—history. This indeed is characteristic of his Byzantine Christian point of view; church history becomes metamorphosed into a history of the emperors and of the state, because a special church history is at bottom impossible. But even so one hardly hears anything about state or court except great enterprises and anecdotes. Political insight is wholly wanting to Socrates; all the orthodox emperors blaze forth in a uniform light of dazzling splendor; even the miserable Arcadius is praised, and Theodosius II. figures as a saint whose exemplary piety turned the capital into a church. If in addition to all this we bear in mind that in his later books the historian's horizon is confined to the city and patriarchate of Constantinople, that he was exceedingly ill informed on all that related to Rome and the West, that in order to fill out his pages he has introduced narratives of the most unimportant description, that in not a few instances he has evinced his credulity (although when compared with the majority of his contemporaries he is still entitled to be called critical), it becomes sufficiently clear that his *History*, viewed as a whole and as a literary production, can at best take only a secondary place. One great excellence, however, cannot be denied him, his honest and sincere desire to be impartial. He tried also, as far as he could, to distinguish between the certain, the probable, the doubtful, and the untrue. He made no pretence to be a searcher of hearts and frequently declines to analyze motives. He has made frank confession of his nescience, and in certain passages his critical judgment and sober sense and circumspection are quite striking. He writes a plain and unadorned style and shuns superfluous words. Occasionally even there are touches of good humor and of trenchant satire,—always the sign of an honest writer. In short, the rule to be applied in the criticism of Socrates is that his learning and knowledge can be trusted only a little but his good-will and straightforwardness a great deal. Considering the circumstances under which he wrote and the miseries of the time, it can only be matter for congratulation that such a man should have become our informant and that his work has been preserved to us.

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[1] See Holder-Egger, *Neues Archiv f. deutsche Gesch.*, ii. 61.

Finally, it is to be noted that Socrates was either himself originally a Novatianist who had afterwards joined the Catholic Church, or that whether through his ancestors or by education he had stood in most intimate relations with the Novatianist Church. In his *History* he betrays great sympathy with that body, has gone with exactness into its history in Constantinople and Phrygia, and is indebted for much of the material of his work to Novatianist tradition and to his intercourse with prominent members of the sect. Both directly and indirectly he has declared that Novatianists and Catholics are brothers, that as such they ought to seek the closest relations with one another, and that the former ought to enjoy all the privileges of the latter. His efforts, however, had only this result, that he himself afterwards fell under suspicion of Novatianism. For bibliography, see SOZOMEN. (A. HA.)

SODIUM AND SODA. Sodium is one of the two principal alkali metals, regarding the general properties of which the reader is referred to CHEMISTRY (vol. v. pp. 454-5) and the introductory portion of POTASSIUM (vol. xix. p. 605). In combination sodium is a generally diffused and most abundant element. The salt dissolved in sea water consists chiefly of chloride of sodium (NaCl), and according to Dittmar's calculation (see SEA WATER) the oceans of the world contain of sodium calculated as chloride not less than $36{,}000 \times 10^{12}$ (*i.e.*, 36,000 million million) tons, whilst of potassium calculated as sulphate the amount in sea water is 1141×10^{12} (1141 million million) tons. From sea water have been deposited the enormous beds of rock salt found in many parts of the world (see SALT). Sodium carbonates are also widely dispersed in nature, forming constituents of many mineral waters, and occurring as principal saline components in natron or trona lakes, as efflorescences in Lower Egypt, Persia, and China, and as urao in Mexico, Colombia, and Venezuela. The solid crusts found at the bottom of the salt lakes of the Araxes plain in Armenia contain about 16 per cent. of carbonate and 80 of sulphate of soda. In Colombia there occurs a double salt, $Na_2CO_3 + CaCO_3 + 5H_2O$, known as gay-lussite. In Wyoming, California, and Nevada enormous deposits of carbonates, mixed in some cases with sulphate and with chloride, occur. About Szegedin in Hungary and all over the vast pusztas (steppes) between the Theiss and the Danube, and from the Theiss up to and beyond Debreczin, the soil contains sodium carbonate, which frequently assumes the form of crude alkaline crusts, called "szekso," and of small saline ponds. A purified specimen of such Debreczin soda was found to contain as much as 90 per cent. of real carbonate ($NaCO_3$) and 4 of common salt. Natural sulphate occurs in an anhydrous condition as thenardite (Na_2SO_4) at Tarapaca in Chili, and in the rocksalt deposits at Espartinas near Aranjuez, Spain. Hydrated sulphates occur at several localities in the province of Madrid and in other provinces of Spain, and at Mühlingen in Aargau, and copious deposits of glauberite, the double sulphate of sodium and calcium, are met with in the salt-mines of Villarrubia in Spain, at Stassfurt and in the province of Tarapaca in Chili, etc. A native nitrate of soda is obtained in great abundance in the district of Atacama and the province of Tarapaca, and is imported into Europe in enormous quantities as cubical nitre for the preparation of saltpetre (see NITROGEN, vol. xvii. p. 531). Cryolite, a fluoride of aluminium and sodium, AlF_3+3NaF, is extensively mined in Greenland for industrial purposes. These form the principal natural sources of sodium compounds,—the chloride as rock salt and in sea water being of such predominating importance as quite to outweigh all the others. But it is questionable whether taken altogether the mass of sodium they represent is as much as that disseminated throughout the rocky crust in the form of soda felspar (*i.e.*, as silicate of soda) and in other soda-containing rocks. From this source all soils contain small proportions of sodium in soluble forms, hence the ashes of plants, although they preferably imbibe potassium salts, contain traces and sometimes notable quantities of sodium salts. Sodium salts also form essential ingredients in all animal juices.

Considered industrially, by far the most important bodies are the carbonates, the sulphates, and caustic soda (sodium hydrate), the manufacture of which forms the basis of the soda industry. Immense quantities of these bodies are used in the manufacture of soap and glass, and under the name of "washing soda" or "soda crystals" the consumption of the hydrated carbonate for domestic washing is also very great. There are indeed few chemical industries in which soda in one form or another does not play an important part, and the combinations of economic value into which it enters are numberless. It will be convenient to treat of the manufacture as a whole by itself, after speaking of sodium and its salts in their chemical relations.

Sodium, in German *Natrium* (symbol, Na; atomic weight, 23.053; O=16), is a univalent metal. It occurs nowhere in nature in an uncombined condition, and was first isolated in 1807 by Sir Humphry Davy through the medium of voltaic electricity. It is prepared by distillation of an intimate mixture of carbonate of soda with charcoal. The process is quite analogous to that followed in making metallic potassium (POTASSIUM, vol. xix. p. 607), but much easier of execution, and free from certain dangers which attend the preparation of the other. The distillation is conducted in cylindrical iron retorts protected against the fire by means of fireclay tubes fitting closely round them. In the charge is included a certain proportion of chalk, which, giving off carbonic acid, aids in driving over the metallic vapor and protects the distillate against oxidation. The metal cast into the form of cakes or ingots is protected from the air by a coating of paraffin and secured in closely fitting soldered-up tinned-iron boxes. Metallic sodium is very similar in properties and appearance to potassium. The principal points of difference are its pure white color, its specific gravity (0.9735 at 13.5° C.), and its fusing point (95.6° C.). In thin layers its vapor is colorless, but dense fumes have a purple tint. It decomposes water violently, but the hydrogen evolved does not take fire, although the reaction is more dangerous than the corresponding phenomena developed by potassium, because it leads frequently to most violent explosions. Yet the process serves in practice for the preparation of pure soda hydrate. In this operation a piece of sodium is placed in a silver basin standing in a shallow cold-water bath. Drop by drop water is added—the metal between the additions being allowed to expend its energy—till the desired quantity of hydrate is formed. The process, in short, is so conducted that, except at first, the metal never touches water in any other form than that of a strong soda lye. Sodium is largely made for use as an agent in the manufacture of aluminium and magnesium, and as a reagent in laboratory operations. The metal does not affect carbonic oxide at any temperature; it acts on hydrogen as potassium does; but the compound is less stable. On ammonia gas it acts, as in the parallel case of potassium, with the formation of NH_2Na, only the reaction is less energetic. Sodium has less powerful affinity to oxygen than potassium; in dry air or oxygen it burns into the dioxide Na_2O_2,—a product obtainable also by heating the nitrate or nitrite. A white solid soluble in cold water, forming a hydrate, $Na_2O_2 + 8H_2O$, is obtainable in crystals, the solution of which is strongly alkaline. With acids it yields sodium salts and peroxide of hydrogen. Sodium tetroxide (Na_2O_4) is not known to exist.

Caustic Soda (NaHO) is prepared from carbonate by means of caustic lime, just as caustic potash is made from its carbonate (see POTASSIUM). The analogy between the two caustic alkalies is so perfect that we need only summarize the points of difference between them. Compared with caustic potash, caustic soda is less easily soluble in water, less caustic, less energetically basilous, less prone when fused in air to pass into peroxide, hence less destructive to platinum, iron, nickel, and silver vessels.

Sodium Chloride (NaCl) occurs in nature in a nearly pure state. Absolutely pure salt is made from commercial salt by precipitating from a solution the lime and magnesia by pure carbonate of soda, filtering, neutralizing with pure hydrochloric acid, concentrating by evaporation, and then precipitating the pure salt by a stream of hydrochloric acid gas. The crystalline precipitate is collected over glass wool, washed with pure fuming hydrochloric acid, and dried by heating in a platinum basin. It forms non-hygroscopic crystals, free from combined water, having a specific gravity at 16° C. of 2.162 (Stolba), and according to Carnelley fusing at 776° C. The solubility of pure salt in water is almost independent of temperature; 100 parts of water dissolve—

at 0°	14°	60°	100°	109.7° (boiling)
35.52	35.87	37.25	39.61	40.53 parts of NaCl.

Regarding its commercial relations, etc., see SALT.

Chlorate of Soda ($NaClO_3$) is a salt of some industrial importance, from its use in the manufacture of aniline black. It may be made from the potash salt (*a*) by decomposing this with hydrofluosilicic acid (which precipitates the potassium as fluosilicate and yields a solution of chloric acid), and neutralizing the chloric acid solution with soda, or (*b*) by double decompositon with bitartrate of soda, $NaHC_4H_4O_6$,—the cream of tartar ($KHC_4H_4O_6$) separating out almost completely, whilst the chlorate of soda remains in solution. According to Weldon, it is best manufactured from caustic soda by the direct action of chlorine, the two salts NaCl and $NaClO_3$ being separated by crystallization. Chlorate of soda forms cubes which often exhibit tetrahedral faces; 100 parts of water dissolve at 0° 81.9, at 20° 99, and at 100° C. 233 parts of the salt. Hence it is much more soluble than the potash salt, on which account it is preferred for aniline black printing.

Sulphate (Na_2SO_4) is the most largely produced of all soda salts in manufacturing operations, although it is regarded principally as an intermediate product. The anhydrous salt readily combines with water into a crystalline soluble compound, $Na_2SO_4 + 10H_2O$, known as Glauber's salt. This forms large transparent monoclinic crystals, and is characteristically prone to form supersaturated solutions. 100 parts of water dissolve—

at 0°	11.67°	25.05°	32.73°	33.88°	
12.17	26.38	99.48	322.1	312.1	parts of $Na_2SO_4 + 10H_2O$,
5.02	10.12	28.11	50.65	50.4	parts of $NaSO_4$

As the temperature rises beyond about 33°, the solubility decreases (Gay-Lussac). Glauber's salt, when exposed to dry air, especially in summer heat, gradually falls into a powder of anhydrous sulphate. It is much less volatile than the chloride. The thiosulphate, $Na_2S_2O_3$ (commercial hyposulphite of soda), and soda salts of other lower sulphur acids, are reserved for SULPHUR.

Of all sodium compounds, except common salt, the carbonates are by far the most important, both industrially and chemically. These comprise the following:

Normal Carbonate, Na_2CO_3.—The anhydrous salt usually presents itself in the form of a white opaque porous solid, specific gravity 2.65 (Karsten). According to Carnelley, it fuses at 818° C. (dull red heat) into a colorless liquid. On fusing it loses some of its carbonic acid, and at a bright red heat it volatilizes appreciably. The porous salt absorbs water from the air; when moistened with water it gives off heat and unites into crystalline hydrates, of which the important compound is

Decahydrate, $Na_2CO_3 + 10H_2O$.—This salt, known as soda crystals or washing soda, forms large transparent monoclinic rhomboidal prisms or double pyramids. The salt dissolves readily in water, forming strongly alkaline solutions, which emulsionize fats, though less readily than is done by caustic lyes. 100 parts of water dissolve—

at 0°	15°	20°	80°	88°	104°	
21.33	63.20	92.82	273.6	1142.2	539.6	of crystals,
6.97	16.20	21.71	37.24	51.67	46.47	of Na_2CO_3

(Löwel). According to this observer, the dissolved salt from 38° C. upwards assumes the form of lower hydrates, hence the diminution in solubility at higher temperatures. A saturated solution, when evaporated down by heat, deposits a granular salt of the composition $Na_2CO_3(H_2O$ or $2H_2O)$. The decahydrate, when exposed to dry air even at ordinary temperatures, loses water, with the formation of monohydrate, Na_2CO_3, H_2O. It also readily takes up carbonic acid with the formation of

Bicarbonate, $NaHCO_3$.—Its formation may be thus formulated — $Na_2CO_3 + 10H_2O + CO_2 = 2NaHCO_3 + 9H_2O$. The bicarbonate remains as a crystalline mass, while the liberated water runs off with more or less of dissolved carbonate and the saline impurities which may be present. Bicarbonate forms small four-sided monoclinic plates with a feebly alkaline taste and reaction. 100 parts of water dissolve—

at 0°	20°	40°	60°
6.90	9.60	12.70	16.40 of $NaHCO_3$

(Dibbits). From about 70° C. upwards the solution gives off carbonic acid with formation of *Sesquicarbonate*,—$2Na_2O + 3CO_2 + 4H_2O = Na_2CO_3 2NaHCO_3 + 3H_2O$. This salt, found in nature as trona or urao, forms in its pure state crystals which do not lose water in the air. At 20° C. 100 parts of water dissolve 18.3 parts of the salt calculated as anhydride, $2Na_2O3CO_2$. Both bicarbonate and sesquicarbonate when heated dry break up readily (below redness) into normal carbonate, water, and carbonic acid.

Other salts of soda which are of importance on account of their acid constituents—nitrate, silicate, phosphate—are dealt with under NITROGEN, SILICA, PHOSPHORUS.

The estimation and analysis of alkalies are sufficiently dealt with at the close of the article POTASSIUM.

Soda Manufacture.

The ancients probably did not know soda in other than its native forms, and till about the end of the 18th century potash was, of the two alkalies, the more abundant and generally used substance. Indeed it was not till well into that century that the chemical distinctions of the alkalies were established; they were previously spoken of indifferently as nitrum, natron, kali, alkali, and soda, names simply meaning a fixed alkali. Soda has properly a separate history only from 1736, when Duhamel established the fact that common salt and mineral alkali have the same base,—a body different from the salt of tartar or vegetable alkali. Yet soda, from both mineral and vegetable sources, had long previously been used in Europe, the Arabs having probably brought into Spain a knowledge of the alkali and its sources. Apart from the trona and soda lakes, etc., already alluded to, the only source till the close of the 18th century was the ashes of certain plants which grow on the sea-coast and in salt-impregnated soils. These plants, principally species of *Salsola* and a few other genera of the natural order *Atriplicea*, on incineration yield an ash containing in some cases about 50 per cent. of carbonate of soda. The ash of these plants, fluxed by red heat into a pasty mass and broken into convenient lumps, forms the barilla of commerce, which in former times was a product of the first importance on the shores of Spain, Sicily, Sardinia, and other coasts of the Mediterranean. In 1834 as much as 12,000 tons of barilla were introduced into England from Spain alone, and, in spite of the cheapness of artificial soda, the manufacture of barilla is still—or at least was till recently—carried on at various localities on the Mediterranean. On the west coasts of Scotland and Ireland large amounts of impure soda carbonate were obtained from the kelp burned from certain sea-weeds; but the introduction of artificial soda early extinguished that industry, although in connection with the production of iodine and other products a small quantity of sea-weed soda continues to be made in Scotland till the present day.

The increasing price of potash salts and the discovery of Duhamel led to strenuous attempts to produce the carbonate from common salt. In 1775 the French Academy of Sciences offered a prize of 2400 livres [$463.20] for a practical method of converting salt into soda. But it was never awarded, although the problem was soon triumphantly solved. Indeed in that same year Scheele succeeded in making soda from common salt by means of litharge. Several claims were made for the prize, the first being based on a process invented by a Benedictine monk, Malherbe, in 1778, which was worked with some success for several years. Some time about or before 1787 De la Métherie proposed a plan for calcining with charcoal the sulphate prepared from chloride,—an impracticable proposal, because nearly all the resulting product is sulphide.[1] But this proposal has historical importance, because from the published account of it Le Blanc received in 1787, according to his own statement, the first suggestion of his process,—probably the most valuable and fertile chemical discovery of all times. Nicolas Le Blanc, born at Issoudun (Indre) in 1753, was private surgeon to the duke of Orleans. He was a chemist as well as a surgeon, and the prospect of the Academy prize attracted his attention to the soda problem. He added to the sulphate and charcoal mixture proposed by De la Methérie a certain proportion of chalk, and by fluxing the mixture in crucibles suceeded in effecting the desired transformation. The chemist D'Arcet and his assistant Dizé, having recognized the soundness of the process, the duke of Orleans, early in 1790, agreed to provide a capital of 200,000 francs [$38,600] for working the process. In September, 1791, the National Assembly granted Le Blanc a patent for fifteen years, and under the superintendence of Le Blanc himself, with Dizé and Henri Shée, the steward of the duke of Orleans, a work was established at Saint Denis. But on the fall and execution of his patron, Le Blanc, and all others owning and working soda processes, were ordered to resign them to the state for the public benefit, he receiving the miserable compensation of 4000 francs [$772]. In 1800 his works were reconveyed to him, but in 1806, broken in hope, health, spirit, and resource, he perished by his own hand in a workhouse.

Le Blanc's process continued to hold the field against all competing schemes till within the last few years, and that essentially in its original form. Owing to the raw materials employed in it and the products evolved, it became the basis of a series of important industries, and many interesting collateral processes have been grafted on the manufacture. Its origin was contemporaneous with the introduction of bleaching-powder (see CHLORINE, vol. v., p. 589), and the hydrochloric acid given off in the conversion of chloride into sulphate of soda became the raw material of that industry, the two processes being worked in conjunction. Since the days of Le Blanc many other methods for more directly manufacturing artificial soda have been proposed; but only one—the so-called "ammonia process"—has seriously threatened to supplant it.

Le Blanc's Process.—This consists of two stages. In the first stage common salt is converted into sulphate of soda by the action of sulphuric acid. At first acid sulphate of soda is produced thus—$2NaCl + H_2SO_4 = HCl + NaHSO_4 + NaCl$; but subsequently at a sufficient temperature the acid sulphate decomposes the remainder of the salt thus—$NaHSO_4 + NaCl = Na_2SO_4 + HCl$, so that all the chlorine is expelled as hydrochloric acid with formation of normal sulphate of soda. In the second stage the sulphate mixed with limestone and coal (charcoal in Le Blanc's original proposal) is calcined in a reducing flame, whereby a mixture of sulphide of Calcium (CaS) and carbonate of soda is formed, oxygen being generally supposed to pass off as carbonic oxide, CO. According to Lunge, however, the gas produced consists chiefly of carbonic acid, so that the reaction should correspond essentially to the equation $Na_2SO_4 + 2C + CaCO_3 = Na_2CO_3 + CaS + 2CO_2$. The sulphide of calcium being practically insoluble in water and only very slowly acted on by a solution of carbonate of soda at temperatures under 45° C., the carbonate is extracted by systematic lixiviation with water at a temperature under that limit and is recovered from the solution by evaporation. If an excess of lime is used, more or less of the soda assumes the caustic form (NaHO). All crude soda-ash lyes contain some caustic alkali besides the following impurities: chloride of sodium, sulphate of soda, sulphide of sodium combined with sulphide of iron into a soluble green compound which occasions much trouble to the manufacturer. This solution contains also occasionally cyanide or ferrocyanide of sodium, produced by the action of cyanide on the soluble form of sulphide of iron.

Salt Cake Making.—The conversion of the salt into sulphate, called "salt cake," is effected by means of sulphuric acid of about 60 per cent. (chamber acid), and may be, and still very commonly is, carried out in reverberatory furnaces having flat soles of cast iron, attached to one end of which is a pan of the same material. The waste heat from the reverberatory furnace is utilized to heat the charge placed in the pan, where the first part of the change is effected, the reaction beginning briskly with evolution of copious fumes of hydrochloric acid immediately the acid and salt are mixed. Before the Alkali Act of 1863 hydrochloric acid was freely allowed to escape through the stalk with the smoke and fire gases, carrying destruction to the vegetation of vast tracts around the works; but now all the acid is everywhere carefully collected, both because it is a source of profit and from sanitary considerations. Hence in modern "open roasters," as these reverberatory furnaces are called, the pan and the calcining sole are separated, so that the comparatively pure and undiluted fumes from the pan can be led away and collected by themselves, leaving the mixed air, fire gases, and acid fumes from the furnace hearth to be separately dealt with. In another class of furnace, called a "blind roaster," the calcination of the half-finished sulphate is carried out in a muffle, so that none of the hydrochloric acid is mixed with air and fire gases. Certain advantages attend each class of furnace. In working these hand-furnaces there is much unpleasant manual labor, to avoid which mechanical furnaces have been devised, in which the stirring of the charge, etc., is accomplished by machinery. The first mechanical roaster actually used was patented by Jones & Walsh in 1875. In it the whole operation from beginning to end is carried out on the sole of a large cast-iron pan heated from above. Through the roof of the chamber inclosing the pan passes a vertical shaft geared to rotate, to which are attached four horizonal arms, and to these slanting rods are fixed which terminate in scrapers. These scrapers are fixed at different lengths from the shaft centre, so that when the shaft is in motion they pass through and turn over the whole of the charge strewn over the sole of the pan. The acid is passed into the pan by a pipe from a tank situated above the roaster. The hot mixture of fire gases and acid fumes is led through a long pipe to cool down before reaching the condensers.

Hargreaves's Process for making sulphate without the direct use of sulphuric acid is based on the employment of sulphurous acid obtained by the ignition of pyrites aided by air and steam. In this way Mr. Hargreaves may be said to get his sulphuric acid *ex tempore*. The process has only been elaborated as the result of a most extensive series of investigations and experiments carried out in conjunction with Mr. Robinson, their first patent having been obtained in January, 1870. The reaction on which the process depends may be thus formulated—$2NaCl + SO_2 + H_2O + O = Na_2SO_4 + 2HCl$. The salt used is rendered porous by first moistening it with water and then redrying it by passing it through a hot-air channel on an endless chain of plates. The salt so prepared is distributed in a range of not less than eight cast-iron cylinders, which are pervaded successively by a current of mixed superheated steam and sulphurous acid given off by pyrites. The reaction begins at about 400° C. and increases in energy with the rise of temperature, but it is impracticable to force the heat beyond 500° to 550°, as the charge then begins to fuse and ceases to be permeable by gases.

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[1] It is well established, however, that carbonate of soda can be produced in this manner. It was Liebig, we believe, who showed that the first step in the Le Blanc process is approximately thus—$2Na_2SO_4 + 6C = Na_2S_2 + Na_2CO_3 + 5CO$, only the disulphide and the carbonate on continued heating act on each other and on the carbon to form Na_2S.—$Na_2S_2 + Na_2CO_3 + 2C = 2Na_2S + 3CO$.

The condensation of the hydrochloric acid given off in these processes is effected by a variety of means according to the purpose in view in securing the gas. In Continental works a favorite method is to pass the gas through a range of Woulfe's bottles arranged in an ascending series,—fresh water entering the topmost and passing through the whole, till in the last and lowest, highly charged with acid, it meets the gas coming direct from the roaster. After leaving the last and highest bottle the gas is generally washed thoroughly out by passing it into a small coke tower, in which it meets a downward trickle of water. In English works Woulfe's bottles are not employed, and the gases are commonly conducted by a long range of piping, in which they are cooled, to one or a series of coke towers, in which they are exposed to an enormously extended condensing surface of water trickling over the coke, stones, or brick with which the interiors of the towers are filled.

Black Ash Making.—The conversion of the crude sulphate or salt cake into carbonate of soda, peculiarly the process of Le Blanc, is conducted in what is termed a "balling furnace." In its simplest form this consists of a long reverberatory furnace in which the fuel occupies a lower grating at one extremity of the flat sole, on which the whole reaction is carried out. This sole has usually two beds, that more distant from the fire-bridge being a little higher than the front division; and on front and back beds two separate charges at different stages of advancement are treated simultaneously. The salt-cake is taken as it comes from the roaster, mixed with limestone or chalk (crushed to pieces not bigger than a walnut) and with coal or anthracite in the form of slack or culm. The proportions of these ingredients used in different works vary widely; but, generally stated, to each 100 parts of sulphate there are added from 100 to 140 parts of chalk or limestone and from 40 to 70 of coal. These ingredients roughly mixed are passed by a hopper into the back bed of the furnace, where they become dried and heated, while a previous charge is being finished on the hot front or working bed. When the charge on the working bed has been withdrawn, the mixture on the back bed is pushed forward and spread over the highly heated sole. During the time it is exposed to the flames the ball-furnaceman is constantly at work with a paddle or rake turning over and exposing equally the whole charge to the action of the flame. Very soon the mixture begins to soften and fuse on the surface, and by degrees the whole mass assumes a stiff pasty form. Meantime bubbles of carbonic acid gas are copiously given off, the material becoming of thinner consistence; but afterwards the charge becomes again stiff, and carbonic oxide instead of carbonic acid is evolved, which as it is given off burns in long pointed flames, called "pipes" or "candles." The copious appearance of these flames indicates the completion of the operation, and the ball of black ash must now be withdrawn without delay. The time required for working off a charge is from forty to fifty minutes.

The manual labor of black ash balling is extremely hard and trying, while it demands for its success considerable judgment and experience. On these accounts the efforts of manufacturers were early directed to the introduction of mechanical furnaces; and in 1848 W. W. Pattinson patented a rotating ball-furnace, which, however, owing to severe tear and wear, was unsuccessful. Improvements on the revolving furnace were effected by Elliott & Russell, Stevenson & Williamson, Mactear, and others, which have rendered the working of revolvers a complete success. In its general features a revolver consists of a large boiler-like cylinder of cast iron, lined internally with fire-bricks, and suspended horizontally so that it can be made to rotate about its axis. One of the two open ends communicates with a furnace, which sends its flame through the cylinder. From the other end the hot gases are led away for evaporating black ash liquor. The cylinder is surmounted by a platform or railway from which it receives the charge through a manhole in its side. The charge is made in two separate instalments,—the whole of the chalk and two-thirds of the coal being first introduced, and the cylinder slowly rotated till a portion of the chalk has been burned to lime. Then the sulphate and the remainder of the coal, well mixed, are added, the revolver going slowly at first, but more rapidly as the end approaches, the whole balling being completed in from two to two and a half hours. The manhole door being opened, the revolver is turned round to allow the fluid black ash to pour out by it into a series of vessels placed beneath it. Under Mactear's improved process the whole of the charge is introduced into the revolver at first, and after the decomposition is complete a small proportion of caustic lime is thrown in and quickly mixed with the charge, which is thereon at once drawn.

The lixiviation of the black ash is conducted in a systematic manner so as to extract all the soda with the minimum of water. The apparatus generally employed—the Buff-Dunlop system—consists of a series of at least four tanks each provided with a false bottom and two outlet pipes, and so arranged that the liquid part of the contents can be made to flow from any one of the tanks into any other. The method of working consists in making fresh water meet nearly exhausted ash, and the liquid, passing on through the series of tanks and becoming gradually stronger, meets ash less and less exhausted, till in the last tank of the series the watery solution in its most concentrated state comes in contact with fresh black ash. As soon as the ash in the first tank is completely exhausted the waste residue is withdrawn and a fresh charge introduced. It then becomes the last of the series, number two taking the first place; and so the work goes on in regular rotation. The lye obtained is allowed to clear in large tanks, from which it is drawn for evaporation.

Boiling Down.—The evaporation of the tank-liquor is generally effected in flat iron pans, heated from the top by the waste heat of the black-ash furnaces. So soon as a certain degree of concentration is passed, soda begins to separate out in the form of granular crystals. These are ladled out and allowed to drain for subsequent calcination and conversion into soda ash. The purity of the granular salt decreases as the evaporation proceeds, chloride and sulphate of sodium, with the sulphides of iron and sodium, separating out with the carbonate. The red liquor which remains with the salt owes its color to the iron sulphide it contains. It is intensely caustic, containing much caustic soda. In draining from the soda it carries off with it much of the sulphide and minor impurities from the tanks. The impure soda obtained from the evaporating pans is known as black salt and consists essentially of a monohydrate, $Na_2CO_3+H_2O$. A process for evaporation from the bottom is also worked in Lancashire and on the Continent.

Carbonating.—Salts that are fished out of the evaporating pan in the early stage of boiling down, being comparatively pure, require little treatment for finishing as soda ash. They have simply to be dried at a moderate heat to expel the water of crystallization. But with the ordinary black salt, which contains a considerable amount of both caustic soda and sodium sulphide, a special purifying and finishing treatment, called "carbonating," has to be adopted. For carbonating black salt the strong lye in the evaporating tanks is mixed with sawdust and evaporated down to dryness. The mixture is then introduced into a carbonating furnace, where the heat is gradually raised till the whole of the sawdust it contains is burnt off, and by the agency of the carbonic acid given off in its combustion the sulphide of sodium and the caustic soda present are converted into carbonate. Mechanical carbonating furnaces have been introduced, the most successful of which is that of Mactear, in which there is a rotating circular hearth acted on by scrapers or ploughs. Ordinary soda ash is at best an impure product containing always some caustic soda, which, however, considering the purposes for which it is used, can scarcely be regarded as an impurity or defect. Its value is determined by analysis and is calculated from the amount of anhydrous soda (Na_2O) it contains as carbonate or hydrate.

In many soda-works the black-ash process is purposely so conducted as to produce much caustic soda, and the red liquor is then worked up into caustic soda in the following manner. It is first highly concentrated by boiling in a deep iron pan. To the concentrated solution nitrate of soda is added, which decomposes the sulphide present with evolution of ammonia and formation of sulphate, thus: $Na_2S + NaNO_3 + 2H_2O = Na_2SO_4 + NH_3 + NaHO$. The evaporation is continued till practically all the water is expelled and the heat is forced till fusion sets in. Then the remaining sulphide of sodium with the cyanide is oxidized by the nitrate, which breaks up thus—$2NaNO_3 = Na_2O + 2N + 5O$, with formation of sulphate of soda and oxide of iron. Part of the carbon of the cyanogen separates as graphite (Pauli). The fused mass is allowed to stand, when the suspended matter, including, singularly, most of the alumina, settles down, leaving a perfectly clear liquid, which is run into iron drums, where it solidifies. By means of this process, which has been principally elaborated by Herr Ph. Pauli of Höchst near Wiesbaden, a remarkably pure product can be obtained from a very dirty liquor.

Refined Alkali.—Ordinary soda ash is sufficiently pure for most purposes for which the alkali is required in bulk; but for glass making, etc., it is necessary to remove all traces of iron. For this purpose the ash is dissolved in water, and if a well-carbonated ash is under treatment it is merely well agitated and allowed to stand quietly till impurities settle. By some manufacturers a small amount of carbonate of lime is added to the settling tank to carry down the impurities. Ash containing iron salts, sulphide and colored impurities is treated with a small proportion of chloride of lime to oxidize the iron and cause its precipitation as hydrated ferric oxide. The settled liquor is boiled down, the crystals drained, dried, and heated in a reverberatory furnace, and finally ground for the market.

Soda Crystals (washing soda) are similarly prepared, by forming a strong solution of soda ash, allowing the liquor to settle, and running it into large coolers or crystallizing cones, in which the crystals form in from one to two weeks, according to the coolness of the position. When the crystallization is complete the crust is broken, the mother-liquor, still holding a large amount of soda, is run off for future use, and the crystals are broken up, drained, and dried for packing and use. Soda crystals contain 63 per cent. of water, and their principal employment is for domestic washing, for which their comparative non-causticity well fits them.

Sulphur Recovery.—Of the several raw materials of the Le Blanc process, sulphur, now always used in the form of pyrites, is by far the most expensive. The sulphuric acid employed passes out in valueless combination as crude sulphide of calcium, and accumulates in huge mounds. Under the influence of rain sulphide of calcium in these heaps gradually assumes the forms of sulphide of hydrogen and hydrated oxide of calcium,—$CaS + 2H_2O = CaOH_2O + H_2S$. The hydrogen sulphide combines in its turn with another quantity of sulphide of calcium into CaS_2H_2, which being soluble in water runs off as yellow liquor to contaminate streams and give off sulphuretted hydrogen gas with its disgusting smell. By the action of atmospheric oxygen part of the CaS_2H_2 loses its hydrogen as water, and the remaining CaS_2 passes into thiosulphate of calcium, CaS_2O_3, with simultaneous formation of polysulphides. Upon this latter tendency Mond founded his original method for recovering sulphur. He hastened the oxidation by blowing air through the moist waste till a certain proportion of the sulphide was converted into thiosulphate, and the residue into sulphhydrate CaH_2S_2, or polysulphide. The mass is lixiviated with water, the liquor decanted off, and mixed with excess of hydrochloric acid, which produces H_2S, and in general sulphur, from the sulphhydrate and sulphides of calcium, with SO_2 and sulphur from the thiosulphate. But $2H_2S + SO_2$ decompose each other into $3S + 2H_2O$. Hence it is obvious that, if the process of oxidation is stopped at the right point, the whole of the sulphur will be recovered as such. The precipitated sulphur is mixed with water placed in a closed cylinder and fused by raising the temperature of water round it in an outer casing above the melting point of sulphur. The sulphur then runs together in the lower part of the cylinder, whence it is drawn off by a pipe and cast into rolls. The Mond process, of all the many sulphur-recovery processes yet introduced, is the best; but even it no more than pays working expenses, and enables the manufacturer to end his process with an innocuous chloride of calcium ($CaCl_2$) without actual loss of money.

About 1880 considerable excitement was caused by a sulphur-recovery process patented by Schaffner and Helbig in 1878, which was expected to revolutionize the soda trade. As these hopes have not been realized, we merely state the principle of the process. The soda waste is digested with a solution of chloride of magnesium, which in the first instance leads to the formation of $CaCl_2$ and MgS. But the latter is at once decomposed, with formation of magnesia and sulphuretted hydrogen,—$MgS + 2H_2O = MgOH_2O + H_2S$. The sulphuretted hydrogen is caused to act on sulphurous acid within a solution of chloride of calcium, when the sulphur settles in a filtrable form. The liquor remaining after the expulsion of H_2S from the mixture of waste and chloride of magnesium consists of a precipitate of magnesia and a solution of chloride of calcium. By blowing carbonic acid into the mixture the following decomposition is effected—$MgO + CO_2 + CaCl_2 = CaCO_3 + MgCl_2$—so that the magnesium is recovered in its original form and the calcium of the waste obtained as carbonate, which may again be returned to the black ash roaster. This very pretty and complete process might probably have been worked out as a practical success had the conviction not arisen that even with profitable sulphur recovery the Le Blanc process will not long be able to hold its own against the ammonia process.

Ammonia Soda Process.—This process is based on the fact that bicarbonate of ammonia, when added to a strong solution of common salt, decomposes the salt with formation of a precipitate of bicarbonate of soda and a solution of ammonium chloride (sal-ammoniac), thus $NaCl + (NH_4)HCO_3 = NH_4Cl + NaHCO_3$. The ammonia is recoverable from the sal-ammoniac by distillation with lime, and, supposing no waste to occur, is usable *ad infinitum*. From bicarbonate the normal salt is easily prepared by the application of heat —$2NaHCO_3 = Na_2CO_3 + CO_2 + H_2O$. Thus by theory one-half of the carbonic acid is recovered, and, supposing the quicklime for the decomposition of the sal-ammoniac to be made by heating limestone, the loss of carbonic acid is made up incidentally from that source. The only waste product which remains for disposal is the entirely innocuous chloride of calcium made in recovering ammonia by means of lime from sal-ammoniac. The ammonia process was first enunciated and patented in England by Dyar & Hemming in 1838; and works on the system were established in Cheshire and some localities on the Continent, where it attracted great attention. Numerous patents, both English and Continental, followed, and many experimental works were erected, which all failed to sustain themselves in competition with the Le Blanc works. The principal difficulties to be overcome were imperfect conversion of the salt, and more especially the loss of ammonia; and it was not till 1861 that real economical success in the ammonia recovery apparatus was attained by Ernest Solvay of Couillet near Charleroi, Belgium. Works on the Solvay principle were established at Couillet in 1863; and since that date by the inventor and others, among whom ought to be mentioned Ludwig Mond, the process has been so perfected that its general adoption now appears to be only a matter of time. Already on the Continent it has practically displaced the Le Blanc process, but in the United Kingdom there is as yet only one establishment manufacturing ammonia soda.

The first essential stage in Solvay's process consists in saturating the brine with ammonia. The brine, treated with milk of lime and ammonium carbonate to precipitate magnesium and calcium salts, and of proper density, is placed in two cylindrical close iron tanks, which communicate by pipes at top and bottom with the ammonia dissolver placed between them. The ammonia dissolver is a cylindrical vessel having the same height as the tanks and provided with a perforated false bottom, down to which a tube is led through the centre of the vessel, and by this tube the ammonia gas is introduced. Coiled within the cylinder is a worm pipe, through which cold water circulates. Each brine tank is put alternately in connection with the dissolver. Circulation from the brine tank into the dissolver is kept up by mechanical agitation. As the ammonia becomes absorbed by the brine the temperature of the liquid rises rapidly, and the cold water circulating within the coiled pipe keeps the temperature down. As soon as sufficient ammonia has been passed into the brine the stirrers in the brine tank are stopped; the sludge of lime and magnesia precipitate is drawn off as it settles at the bottom of the brine tank, or when such precipitate is abundant it is settled and withdrawn in a special decanting tank. The decanted liquor is filtered through fine cloth by pressure, and the filtrate is cooled down in a refrigerating apparatus previous to the next operation.

Treating the Ammoniacal Brine with Carbonic Acid.—For this purpose a cylindrical tower is employed, divided internally into a series of superimposed segments by diaphragms consisting of perforated dome-shaped plates. The tower is about 40 to 50 feet in height and is kept nearly full of liquid, which is introduced by a pipe half way up its side. Carbonic acid under a pressure 1.5 to 2 atmospheres is forced in at the bottom of the tower and works its way gradually upwards through the perforations in the diaphragms, thus coming into intimate contact with the ammoniacal brine. Every half hour a part of the pasty mixture of bicarbonate of soda and ammonium chloride solution is drawn off and replaced by fresh liquor. The solid bicarbonate is separated out either by centrifugal action or by a vacuum filter; as thus obtained it is still contaminated with ammonia, of which it smells. To free the bicarbonate from this impurity water is squirted over it till the smell almost entirely disappears.

Conversion into Soda Ash of the bicarbonate is essential, because there is a comparatively limited demand for bicarbonate, and that salt, moreover, obstinately retains an ammoniacal odor, which lessens its value. The preparation of soda ash is attended with considerable practical difficulties, owing to the necessity of retaining the contained ammonia. The bicarbonate is first exposed to a comparatively low heat in a closed roaster, after which it is finished in a muffle furnace at a bright red heat. The gases given off are drawn by an air-pump into a washing apparatus, where the ammonia is retained, and the carbonic acid, which passes on, is conducted to the absorption tower for again impregnating the ammoniacal brine. By this process the whole of the chlorine of common salt comes away as waste in the form of chloride of calcium. To obtain that body in combination as hydrochloric acid, Solvay proposed in his patent of 1872 to employ magnesia in place of lime in the decomposition of the sal-ammoniac, the solution of chloride of magnesium remaining after the distillation is boiled to dryness, and being by the action of steam separated into magnesia and hydrochloric acid,—$MgCl_2 + H_2O = MgO + 2HCl$. The magnesia theoretically works in a circle, being changed into chloride on the liberation of the ammonia from the sal-ammoniac, and recovered again as magnesia with the formation of hydrochloric acid, as above indicated. But the expense of the process has hitherto been greater than the value of the product obtained, and the one weak point of the Solvay process is the loss of the hydrochloric acid, which forms an important element in the Le Blanc cycle. The loss of ammonia calculated as sulphate in the early days of the Solvay process was as much as 9 per cent. on the carbonate of soda produced; but by successive improvements it has been reduced to not more than 5 per cent. The Solvay plant is very expensive, amounting, according to his own estimate, to £1600 [$7778] per ton of soda ash produced daily; but other authorities put the capital expenditure as high as £2400 [$11,664] per ton worked daily.

Cryolite Soda.—Of the many processes other than those above mentioned, which have been proposed for soda-making, the only one practically employed is that in which cryolite forms the raw material. Cryolite, a fluoride of aluminium and sodium, $AlF_3 + 3NaF$, is a mineral substance found in extensive deposits at Ivikat (Ivigtut) (61° 34′ N. lat.) in southwest Greenland. For soda-making the mineral is treated by a process discovered in 1850 by Professor Julius Thomsen of Copenhagen. It is ignited with chalk or limestone, whereby carbonic acid is driven off and fluoride of calcium and aluminate of soda are formed—$2(AlF_3 + 3NaF) + 6CaCO_3 = 6CaF_2 + 3Na_2O, Al_2O_3 + 6CO_2$. The aluminate of soda is separated from the artificial fluoride of calcium by lixiviation, and the solution so obtained is decomposed by treatment with carbonic acid, which produces a precipitate of alumina available for alum-making, etc., leaving a solution of carbonate of soda. About 8000 tons of cryolite are annually treated in Pennsylvania and in Denmark.

Statistics of Soda Trade.—No means exist for obtaining an accurate statement of the extent of the soda trade; and such estimates as are published can only be accepted as approximations based on knowledge of the productive capacity of existing works and the general course of trade. Speaking at the Society of Chemical Industry (London section) in January, 1883, the late Walter Weldon gave the following estimate (in tons) of the soda production of the world at that date

	Le Blanc Soda.	Ammonia Soda.	Total.
Great Britain............	380,000	52,000	432,000
France........................	70,000	57,125	127,125
Germany	56,500	44,000	100,500
Austria	39,000	1,000	40,000
Belgium.....................	...	8,000	8,000
United States............	...	1,100	1,100
	545,500	163,225	708,725

In these figures the whole of the products made—soda ash crystals, bicarbonate, caustic soda, etc.—are calculated in terms of pure carbonate, $NaCO_3$. Assuming the fairness of the calculation, we are warranted in stating the present (1887) production of alkali, as pure carbonate, to be not less than three quarters of a million of tons annually.

(W. D.—J. PA.)

SODOM AND GOMORRAH. See DEAD SEA, vol. vii. pp. 4-5; comp. PHŒNICIA, vol. xviii. p. 816, and LOT.

SODOMA, IL, or, more properly, **SODONA** (*c.* 1479-1549), Italian painter. GIANNANTONIO BAZZI (who until recent years was erroneously named RAZZI) appears to have borne also the name of "Sodona" as a family name; it is signed upon some of his pictures. While "Bazzi" was corrupted into "Razzi," "Sodona" was corrupted into "Sodoma"; and Vasari, followed by other writers on art, accounts for the latter name by giving various and explicit details which we leave undiscussed, for, if the painter did not really pass by the appellation of "Sodoma," we may fairly infer that explanations which would have been germane to that appellation are not germane to the man himself. Bazzi was born at Vercelli in Piedmont towards 1479, and appears to have been in his native place a scholar of the painter Giovenone. Acquiring thus the strong coloring and other distinctive marks of the Lombard school, he was brought to Siena towards the close of the 15th century by some agents of the Spannocchi family; and, as the bulk of his professional life was passed in this Tuscan city, he counts as a member of the Sienese school, although not strictly affined to it in point of style. He does not seem to have been a steady or laborious student in Siena, apart from some attention which he bestowed upon the sculptures of Jacopo della Quercia. Along with Pinturicchio, he was one of the first to establish there the matured style of the *Cinquecento*. His earliest works of repute are seventeen frescos in the Benedictine monastery of Monte Oliveto, on the road from Siena to Rome, illustrating the life of St. Benedict, in continuation of the series which Luca Signorelli had begun in 1498; Bazzi completed the set in 1502. Hence he was invited to Rome by the celebrated Sienese merchant Agostino Chigi, and was employed by Pope Julius II. in the Camera della Segnatura in the Vatican. He executed two great compositions and various ornaments and grotesques. The latter are still extant; but the larger works did not satisfy the pope, who engaged Raphael to substitute his Justice, Poetry, and Theology. In the Chigi palace (now Farnesina) Sodona painted some subjects from the life of Alexander the Great; Alexander in the Tent of Darius and the Nuptials of the Conqueror with Roxana are more particularly noticed. When Leo. X. was made pope (1513) Bazzi presented him with a picture of the Death of Lucretia (or of Cleopatra, according to some accounts); Leo gave him a large sum of money in recompense and created him a cavaliere. Bazzi afterwards returned to Siena, and at a later date went in quest of work to Pisa, Volterra, and Lucca. From Lucca he returned to Siena, not long before his death, which took place on 14th February, 1549 (the older narratives say 1554). He had squandered his property and died in penury in the great hospital of Siena. Bazzi had married in youth a lady of good position, but the spouses disagreed and separated pretty soon afterwards. A daughter of theirs married Bartolommeo Neroni, named also Riccio Sanese or Maestro Riccio, one of Bazzi's principal pupils.

It is said that Bazzi jeered at the *History of the Painters* written by Vasari, and that Vasari consequently traduced him; certainly he gives a bad account of Bazzi's morals and demeanor, and is niggardly towards the merits of his art. According to Vasari, the ordinary name by which Sodona was known was "Il Mattaccio" (the Madcap, the Maniac),—this epithet being first bestowed upon him by the monks of Monte Oliveto. He dressed gaudily, like a mountebank; his house was a perfect Noah's ark, owing to the strange miscellany of animals which he kept there. He was a cracker of jokes and fond of music, and sang some poems composed by himself on indecorous subjects. In his art Vasari alleges that Bazzi was always negligent,—his early success in Siena, where he painted many portraits, being partly due to want of competition. As he advanced in age he became too lazy to make any cartoons for his frescos, but daubed them straight off upon the wall. Vasari admits, nevertheless, that Bazzi produced at intervals some works of very fine quality, and during his lifetime his reputation stood high.

The general verdict is that Sodona was an able master in expression, motion, and color. His taste was something like that of Da Vinci, especially in the figures of women, which have grace, sweetness, and uncommon earnestness. He is not eminent for drawing, grouping, or general elegance of form. His easel pictures are rare. His most celebrated works are in Siena. In S. Domenico, in the chapel of St. Catherine of Siena, are two frescos painted in 1526, showing Catherine in ecstasy and fainting as she is about to receive the Eucharist from an angel,—a beautiful and pathetic treatment. In the oratory of S. Bernardino, scenes from the history of the Madonna, painted by Bazzi in conjunction with Pacchia and Beccafumi (1536 to 1538)—the Visitation and the Assumption—are noticeable. In S. Francesco are the Deposition from the Cross (1513) and Christ Scourged; by many critics one or other of these paintings is regarded as Bazzi's masterpiece. In the choir of the cathedral at Pisa is the Sacrifice of Abraham, and in the gallery of Florence a St. Sebastian.

SOEST, an ancient industrial town in **Westphalia**, Prussia, is situated in a fertile plain (*Soester Börde*), 27 miles to the east of Dortmund and 34 to the southeast of Münster. Its early importance is borne witness to by its six fine churches, of which the most striking are St. Peter's, St. Mary-in-the-Fields, founded in 1314 and restored in 1850–52, and the Roman Catholic cathedral, founded in the 10th century by Bruno, brother of Otho the Great, though the present building was erected in the 12th century. This last, with its very original façade, is one of the noblest ecclesiastical monuments of Germany. Remains of the broad wall (now partly inclosing gardens and fields) and one of the gates still remain; but the thirty-six strong towers which once defended the town have disappeared and the moats have been converted into promenades. Iron-working, the manufacture of soap, hats, cigars, and bricks and tiles, linen-weaving, tanning, and brewing, together with market-gardening and farming in the neighborhood, and trade in cattle and grain, are the leading industries. The population in 1880 was 13,985, and in 1885 14,848, of whom about 6000 were Roman Catholics.

Mentioned in documents as early as the 9th century, Soest was one of the largest and most important Hanseatic towns in the Middle Ages, with a population estimated at from 30,000 to 60,000. It was one of the chief emporiums on the early trading route between Westphalia and Lower Saxony. Its code of municipal laws (*Schran; jus susatense*), dating from 1144 to 1165, was one of the earliest and best, and served as a model even to Lübeck. On the fall of Henry the Lion, duke of Saxony, Soest passed with the rest of Angria to Cologne. In the 15th century the strife between the townsmen and the archbishops broke out in open war, and in 1444 the strong fortifications of the town withstood a long siege by an army of 60,000 men. The women of Soest are said to have distinguished themselves in this contest (*Soester Fehde*). Papal intervention ended the strife and Soest was permitted to remain under the protection of the dukes of Cleves. The prosperity of the town waned in more modern times: in 1763 its population was only 3800; in 1816 it was 6687.

SOFÁLA, a seaport town on the east coast of Africa, at the mouth of a river of the same name to the south of 20° S. lat., the seat of a Portuguese commandant. It is now a wretched place of about 1000 inhabitants, with not more than twenty European residents, and, as its port is obstructed with sandbanks, there is only a small coasting trade with Chiluan and Inhambane. But Sofála was formerly a town of considerable importance, with a harbor capable of holding a hundred large vessels. Previous to its conquest by the Portuguese in 1505, it was the chief and populous centre of a wealthy Mohammedan state; and the first governors of the Portuguese East African possessions were entitled captains-general of Sofála. The identification of Sofála with Solomon's Ophir, to which Milton alludes (*Par. Lost*, xi. 399–401), is untenable.

See *Bull. Geogr. Soc. Mozambique* (1882) for an account of the Sofála mines; and, generally, Edrísí, *Climate* i., 8th section; Dapper; Baines, *The Gold Regions of South Africa* (1877); and Burton's notes to his edition of Camoens.

SOFIA, since 1878 the capital of Bulgaria, though previously only a district town of the Tuna (Danube) vilayet of Turkey, is situated 1755 feet above the sea, in the midst of a dreary plain between the Stara Planina or main range of the Western Balkans and the bare but imposing granite mass of the Vitosh Mountains (3400 feet). It stands at the meeting of five great routes from Nish and Belgrade, Lom and Vidin, Plevna and Rustchuk, Philippopolis and Constantinople, and Köstendil and Salonica. At present (1887) it is two days' journey from the nearest railway station (Tatar-bazarjik), and as the seat of government is inconveniently near the southwest extremity of the kingdom; but it lies on the prospective great railway route between Constantinople and Belgrade, and was in the eyes of those who selected it the prospective capital of a much more extensive territory. The climate of Sofia is subject to severe seasonal and diurnal changes; in January the thermometer sinks 4° below zero and in August approaches 100°, and the daily range is frequently 27 or 28 degrees. Minarets and gardens give a certain beauty to the aspect of the town itself, but the outskirts are painfully destitute of foliage. In an eastern suburb stands the royal palace, a vast building which cost more than 4,000,000 francs [$772,000]; and in that neighborhood, on the site of an abandoned Turkish quarter, quite a new "European" town has sprung up. The rest of Sofia retains its Turkish character, with tortuous streets and mean wooden houses. The modern cathedral and the archbishop's palace are both large edifices of no special note. Of the many mosques the most striking is the Buyuk-Jami, with its nine metal cupolas; but more historical interest attaches to the Sophia mosque, occupying the highest point in the town to which it gave its name. It is now completely in ruins (the result of an earthquake), but tradition, which in this case is confirmed by the architecture of the building, asserts that it was a Christian church erected by a certain Byzantine princess Sophia. Kanitz in 1871 still observed remains of old Byzantine frescos in the narthex. The public baths occupy a very extensive building, with separate suites of apartments for different nationalities or rather religions. The water as it issues from the springs has a temperature of 117°. Sofia exports hides and skins to Vienna, etc., and especially goat-skins to Marseilles; its principal imports are Indian corn, wheat, and alcoholic liquors—the last a very large item. Formerly the population was 50,000. In 1870 Kanitz found 19,000—a liberal estimate—8000 being Bulgarians, 5000 Turks, 5000 Jews (a colony dating from the expulsion from Spain), 900 Gypsies. At present (1887) the total is 20,000. Close to the north of the town are extensive remains of strong Roman fortifications.

Sofia is the *Serdica* or *Sardica* of the Romans and Greeks (so called after the Serds or Sards), the *Triaditza* of the Byzantine writers, and the *Sredec* of the Slavs. "Sardica is my Rome," said Constantine before he thought of his new capital on the Bosphorus. It had already been made the capital of Dacia Ripensis by Aurelian, and about 343 it became famous as the seat of a church council. The town was plundered by Attila; and in 809 it was captured by the Bulgarians, who held it until the Turks got possession of it by stratagem in 1378, or more probably 1382. In 1443 Sofia was for a brief period occupied by the Hungarian John Hunyady (Corvinus), and on the defeat of his enterprise was laid waste by the retreating army. In 1829 it was the headquarters of Mustapha Pasha of Scutari, whose ravages have made the name of Albanian a word of terror to the children in Sofia even now. The Russians entered Sofia on 4th January, 1878, after Gourko's passage of the Balkans.

See Kanitz, *Donau Bulgarien*, 1877; Laveleye, *La Péninsule des Balkans*, 1886.

SOGDIANA, or **SOGDIANE**, in old Persian *Sughuda*, a province of the Achæmenian empire, the eighteenth in the list in the Behistun inscription of Darius (i. 16), corresponded to the modern districts of Samarkand and Bokhara; that is, it lay north of Bactriana between the Oxus and the Jaxartes and embraced the fertile valley of the Polytimetus or Zarafshan. Under the Greeks Sogdiana was united in one satrapy with Bactria, and subsequently it formed part of the Bactrian Greek kingdom till the "Scythians" (the Yue-chi) occupied it in the middle of the 2d century B.C. (comp. vol. xviii. pp. 594 *sq.*, 604 *sq.*). The valley of the Zarafshan about Samarkand retained even in the Middle Ages the name of the Soghd of Samarkand. Arabic geographers reckon it as one of the four fairest spots in the world.

ṢOḤÁR, the second port of 'Omán, Arabia, situated on the Gulf of 'Omán in 24° 22′ N. lat. and 56° 45′ E. long. It is a place of considerable trade and industry, well built, fortified with walls and a castle, and inhabited by a hospitable and far from bigoted population of the 'Ibádí sect. The anchorage is good, sheltered between two promontories, and the surrounding country is populous and fertile. Indeed the coast-land of ‘Omán is naturally the most favored part of Arabia.

The town of Ṣoḥár is older than Islam, and its cloths are mentioned in the life of Mohammed (Ibn Hisham, p. 1019). Before the Moslem conquest it was in the hands of the Persians, and the Persian name Mazūn is not uncommonly applied to it by older Arabic writers. Under Islam it became the capital of ‘Omán, and it is sometimes called ‘Omán, from which fact it has sometimes, but very precariously, been identified with the Omana of classical writers. In the earlier Middle Ages Ṣoḥár was one of the first commercial cities of Islam on the Indian Ocean and had an active part in the China trade. This prosperity was unabated when Moḳaddasí wrote of it (p. 92) towards the close of the 10th century; in the 12th century, when Edrísí wrote, the China trade was a thing of the past; and about 1230 Ibn Mojáwir describes it as a ruin inhabited by the demons of the desert. Its decay appears to be connected with the rise of other ports—Ḳalhát on the Arabian and Ormuz on the Persian side of the Persian Gulf—but more especially with the political convulsions of ‘Omán. This district, which has always had an isolated position in Eastern history, early became a stronghold of the Khawárij (‘Ibáḍíya) and paid very intermittent obedience to the caliphs till it was reduced by Mo‘taḍid about the year 900. Even after this conquest the native imáms held their ground in the mountainous inland country at Nazwa (Iṣṭakhrí, p. 26), and renewed the struggle for independence with the Buwaihīd and Seljúḳ sovereigns of Fars, who succeeded in these regions to the power of the caliphate. Ibn Mojáwir connects the destruction of Ṣoḥár with these struggles, and, though he seems to imply a later date, it is possible that his statement is to be combined with what Ibn al-Athír (ix. 387) tells of the rising of Al-Ráshid billáh about 1050. After this event there is a period of obscurity in the annals of ‘Omán; the independence of the country was ultimately secured under the native (Azdite) princes of Nazwa, but Ṣoḥár never recovered its importance. It is mentioned, however, by Marco Polo, under the name of Soer, as trading in horses with Malabar, and also by Ibn Baṭúṭa, and must therefore have been resettled soon after the time of Ibn Mojáwir. Ṣoḥár was seized by the Portuguese in 1508 and held by them till about 1650. In the 18th century Niebuhr speaks of it as a quite unimportant place; Wellsted, in 1836, assigned to it a population of 9000; Palgrave in 1863 estimated the population at 24,000, an estimate the more remarkable that in the interval the town had suffered severely from the Wahhábís. The *Red Sea Pilot* (1883) gives the more probable figure of 4000 to 5000.

SOISSONS, a city of France, in the department of Aisne, the seat of a bishopric and a fortified post on the left bank of the Aisne at the junction of the Crise, lies 65 miles northeast of Paris by the railway to Laon. The population in 1881 was 10,895 (11,112 in the commune). The cathedral of Notre Dame St. Gervais and St. Protais, begun in the second half of the 12th century and finished about the end of the 13th, is 328 feet long and 87 wide; the vaulting of the nave is 100 feet above the pavement. The single tower dates from the middle of the 13th century, and is a fairly good imitation of those of Notre Dame of Paris, which it equals in height (216 feet). The transepts are of different dates and dissimilar in their arrangement. In the north transept there is a very fine door on the east; the south transept is the oldest and most graceful portion of the whole edifice. The choir is surrounded with eight square chapels, and the apse with five large polygonal chapels, of which the three in the middle (as well as the high windows of the choir) still retain their fine 13th-century glass. The rose window of the north transept represents the life of the Virgin in twelve medallions. The high altar is flanked by two marble figures representing the annunciation, and above it is an Adoration of the Shepherds ascribed to Rubens. The cathedral also has some rich 16th-century tapestries. Considerable remains still exist of the magnificent abbey of St. Jean des Vignes, where Thomas á Becket resided from 1161 to 1170,[1] and which was rebuilt in the 13th century; these include the ruins of two cloisters (the smaller dating from the Renaissance), the refectory, and above all the cathedral-like façade of the church (recently restored). Of the three portals with twisted columns, the central one is adorned with statues; above them runs a gallery over which again is a large window; the two unequal towers (230 and 246 feet) of the 15th and 16th centuries, are surmounted by beautiful stone spires, which command the town. The ruins of this fine building are unfortunately occupied by the military authorities. The church of St. Léger, erected in 1139 and rebuilt at the beginning of the 13th century, was formerly attached to an abbey of the Génovéfains. Beneath are two crypts of the 12th and 13th centuries. Of the abbey church of St. Pierre, built in the 12th century in the Romanesque style, the only remains are the façade and two bays of the choir. The royal abbey of Notre Dame was founded in 660 for monks and nuns by Leutrade, wife of Ebroin, the celebrated mayor of the palace. The number of the nuns (216 in 858), the wealth of the library in manuscripts, the valuable relics, the high birth of the abbesses, the popularity of the pilgrimages, all contributed to the importance of this abbey, of which there exist only some inconsiderable remains. The wealthiest of all the abbeys in Soissons, and one of the most important of all France during the first two dynasties, was that of St. Médard, on the right bank of the Aisne, founded in 560 by Lothaire I., beside the villa of Syagrius, which had become the palace of the Frankish kings. St. Médard, apostle of Vermandois, and kings Lothaire and Sigebert were buried in the monastery, which became the residence of 400 monks, and the meeting-place of several councils. It was there that Childeric III., the last Merovingian, was deposed and Pippin the Short was crowned by the Papal legate; and there Louis the Pious was kept in captivity in 833. The abbots of St. Médard coined money, and in Abelard's time (12th century) were lords of 220 villages, farms, and manors. At the battle of Bouvines (1214) the abbot commanded 150 vassals. In 1530 St. Médard was visited by a procession of 300,000 pilgrims. But the religious wars ruined the abbey, and, although it was restored by the Benedictines in 1637, it never recovered its former splendor. Of the seven churches and the conventual buildings of the ancient foundations there hardly remains a trace. The site is occupied by a deaf and dumb institution, the chapel of which stands over the crypt of the great abbey church, which was altered in the 12th century. In the crypt is a stone coffin, said to have been Lothaire's, and close at hand is an underground chamber, reputed to have been the place of captivity of Louis the Pious. The civil buildings of Soissons are not of much interest. The hôtel de ville contains a museum with scientific and archæological collections; the hôtel dieu goes back to the 13th century; the library contains 40,000 volumes and curious manuscripts. Among the industrial establishments are tanneries, saw-mills, and foundries and factories for the production of stoves, agricultural implements, candles, and chocolate. Grain, flour, haricot beans of exceptional quality, pease, wool, hemp, flax, cattle, timber, and charcoal, are the principal articles of trade. There is also a large bottle factory, and work is done for the flannel and blanket factories of Rheims.

Soissons is generally believed to occupy the site of the oppidum of Gallia Belgica, called *Noviodunum* by Cæsar; but some writers identify this place with Noyon, Noyant, or Nouvion. One thing is clear, that this oppidum was the capital of the Suessiones, who occupied twelve towns, and whose king, Divitiacus, one of the most powerful in Gaul, had extended his authority even beyond the sea among the Britons. In 58 B.C., Galba, king of the Suessiones, separated from the confederation of the Belgians and submitted to the Romans. At the beginning of the empire Noviodunum took the name of *Augusta Suessionum* and afterwards that of *Suessiona*, and became the second capital of Gallia Belgica, of which Rheims was the metropolis. The town was before long surrounded with a regular wall and defended by a citadel; and it became the starting-point of several military roads (to Rheims, Château-Thierry, Meaux, Paris, Amiens, and St. Quentin). Christianity was introduced by St. Crispin and St. Crispinian, men of noble birth, who, however, earned their livelihood by shoemaking, and thus became patrons of that craft. After their martyrdom in 297, their work was continued by St. Sinitius, the first bishop of Soissons. After the barbarians had crossed the Rhine and the Meuse, Soissons became the metropolis of the Roman possessions in the north of Gaul, and on the defeat of Syagrius by Clovis, the Franks seized the town. It was at Soissons that Clovis married Clotilde, and, though he afterwards settled at Paris, Soissons was the capital of his eldest son, Lothaire, and afterwards of Chilperic I., king of Neustria. It was not till the time of Chilperic's son, Lothaire II., that the kingdom of Soissons was incorporated with that of Paris. In 752, Pippin the Short was at Soissons proclaimed king by an assembly of *leudes* and bishops, and he was there crowned by the papal legate, St. Boniface, before being crowned at St. Denis by the pope himself. Louis the Pious did penance there after being deposed by the assembly at Compiègne. Under Charles the Fat (886) the Normans failed in an attempt against the town, but laid waste St. Médard and the neighborhood. In 923, Charles the Simple was defeated outside the walls by the supporters of Rudolph of Burgundy, and Hugh the Great besieged and partly burned the town in 948. Under the first Capets Soissons was held by hereditary counts, frequently at war with the king or the citizens. Thus the latter bought in 1131 a communal charter from Louis VI. and their bishop. In 1155, at an assembly of prelates and barons held at Soissons, Louis VII. issued a famous decree forbidding all private wars for a space of ten years; and in 1325 Charles the Fair replaced the mayor of Soissons by a royal provost dependent on the bailiwick of Vermandois, the inhabitants retaining only the right of electing four *échevins*. Louis of Châtillon, count of Soissons, was killed at Crécy, and his son, a hostage for King John in England, sold his countship to Enguerrand de Coucy to obtain money for his ransom in 1367. Finally, the last count of Soissons, sprung from a branch of the house of Bourbon, rebelled against Louis XIII., and defeated the royal troops at La Marfée in 1641, but perished in the battle. The town had to suffer severely during the war of the Hundred Years; in 1414, when it was held by the Burgundians, it was captured and sacked by the Armagnacs under the dauphin, and this same fate again befel it six times within twenty years. The treaty of Arras (1435) brought it again under the royal authority. It was sacked by Charles V. in 1544, and in 1565 by the Huguenots, who laid the churches in ruins and, supported by the prince of Condé, Count of Soissons, kept possession of the town for six months. During the League, Soissons eagerly joined the Catholic party. Mayenne made the town his principal residence, and he died there in 1611. A European congress was held there in 1728. In 1814 Soissons was captured and recaptured by the allies and the French. In 1815, after Waterloo, it was a rallying point for the vanquished, and it was not occupied by the Russians till the 14th of August. In 1870 it capitulated to the Germans after a bombardment of three days.

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[1] [Á Becket was consecrated in 1162, fled to France in 1164, and, with the exception of a short stay in Soissons, found a refuge chiefly at Pontigny, a famous retreat for English prelates, and at Sens. See Froude's *Life and Times of Thomas Becket*, N. Y., 1833.—AM. ED.]

SOKOTO, an important Fulah kingdom or empire in Central Soudan, comprising what are frequently called the Haussa states. Its boundaries (see vol. i. pl. II.) are irregularly marked off by the plateau lands of Air or Asben on the north, the kindred Fulah state of Gandu on the west, while the river Binué practically forms its southern limit as far as the meridian of 10° E.; beyond this it runs south into the Congo basin. On the east lies the kingdom of Bornu. From northwest to southeast Sokoto has a length little short of 900 English miles and its average breadth is about 280. The whole area has been roughly computed to be equal to that of Spain (about 195,000 square miles), and to have a population of from ten to twelve millions. The country may be described as a great undulating plain, rarely exceeding 1000 feet in height, with the exception of the province of Bauchi in the centre, which runs into a highland region with heights of 3000 feet, and the still more imposing masses of Adamawa in the south, which are said to attain an altitude of 10,000 feet in Mount Alantika. In other respects Sokoto presents more varied features, chiefly determined by the amount of rainfall, though the varying fertility of the soil is a not unimportant factor. In the southern parts, where there are almost perpetual rains, large streams and rivers are numerous,—the feeders of the Binué, the great eastern (left-hand) tributary of the Niger. Here grow the virgin forests with giant growths and exuberant foliage, with creepers, with bananas and plantains, palm-oil trees and yams. In the more temperate—because more elevated—districts of the middle area, with a smaller rainfall, the vegetation is less luxuriant, and such fruits as the date, lime, and pomegranate are cultivated. In the northern parts the climate is still more arid, and the country is burned up for the greater part of the year. This is the region of acacias and mimosas, of baobabs, of the branching dúm palm and the curiously bulged deléb. Here are no forests nor rank grass, while the exigencies of a dense population have caused the clearing away of the bush except on the most barren spots, where it supplies the necessary fuel for domestic purposes. In this northern district there are no streams except in the wet season, and the wants of the people are supplied by fountains in the more favored places, and by wells—frequently very deep—in those not so advantageously situated. Lying within the tropics, Sokoto is subject to excessive heat,—damp and steamy in the south, dry and furnace-like in the north, where it suffers from the hot winds from the Sahara. In Adamawa the rainy season—or, to be more correct, the season of excessive rains—commences in April and lasts till October or later, while in Gober in the north the rains commence in June and seldom last more than three months, during which the country becomes transformed from a repellent desert into a well-cultivated nursery garden.

For Central Africa Sokoto may be described as fairly healthy, though, as may be expected from a conjunction of excessive heat with excessive rain, fevers are not uncommon in the southern parts, while ophthalmia is prevalent in the north, especially among the poorer classes, who are compelled to expose themselves to the blinding dust from the deserts and the excessive glare of the sun reflected from the burning sands.

The natural productions of Sokoto are such as are more or less common throughout the whole of the SOUDAN (*q.v.*). Among cereals rice and wheat are cultivated in many parts, though the staple productions are Kaffre corn, millet, and maize. Sweet potatoes, ground nuts, yams, onions, and other vegetables are largely grown. Of fruits dates, pomegranates, citrons, and bananas abound in more restricted areas. The Shea butter tree supplies an excellent oil for lamps, and also for cooking, though it is only used by the poorer classes. The palm-oil tree is only found in the damp basin of the Binué. The most important vegetable products are cotton and indigo, which are universally grown. The cotton is manufactured into cloth, being used by the native population as well as largely exported to neighboring countries. In some parts a species of silk found in the forests is largely used, and the people of Yakoba in Bauchi are said to rear the silkworm. Of mineral products there seem to be few, though it is known that both silver and lead occur in the Binué area. Iron is extensively diffused and of excellent quality.

The inhabitants of this extensive region, held together by a conquering race and not by any natural tie into one common kingdom, are of diverse tribes and affinities. They, however, may be roughly divided into three groups. (1) First come the pure Negro races of Adamawa, of which the chief tribe is the Batta. (2) The Haussa form the mass of the population except in Adamawa. They are preeminent among Negroes for their physical appearance and intellectual abilities. They are wonderfully skilled in various arts and industries and noted for their commercial genius and enterprise. Mohammedanism is their religion, and indeed in all respects they are well advanced on the road to civilization. They are very fond of voluminous clothes. (3) The Fulahs are a Hamitic race, who from being simple herdsmen in the beginning of the 19th century have become the rulers and masters over a hundred alien races between the Atlantic and Lake Tchad. They have not the commercial or industrial skill of the Haussa, but in other respects have reached a higher level. They are of slender build and are distinguished by their light coppery color. The inhabitants of Sokoto live mostly in large towns, many of which contain from 10,000 to 20,000 inhabitants. These towns are all protected by strong mud walls and outer dry moats. Their interior is divided into a series of compounds, each entered through a flat-roofed audience chamber. Inside are the beehive-shaped huts of the household. The gateways are also strongly fortified. The ruler over Sokoto is a Fulah sultan, whose power is absolute, though tempered by a species of feudal system. The governors of some of the larger provinces, though owning allegiance to the sovereign, are mostly hereditary, and beyond sending a yearly tribute are practically independent. The tie indeed is more religious than anything else. The great weakness of the empire is its want of coherence and the absence of a strong central Government. Yet, though always appearing to be on the point of falling to pieces, it contrives to keep together. The condition in which Barth found it in 1855 was practically the same as when the present writer visited it in 1885.

The chief provinces of Sokoto are Zamphoro, Zaria, Katsena, Bauchi, Kano, and Adamawa. The most important towns are: Sokoto, the acknowledged capital of the empire, famed chiefly for its leather-work and straw hats (it divides with Wurnu the distinction of being the residence of the sultan; Clapperton died here in 1827); Wurnu, about 18 miles farther east, the present (1887) headquarters of the court; Kano, the great commercial emporium of Central Soudan; and Yakoba, chiefly noted for its large size,—said to contain 150,000 inhabitants.

The history of Sokoto may be said to have commenced with the 19th century. Previous to that date little is known further than that the country was divided among a number of small chiefs, a prey to the powerful kings of Bornu, Kebbi, and Songhwai (Songhai). In 1802 the Fulahs, then little regarded and semi-serfs in position, were scattered all over the country, apparently without any national tie to unite them to common action. At last, however, an imâm—one Othman dan Fodio—appeared, who with the watchword of Islam gave a new life to his tribesmen and in an incredibly short time transformed them from peaceable nomads into soldiers of the Crescent, and after a few initial reverses swept like a whirlwind over an enormous area, establishing himself as ruler and Mohammedanism as the religion of the whole of Central Soudan. At his death the parts now known as Sokoto fell to the share of his son Bello, and in the family of Othman the reins of government have since remained, though the descent is not as a rule from father to son, but either to a brother or a brother's son. The latest phase in the history is the proclaiming of a protectorate over a part of Sokoto on the Binué by the British Government, and the handing over of the administration of the Niger region to the Royal Niger Company. To this company the sultan has conceded all his rights on the Binué and a monopoly of trade throughout his dominions, thus making them practically masters of all foreign intercourse.[1]

The most important sources of information regarding Sokoto are: Clapperton's *Journeys* in the early part of the 19th century; Barth's *Travels in Central Africa* between 1849 and 1855—a perfect mine of information; and Rohlfs's *Reise durch Nordafrika vom Mittelmeer nach dem Tschad-See* in 1866-67. Among later and minor travellers have been Flegel, who visited Sokoto in 1880, and Thomson, who conducted a commercial and political mission to the court of the sultan in 1885. (J. TH.)

SOLAN GOOSE. See GANNET.

SOLARIO, ANTONIO (*c.* 1382–1455), a painter of leading importance in the Neapolitan school, is commonly called Lo Zingaro, or The Gypsy. His father is said to have been a travelling smith. To all appearance Antonio was born at Civita in the Abruzzi, although it is true that one of his pictures is signed "Antonio de Solario Venetus," which may possibly be accounted for on the ground that the signature is not genuine. Solario is said to have gone through a love-adventure similar to that of the Flemish painter, Quintin Massys. He was at first a smith, and did a job of work in the house of the prime Neapolitan painter Colantonio del Fiore; he fell in love with Colantonio's daughter, and she with him; and the father, to stave him off, said if he would come back in ten years an accomplished painter the young lady should be his. Solario studied the art, returned in nine years, and claimed and obtained his bride. The fact is that Colantonio del Fiore is one of those painters who never existed; consequently his daughter never existed, and the whole story, as relating to these particular personages, must be untrue. Whether it has any truth, in relation to some unidentified painter and his daughter is a separate question which we cannot decide. Solario made an extensive round of study,—first with Lippo Dalmasio in Bologna, and afterwards in Venice, Ferrara, Florence, and Rome. On returning to Naples he rapidly took the first place in his art. His principal performance is in the court of the monastery of S. Severino—twenty large frescos illustrating the life of St. Benedict, now greatly decayed; they present a vast variety of figures and details, with dexterous modelling and coloring. Sometimes, however, Lo Zingaro's color is crude, and he generally shows weakness of draughtmanship in hands and feet. His tendency is that of a naturalist,—the heads life-like and individual, and the landscape backgrounds better invented and cared for than in any contemporary. In the Studj gallery of Naples are three pictures attributed to this master, the most remarkable one being a Madonna and Child Enthroned with Saints. The heads here are reputed to be mostly portraits. Solario initiated a mode of art new in Naples; and the works painted between his time and that of Tesauro are locally termed "Zingareschi." He had many scholars, but not of pre-eminent standing—Nicola Vito, Simone Papa, Angiolillo Roccadirame, Pietro and Ippolito dal Donzello. It has often been said that Solario painted in oil, but of this there is no evidence.

SOLDER is a metallic alloy or metal employed for cementing or binding together two metallic surfaces. The solder is applied to the surfaces to be united in a molten state, and it is therefore generally either a more fusible body than the metal to be acted on or it is presented in a more fusible condition. The process of autogenous soldering consists in uniting the individual metallic edges themselves by melting and fusing them in the heat of the oxyhydrogen blowpipe or by means of an ignited blast of mixed coal gas and air. Autogenous soldering is extensively used in connection with large plumber work. Ordinary solders are divided into hard and soft classes, the hard comprising such as require a red heat for their melting. The soft solders used by plumbers and tinsmiths consist of variable mixtures of lead and tin, and for pewterers' use bismuth is added to these. The hardest brazing solder has equal parts of copper and zinc, and for softer qualities increased amounts of zinc with tin and sometimes antimony are employed. For fine jewelry alloys of gold, silver, and copper are used; silver solder is employed for inferior qualities, and even common soft solder finds extensive employment in the jewelry trade. Silver is the proper solder for German silver manufactures also; and gold is the medium for joining the edges of platinum vessels. In soldering, the metallic edges to be united must be free from oxidation and dirt; and to keep them unoxidized during the operation several fluxes are used, such as borax in brass soldering, rosin and solution of zinc chloride for tin-plate, zinc chloride for zinc, rosin and tallow for lead and tin, and olive oil in pewter work. Special machinery has been devised for the soldering of the tinned cases now so extensively employed in the preserved food trade. In common soft soldering the solder is melted and applied to the joint by a heated iron or copper soldering bolt, but solders are also applied by being melted on in the open fire, or in the muffle furnace, by immersing the joint in a bath of molten solder, or by pouring the molten material on the joint. In dealing with hard solders the heat of the blowpipe flame is used.

SOLE. Soles are a group of Flat-Fishes (*Pleuronectidæ*), which is represented by numerous species in all suitable localities within the temperate and tropical zones; they become, however, scarce in the southern parts of the southern temperate zone, and are absent altogether in some districts—for instance, on the coasts of southern Australia. Many of the species enter fresh water freely, and some have become thoroughly acclimatized in it. Soles are a highly specialized type of flat-fish; their mouth is very narrow, twisted round to the blind side, and small teeth are developed on that side only. As they always lie or swim on one side, the pectoral fins have ceased to have a function, and consequently these organs are reduced in size, and in many of the species are mere rudiments or are lost entirely. The eyes are small, invariably on the right side of the fish, the upper occupying a position more or less in advance of the lower. Soles are littoral fishes inhabiting sandy bottoms, shifting with the season from shallow into somewhat deeper water. Like all flat-fishes they are carnivorous, but feed on small animals only; none attain to a large size, scarcely exceeding that of 2 feet. Of the forty species known of the genus *Solea*, four are found on the British coast; the one most generally known and commercially most important is the Common Sole (*Solea solea*); it seems to occur in greater or less abundance on all flat coasts of Europe, but its numbers have been considerably thinned within the last quarter of a century, at least on the British coasts, doubtless in consequence of the introduction of the trawl. At any rate, that over-fishing is the cause of the decrease of this valuable table fish is amply proved by the fact that simultaneously with the quantity the average weight of the fish has been diminished, soles of 12 inches in length and of 8 ounces in weight being now in many localities the largest that can be obtained. At present young specimens form the majority of the soles in the market, and are sold under the names of "slips" or "tongues." During the breeding-season, which falls in the months from February to April, soles lose much of their flavor. It is a singular fact that male soles seem to be almost unknown, and some ichthyologists account for it by supposing that the males remain much smaller than the females, and are overlooked in consequence. The Lemon Sole (*Solea aurantiaca*) is much less esteemed than the common sole, and more rarely seen in the market, probably because it is locally distributed in deeper water. It is of a yellow color, marbled with brown and irregularly spotted with black; the pectoral fin is ornamented with an ovate black spot on its hinder half. Even when this bright coloration has disappeared in the fish after death, it may always be distinguished from the common sole by its large dilated nasal opening on the blind side, which is surrounded by a broad fringe. The Variegated Sole (*Solea variegata*) is at times taken in considerable numbers on the south coast by means of the trawl, and esteemed as a table fish. It differs from the two preceding species by the rudimentary condition of the pectoral fins, that of the blind side being minute. The color is brown; darker bands cross the body, and are darkest on the dorsal and anal fins, where they appear as a row of about six large spots. It does not appear to grow to the same size as the common sole. The fourth British species, *Solea minuta*, is still smaller, not much exceeding 5 inches in length; it is therefore not of commercial importance, although it may be caught at times in the trawl in large numbers. As in the preceding species, the pectoral on the blind side is minute, but that of the right side is large enough to show a distinct black spot. The color of the body is brownish or grayish, with small black spots, and every sixth or seventh ray of the dorsal and anal fins is black.

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[1] [By Anglo-French treaty of 1890, Sokoto was placed under a British protectorate and assigned to the Niger Territory, governed by the Royal Niger Company.—AM. ED.]

Flat-fishes resembling soles abound on the shores of the Indian Ocean beside the true soles, but they have the eyes on the left side of the head and lack pectoral fins altogether. They have been referred, therefore, to distinct genera, such as *Plagusia* and *Cynoglossus*.

SOLEURE, or SOLOTHURN, is one of the cantons of Switzerland, ranking as tenth in the Confederation, and taking its name from its chief town. As it consists simply of the territories won by the city, its irregular shape is easily accounted for. It takes in most of the valley of the Aar between the towns of Soleure and Olten, but stretches across the eastern Jura to Dornach not far from Basel, while to the south it tends in the direction of Bern. The total area is 305.9 square miles, of which all but 25.4 square miles is classed as "productive," 103.3 square miles of this being covered by forests. In other words, 91.7 per cent. is fertile. The highest point in the canton is the Hasenmatte (4754 feet), in the range behind the town of Soleure, in which too is the Weissenstein (4213 feet), so well known as a great centre for the air and whey cure, as also for its fine view. In 1880 the population of the canton was 80,424 (an increase of 5754 on the census of 1870), the women outnumbering the men by 1704. Of these no fewer than 79,514 are German-speaking.

Soleure now includes 63,037 Roman Catholics to 17,114 Protestants, but in the ten years 1870–1880 the latter increased by 4666, the former only by 965. Ecclesiastically the districts now forming part of the canton belonged till 1814 to the dioceses of Lausanne, Basel, and Constance; but since the complete reorganization of 1828 it is part of the diocese of Basel, and the bishop of Basel lives in the city of Soleure.

The only places of any size in the canton are its capital, Soleure (7668 inhabitants), which possesses the finest armory in Switzerland, and Olten (3979). It is counted as one of the most fertile and productive cantons in the Confederation, and exports iron, wood, marl, marble, glass, etc. In educational matters it takes a high place, and its two chief towns are connected by a railway, Olten being one of the principal railway junctions in Switzerland, and the meeting-place of the St. Gotthard railway with the main lines branching off to the north, east, and west.

An old rhyme claims for the town of Soleure the fame of being the oldest place in "Gallia" save Treves. Certainly its name "Salodurum" is found in Roman inscriptions (the termination possibly pointing to a Celtic origin), and its position as commanding the approach to the Rhine from the southwest has led to its being more than once strongly fortified. Situated just on the borders of Alamannia and Burgundy, it seems to have inclined to the latter allegiance, and it was at Soleure that in 1038 the Burgundian nobles made their final submission to the emperor Conrad II. The mediæval town grew up round the house of secular canons founded in honor of St. Ursus and St. Victor (two of the Theban legion who are said to have been martyred here in the 3d century) by Queen Bertha, either the mother of Charlemagne and wife of Pippin (8th century) or the more famous wife of Rudolph II., king of Burgundy (10th century), and was naturally in the diocese of Lausanne. The prior and canons had many rights over the town, but criminal jurisdiction and the "advocatia" of the house remained with the kings of Burgundy, passed to the Zäringen dynasty, and on its extinction in 1218 reverted to the emperor. The city thus became a free imperial city, and in 1252 shook off the jurisdiction of the canons and took them under its protection. In 1295 we find it allied with Bern, and this connection is the key to its later history. It helped Bern in 1298 in the great fight against the nobles at the Dornbühl, and again at Laupen in 1339 against the jealous Burgundian nobles. It was besieged in 1322 by Duke Leopold of Austria (the defeated of Morgarten) during the struggle for the empire, but he was compelled to withdraw. In the 14th century the government of the town fell into the hands of the guilds, which practically filled all the public offices. Through Bern (which became a member in 1353) Soleure was drawn into association with the Swiss Confederation. An attempt to surprise it in 1382, made by the decaying Kyburg branch of the Hapsburgs, was foiled, and resulted in the admittance of Soleure in 1385 into the Swabian League and in its sharing in the Sempach war. Though Soleure took no part in that battle, she is included in the Sempach ordinance of 1393 and in the great treaty of 1394, by which the Hapsburgs renounced their claims to all territories within the Confederation. In 1411 she in vain sought to be admitted into the Confederation, a privilege only granted to her in 1481 at the diet of Stanz, after she had taken part in the Aargau, Italian, Toggenburg, and Burgundian wars. It was also in the 15th century that by purchase or conquest the town acquired the main part of the territories forming the present canton. In 1529 the majority of the "communes" went over to the Reformers, and men were sent to fight on Zwingli's side at Kappel (1531), but in 1533 the old faith regained its sway, and in 1586 Soleure was a member of the Golden or Borromean League. Though the city ruled the surrounding districts, the peasants were fairly treated, and hence their revolt in 1653 was not so desperate as in other places. Soleure was the usual residence of the French ambassador, and no doubt this helped on the formation of a "patriciate," for after 1681 no fresh citizens were admitted, and later we find only twenty-five ruling families distributed over the eleven guilds. Serfage was abolished by Soleure in 1785. The old system of the city ruling over eleven bailiwicks came to an end in March, 1798, when Soleure opened its gates to the French army. She was one of the six "directorial" cantons under the 1803 constitution. In 1814 the old aristocratic government was set up again, but this was finally broken down in 1839, Soleure in 1832 joining the League of the Seven to guarantee the maintenance of the new cantonal constitutions. Though distinctly a Roman Catholic canton, she did not join the "Sonderbund," and voted in favor of the federal constitutions of 1848 and 1874. Since 1830 she has revised her constitution in 1840, 1850, 1856, and 1875, besides three partial revisions of 1867, 1869, and 1881. The present constitution may be described as an ultramontane democracy, the priests having very great influence. The "Kantonsrath" or legislative assembly is elected by all citizens over twenty years of age, in the proportion of one member to 800 inhabitants. This assembly selects the "Regierungsrath" or executive, consisting of five members. In both cases the period of office is five years, though on the demand of 4000 citizens a popular vote must be taken as to whether the existing members shall continue to sit or not. In the canton the "obligatory referendum" and the "initiative" are legal. By the former all laws passed by the assembly, and all financial resolutions involving the expenditure of 100,000 francs [$19,300], or of an annual sum of 20,000 francs [$3860], must be approved by a popular vote. By the latter 2000 citizens can compel the assembly to consider any proposal for making a new law or for amending an old one. Further, the demand of the majority of the assembly or of 3000 citizens is sufficient to necessitate a popular vote as to the advisability of revising the constitution, the revised draft itself requiring a further popular vote.

SOLI, an ancient town of Asia Minor, on the coast of Cilicia, between the rivers Lamus and Pyramus, from each of which it is about 62 miles distant. Colonists from Argos in Greece and Lindus in Rhodes are described as the founders of the town, which is first mentioned in history at the time of the expedition of the younger Cyrus. In the days of Alexander the Great it was so wealthy that that conqueror exacted from its inhabitants a fine of 200 talents. In the war between Mithradates and the Romans Soli was destroyed by Tigranes, but it was subsequently rebuilt by Pompey, who settled there many of the pirates whom he had captured, and called the town after himself, Pompeiopolis. Soli was the birthplace of Chrysippus the Stoic and of the poets Philemon and Aratus. The bad Greek spoken there gave rise to the term *σολοικισμός*, "solecism," which has found its way into all the modern languages of Europe. Extensive ruins still mark the site of the town; the place is now called Mezetlu.

SOLICITOR. See ATTORNEY. It should be noticed that by the Supreme Court of Judicature Act, 1873, § 87, all persons admitted as solicitors, attorneys, or proctors of any English court, the jurisdiction of which was transferred by the Act to the High Court of Justice or the Court of Appeal, were thenceforth to be called solicitors of the supreme court. The title of attorney-general, however, still remains as that of the highest law officer of the crown. The Legal Practitioners Act, 1876, and the Solicitors Act, 1877, enabled solicitors to practice as proctors in the ecclesiastical courts (see PROCTOR). The Conveyancing Act, 1881, having made great changes in the practice of conveyancing, it became necessary to place the remuneration of solicitors upon a new basis. This was done by the Solicitors Remuneration Act, passed on the same day as the Conveyancing Act. It provides for the framing of general orders, fixing the principles of remuneration with reference *inter alia* to the skill and responsibility involved, not, as was generally the case before, with reference simply to the length of the documents perused or prepared. General orders in pursuance of the Act were issued in 1882.

In Scotland solicitors in the supreme court are not, as in England, the only persons entitled to act as law agents. They share the privilege with writers to the signet in the supreme court, with solicitors at law and procurators in the inferior courts. This difference is, however, now of little importance, as by the Law Agents Act, 1873, any person duly admitted a law agent is entitled to practice before any court in Scotland. In the United States the term solicitor is used in some States in the sense which it bore in England before the Judicature Act, viz., a law agent practicing before a court of equity.

Many of the great public offices in England and the United States have their solicitors. In England the treasury solicitor fills an especially important position. He is responsible for the enforcement of payments due to the treasury. The office of queen's proctor is now combined with that of treasury solicitor. Under his powers as queen's proctor the treasury solicitor acts as administrator of the personal estate of an intestate which has lapsed to the crown, and intervenes in cases of divorce where collusion is alleged (see DIVORCE). Since the Prosecution of Offences Act, 1884, he has also acted as director of public prosecutions. In the United States the office of solicitor to the treasury was created by Act of Congress in 1830. His principal duties are to take measures for protecting the revenue and to deal with lands acquired by the United States by judical process or vested in them by security for payment of debts.

SOLICITOR-GENERAL. See ATTORNEY-GENERAL. The position of the solicitor-general for Scotland in the main corresponds with that of the English solicitor-general. He is next in rank to the lord-advocate. In the United States the office of solicitor-general of the United States was created by Act of Congress in 1870.

SOLIMAN, or SULEIMAN, sultan of the Ottomans, surnamed The Magnificent, born about 1490, was the only son of Selim I., whom he succeeded in 1520. He died while he was besieging Sziget in Hungary, on September 5, 1566. See TURKEY.

SOLIMAN, or SULEIMAN, shah of Persia. See PERSIA, vol. xviii. p. 650.

SOLINGEN, a Prussian town, in the province of the Rhine, stands on a height near the Wupper, 13 miles east-by-south of Düsseldorf. It is one of the chief seats of the German iron and steel industry, its specialty consisting in all kinds of cutting implements of steel. Solingen sword-blades have been celebrated for centuries, and probably form part of the equipment of every modern army, while bayonets, knives, scissors, surgical instruments, files, steel frames, and the like are also produced in enormous quantities. These articles are largely made by the workmen at their own homes and supplied to the depôts of the large dealers; there are about 30,000 workers in steel in Solingen and its vicinity. The population of the town in 1885 was 18,643, of whom three-fourths were Protestants.

Solingen is an ancient place, and received its town charter in 1374. Sword-blades have been made here since the early part of the Middle Ages, and tradition affirms that the art was introduced during the crusades by smiths from Damascus.

SOLIS, ANTONIO DE (1610–1686), Spanish dramatist and historian, was born in 1610 at Alcalá de Henares, and studied law at Salamanca, where he is said to have produced a comedy which was acted in 1627. About 1640 he became secretary to the duke of Oropesa, whom he accompanied in various official missions; in 1654 he became one of the secretaries of Philip IV., and afterwards he was appointed chronicler. In his later years he joined one of the religious orders. He died at Madrid in 1686.

Of the nine extant plays of Solis two at least have some place in the history of the drama,—*El Amor al Uso* ("Love à la Mode") having afterwards been adapted by T. Corneille, while *La Gitanilla de Madrid* ("The Gypsy of Madrid") itself founded on the "novela" of Cervantes, has been made use of by Rowley and Middleton, P. A. Wolff, and, directly or indirectly, by other more recent authors. The titles of the remaining seven are *Triunfos de Amor y Fortuna*, *Erudice y Orfeo*, *El Alcazar del Secreto*, *Las Amazonas*, *El Doctor Carlino*, *Un Bobo haze ciento*, and *Amparar al Enemigo*. The *Historia de la Conquista de Mejico*, covering the three years between the appointment of Cortes to command the invading force and the fall of the city, deservedly ranks as a Spanish prose classic. It first appeared in 1684; there have been numerous reprints, the most recent being that published with notes by Revilla (Paris, 1858); an English translation by Townshend appeared in 1724. A volume of *Poesias sagradas y humanas* by Solis was published in 1692, and several unimportant letters of his may be read in the *Epistolario Español* of Rivadeneyra.

SOLOMON (Hebrew שְׁלֹמֹה, *Shĕlōmō* for Shĕlōmōn, "man of peace"; the English form follows the *Σολομων* of N.T. and Josephus; the Latin *Salomo* agrees with *Σαλώμων*, one of several variant forms shown in MSS. of the LXX.), son of David by Bathsheba, and his successor in the kingdom of Israel. The reign of Solomon has been sketched in ISRAEL (vol. xiii. pp. 415–16), and his relation to the philosophical and proverbial literature of the Hebrews, the so-called *chokma*, or "wisdom," has been critically considered in the article PROVERBS. The political system of Solomon fell to pieces at his death, but the fame of his wisdom and splendor in succeeding generations was all the greater that none of his successors at Jerusalem was in a position to rival him. The many floating and fragmentary notes of various dates that have found a place in the account of his reign in the book of KINGS (*q.v.*) show how much Hebrew tradition was occupied with the monarch under whom the throne of Israel reached its highest glory; and that time only magnified in popular imagination the proportions of so striking a figure appears alike in the unfriendly picture of Solomon in the Song of Solomon (originally, it would seem, sketched in the Northern kingdom, however much it may have been retouched and overlaid by additions of later date—see CANTICLES) and in the monologue of ECCLESIASTES (*q.v.*) placed in the mouth of the wise king who had tasted all that life can offer by one of the latest writers of the Old Testament. In the apocryphal book of Wisdom, again, the composition of an Egyptian Hellenist, who from internal evidence is judged to have lived somewhat earlier than Philo, Solomon is introduced uttering words of admonition, imbued with the spirit of Greek philosophers, to heathen sovereigns. The so-called Psalter of Solomon, on the other hand, a collection of Pharisee psalms written in Hebrew soon after the taking of Jerusalem by Pompey, and preserved to us only in a Greek version, has nothing to do with Solomon or the traditional conception of his person, and seems to owe its name to a transcriber who thus distinguished these newer pieces from the older "Psalms of David."[1] In New Testament times Solomon was the current type alike of magnificence and of wisdom (Matt. vi. 29; Luke xi. 31). But Jewish legend was not content with this, and, starting from a false interpretation of Eccles. ii. 8, gave him sovereignty over demons, to which were added (by a perversion of 1 Kings iv. 33) lordship over all beasts and birds, and the power of understanding their speech. These fables passed to the Arabs before the time of Mohammed (Nábigha, i. 22), found a place in the Koran, and gave Solomon (Suleimán) a lasting fame throughout the Moslem East. The story of Solomon, the hoopoe, and the queen of Sheba in sur. xxvii. of the Koran closely follows the second Targum to Esther i. 2, where the Jewish fables about him may be read at large. Solomon was supposed to owe his sovereignty over demons to the possession of a seal on which the "most great name of God" was engraved. See Lane, *Arabian Nights*, introd., note 21, and chap. i. note 15.

SOLOMON, SONG OF. See CANTICLES.

SOLOMON, WISDOM OF. See APOCRYPHA.

SOLOMON ISLANDS, an extensive group of islands, the largest and as yet least known of any in the Pacific Ocean, though among the very first that were discovered. They form a double chain of seven large and many small islands, extending for over 600 miles in a northwest and southeast direction between 5° S. lat., 154° 40′ E. long. and 10° 54′ S. lat., 162° 30′ E. long. The northern extremity stretches to within 120 miles of New Ireland, the southeastern point to 200 miles west of Santa Cruz, and the nearest portion of New Guinea lies about 400 miles to the southwest of the group.[2] See vol. xix. Plate III.

The Solomon Islands vary considerably both in size and character. It is as yet doubtful which of them is the largest, but seven are from 50 to over 100 miles in length and from 15 to 30 miles in breadth; several must therefore equal the county of Cornwall in area. They are well watered, though the streams seem to be small; their coasts afford some good harbors.[3] All the large and some of the smaller islands appear to be composed of ancient volcanic rock, with an incrustation of coral limestone showing here and there along the coast. Their interior is mountainous, and Guadalcanal, where there is an active volcano, reaches an altitude of 8000 feet. Malanta and Christoval are over 4000, Ysabel and Choiseul 2000 feet high. The mountains of the latter fall steep to the sea, and the whole of its northeast portion forms an elevated wooded plain. There is some level land in Bougainville, which is also said to possess an active volcano. Every traveller has extolled the beauty and fertility of the islands. In San Christoval deep valleys separate the gently-rounded ridges of its forest-clad mountains, lofty spurs descend from the interior, and, running down to the sea, terminate, on the north, in bold rocky headlands 800 to 1000 feet in height, while, on the south, they form and shelter bays of deep water. On the small high island of Florida there is much undulating grass land, interspersed with fine clumps of trees; but patches of cultivated land surround its numerous villages, and plantations on the hill-sides testify to the richness of its soil. To the south of Choiseul lies a small cliff-girt islet, Simba (Shortland's Eddystone), with a peak ending in a crater 1200 feet high, on the side of which are a solfatara and two boiling springs. It is inhabited, and has a small safe harbor. Surgeon Guppy, late of H.M.S. "Lark," has recently made valuable geological observations in the north and south of the group. The whole chain of islands appear to be rising steadily, and traces of ancient upheaval are very general,—for instance, Treasury Island, where a coral-encrusted volcanic peak has been raised 1200 feet, and the atoll of Sta. Anna, the ring of which now stands hundreds of feet above the present level of the sea. Some of the smaller islands are of recent calcareous formation. Barrier and fringing reefs, as well as atolls, occur in the group, but the channels between the islands are dangerous, chiefly from the strong currents which set through them.

The climate is very damp and debilitating. The rainfall is unusually heavy. Fever and ague prevail on the coast, but it is likely that the highlands will prove much more healthy. The dry season, with northwest winds, lasts from December to May.

A comparatively shoal sea—under 1000 fathoms—surrounds the Archipelago, and, including the New Britain and Admiralty Islands, stretches to New Guinea and thence to Australia. This sufficiently accounts for the Papuan character of its fauna, of which, however, it is the eastern limit, in spite of the fact that this shoal water extends to the extreme south of the New Hebrides. Here the strange little marsupial the cuscus (see **Phalanger**) is still to be met with; the hornbill, the cockatoo, the crimson lory, and birds of a dozen other genera have already been discovered, "all," as Wallace remarks, "highly characteristic of the Moluccas and New Guinea, and quite unknown in any of the more remote Pacific islands." But, like the New Hebrides, the Solomon Islands possess a megapode (*M. brenchleyi*) which is peculiar to itself. An alligator frequents the coast, and the sea teems with fish. Insects seem to be fairly well represented. The flora has been even less studied than the zoology, but it also shows strong Papuan affinities. Vegetation is most luxuriant: unbroken tracts of magnificent forest clothe the mountains, where sandalwood, ebony, and lignum vitæ have already been found. Mangrove swamps are common on the coasts.

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[1] The most ancient tradition, that of the LXX., gives Solomon no part in the authorship of the canonical psalter; see vol. xx. p. 34.

[2] *Islands of the Archipelago.*—The larger are—in the eastern chain, Bougainville, Choiseul, Ysabel, Malanta; and in the western chain, New Georgia, Guadalcanal (often misspelt Guadalcanar), San Christoval. The smaller are—Buka (the most northern), Shortland, Treasury, Faro, Simba (Eddystone), Rubiana, Hammond, Marsh, Savo, Buena Vista, Anuda, Ngela (Florida), Ulawa (Contrariété), Ugi, Three Sisters, Sta. Anna, Sta. Catalina, Bellona, Rennel (the most southern). Medaña mentions seeing near Buena Vista a small island in a state of violent eruption; he named it Sesarga. Ongtong Java is a group of coral islands in the northeast, but it does not, geographically, form part of the group.

[3] Blanche Bay, Bougainville; Port Praslin, Ysabel; Maruvo, New Georgia; Port Wiseman, Florida; Curaçoa Harbor in Marau Sound, Guadalcanal; Recherche Bay, Makira Bay, and Vanga Harbor, San Christoval.

The Solomon Islanders, excepting those of Bellona and Rennell in the south, and Ongtong Java in the north—who are pure Polynesians—are a small, sturdy Melanesian race, taller in the north than in the south, but averaging about 5 feet 4 inches for men, and 4 feet 9 inches for women. They are well proportioned, with nicely rounded limbs. Projecting brows, deeply-sunk dark eyes, short noses, either straight or arched, but always depressed at the root, and moderately thick lips, with a somewhat receding chin, are general characteristics. The expression of the face is not unpleasing. The mesocephalic appears to be the preponderant form of skull, though this is unusual among Melanesian races. In color the skin varies from a black-brown to a copperish hue, but the darker are the most common shades. The hair is dark, often dyed red or fawn. Crisp, inclining to woolly, it naturally hangs in a mop of ringlets 3 to 8 inches in length; but, when carefully tended, it forms one smooth bush—the usual fashion for both sexes. Epilation is practiced; little hair, as a rule, grows on the face, but hairy men are not rare.[1] Skin diseases are prevalent.

The Solomon Islanders are intelligent, of a quick and nervous temperament, crafty, thievish, and revengeful, yet, quickly amenable to good treatment, they make faithful servants. They are fond of dancing; their music is a monotonous chant with an accompaniment of bamboo drums. They make pan-pipes and jew's harps. Of their religion and manners and customs very little is known. Their language is of pure Melanesian type, though a number of dialects are spoken throughout the group,—many even on the same island. Broken into numerous clans, they are rarely at peace with each other; but the attention bestowed on plantations proves them good agriculturists. Yams, arum-roots, bread-fruit, cocoa-nuts, and fish constitute the chief of their food. Pigs, dogs, and fowls are also eaten, and, as these are mentioned by Mendaña, they must have been known in the islands for over three hundred years. The islanders are great betel-chewers, but little palm arrack or kava seems to be drunk. The respect paid to chiefs and elders varies in different islands. They are cannibals, though to what extent is unknown. Trophies of human skulls are common, and preserved heads—the face inlaid with shell—have been procured in Guadalcanal and Rubiana. They are said to pay honor to departed spirits. Carvings representing both men and animals often form the posts of houses and sheds, and adorn the prows of canoes. Their houses are square or oblong, strongly built, with high projecting roofs, which sometimes, as in their canoe-sheds, almost reach to the ground. The floor-mats are very rough. Large halls and spirit-houses exist in some of the villages, and great care and skill are bestowed on their decoration.[2] Great nicety of finish characterizes their weapons. They are mostly light and graceful, and consist of bows and arrows, spears, and clubs; the sling seems unknown. Some of the spears have the barbed head carved out of a human leg or arm bone; others, if not cut out of the solid wood, have bones, thorns, or splinters of wood attached in a most masterly manner. Arrows are similarly fashioned, and their reed shafts ornamented with incised lines. None of them appear to be poisoned. The bows, often large and powerful, are made of palm-wood or a strip of bamboo. Clubs vary considerably in shape; their butts are sometimes covered with finely-plaited colored grass. Some, which are long and slight, are sickle- or scythe-like, others lanceolate or spoon-shaped; and some, smaller, resemble a very broad dagger. This is, in the Pacific, the eastern limit of the shield. It is an unknown weapon in the other islands—Melanesian as well as Polynesian,—but to the west, in the New Britain group, and in New Guinea, various forms of it occur, whence, through the Malay islands, it may be traced back to the Asiatic continent. The shield is also used by the Australians. That of the Solomon Islanders is made of reeds, and is of an oval or oblong form. Their canoes are built of planks sewn together and caulked, and are the most beautiful in the Pacific. They are very light, slim, and taper, 20 to 60 feet in length, with 1 to 3 feet beam, but they balance so well that an outrigger is dispensed with. The high carved prow and stern—which are said to act as a shield from arrows when stem on—give the craft almost a crescent shape. These and the gunwale are tastefully inlaid with mother-of-pearl and wreathed with shells and feathers. Sails are not used, but the narrow pointed paddles propel the canoes with great speed through the water.[3] Graceful bowls, with some bird or animal for model, are also made. They are cut out of the solid, and sometimes measure over 8 feet in length. Stone adzes appear to be now used only in the interior and in the north of the group. They are well ground, flat and pyriform in shape, and very different from any made in the neighboring groups of islands. Clothing is of the scantiest. Both men and women not unfrequently go naked; but, as a rule, some slight covering is worn, and neatly-made fringed girdles are used in some districts. Tattooing and scarring of the body is but slightly practiced. Ornaments are used in profusion, and often are very tasteful. Carved wooden belts, colored shell-bead bands, and a variety of armlets, combs, and feather head-dresses are worn, also shell disks covered with tortoise-shell fretwork. Necklaces of teeth and shell are common and multiform; one much prized is made of human incisors. The ears, and in men the septum of the nose, are pierced, —frequently, also, the cartilage of one or both nostrils. In these the strangest ornaments are inserted, such as tortoise-shell rings, bones, teeth, shells, crab-claws, and the like.[4]

History.—The Spanish navigator Mendaña must be credited with the discovery of these islands, though it is somewhat doubtful whether he was actually the first European who set eyes on them. He sailed from Callao in 1567, by command of the governor of Peru, to discover the southern continent, the presumed existence of which in the then unknown region between America and Asia had already given rise to much speculation; but he seems to have been strangely unfortunate. Sailing west he discovered only a few coral islets (? Ellice group) until, having crossed more than 7000 miles of ocean, he fell in with an archipelago of large islands. By their size and position he considered them to form part of the land he was in search of, and in pleasing anticipation of their natural riches he named them Islas de Salomon. The expedition surveyed the southern portion of the group, and named the three large islands San Christoval, Guadalcanal, and Ysabel. On his return to Peru Mendaña endeavored to organize another expedition to colonize the islands, but it was not before June, 1595, that he, with Quiros as second in command, was enabled to set sail for this purpose. The Marquesas and Santa Cruz Islands were now discovered; but on these latter islands, after various delays and troubles, Mendaña died, and the expedition eventually collapsed.

Even the position of the Solomon Islands was now veiled in uncertainty, and they were quite lost sight of until, in 1767, two centuries after their first discovery, Carteret lighted on their eastern shores at Gower Island, and passed to the north of the group, without, however, recognizing that it formed part of the Spanish discoveries. In 1768 Bougainville found his way thither. He discovered the three northern islands (Buka, Bougainville, and Choiseul), and sailed through the channel which divides the latter two. In 1769 Surville explored the east coast, and was the first, in spite of the hostility of the natives, to make any lengthened stay in the group. He brought home some detailed information concerning the islands, which he called Terres des Arsacides; but their identity with Mendaña's Islas de Salomon was soon established by French geographers. In 1788 Shortland discovered New Georgia, with some of the smaller islands; and in 1792 Manning sailed through the strait which separates Ysabel from Choiseul and now bears his name. In the same year, and in 1793, D'Entrecasteaux surveyed portions of the coast-line of the large islands. In 1794 Butler visited the group, and Williamson in the "Indispensable" explored the channels which divide Guadalcanal from San Christoval and Ysabel from Malanta. There was a break of nearly half a century before D'Urville in 1838 took up the survey.

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[1] On the islands in Bougainville Strait tribes with lank, almost straight, black hair and very dark skin are found. The mountains of the large islands seem to be thinly inhabited by a smaller and ruder race, with whom the coast tribes wage perpetual war and for whom they express great contempt.

[2] See frontispiece to Brenchley's *Curaçoa*.

[3] Rude outrigger canoes with mat sails are used in some parts of the archipelago.

[4] Of the island manufactures fine specimens may be seen in the British, Cambridge, and Maldstone museums.

Traders now endeavored to settle in the islands, and missionaries began to think of this fresh field for labor, but neither met with much success, and little was heard of the islanders save accounts of murder and plunder perpetrated by them. In 1845 the French Marist fathers went to Ysabel, where Mgr. Epaulle, first vicar-apostolic of Melanesia, was killed by the natives soon after landing. Three years later this mission had to be abandoned; but since 1881 work has again been resumed. In 1856 John Coleridge Patteson, afterwards bishop of Melanesia, paid his first visit to the islands, and native teachers trained at the Melanesian mission college have since established themselves there, as well as a few traders. About this date the yacht "Wanderer" cruised in these seas, but her owner was kidnapped by the natives and never afterwards heard of. In 1873 the "foreign labor" traffic in plantation hands for Queensland and Fiji extended its baneful influence from the New Hebrides to these islands. Noteworthy recent visits are those of H. M. S. "Curaçoa" in 1865, H. M. S. "Blanche" and Mr. C. F. Wood's yacht in 1872, the German war-ship "Gazelle" in 1876, and H. M. S. "Lark" in 1881-84.[a]

See Dalrymple, *Voyages and Discoveries in the South Pacific Ocean* (Spanish voyages), 1770, i.; Hawkesworth, *Collection of Voyages* (Carteret, etc.), 1792, i.; Fleurien, *Découvertes des François en* 1768 *et* 1769 (Spanish voyages and Surville); Labillardière (D'Entrecasteaux), *Recherche de la Pérouse*, 1791-94, i.; Dumont d'Urville, *Voyage au Pole Sud, etc.*, 1837-40, v., and *Voyage autour du Monde*, ii.; Meade, *Ride through the Disturbed Districts of New Zealand, etc.*; Brenchley, "*Cruise of H. M. S. "Curaçoa,"* 1865; Wood, *Yachting Cruise in the South Seas*; Romilly, *The Western Pacific, etc.*; Schleinitz, "Geogr. u. Ethnogr. Beobachtungen auf Neu Guinea, etc." (S. M. S. Gazelle, 1874-76), *Zeits. Ges. Erdkunde*, xii., 1877; Guppy, "Recent Calcareous Formations of the Solomon Group," *Trans. Roy. Soc. Edin.*, xxxii., and "Physical Characters of the Solomon Islanders," *Journ. Anth. Inst.*, xv.; Flower, *Cat. Mus. Royal Coll. of Surgeons*, pt. 1, Man; Codrington, *The Melanesian Language*; Meinicke, *Die Inseln des Stillen Oceans*; Wallace, *Australasia*; Yonge, *Life of Bishop Patteson*; Redlick, "A Cruise Among Cannibals," *Geogr. Review*, i. (A. V. H.)

SOLON. The legislation of the Athenian Solon, which to a large extent moulded the subsequent political life of Athens, belongs to the early part of the 6th century B.C.[1] It followed almost immediately on an unsuccessful attempt to overthrow the government of the aristocratic families of Attica, one of which, however, that of the Alcmaeonids, was driven into exile; and it preceded by a short interval the famous usurpation of Pisistratus. Solon had won the confidence of his fellow-citizens by having recovered for them the island of Salamis, close to the shores of Attica, an old and valued possession, which their neighbors of Megara had taken from them. Solon, himself a native of Salamis, encouraged them to fight once again for the "lovely island," as he called it, in a short poem which he publicly recited, feigning, it is said, the excitement of a madman. Through Spartan intervention in the war between Athens and Megara Salamis was restored to the Athenians, and Solon had the credit of the result. In 594 B. C. he was summoned under the constitutional title of "archon" to undertake the work of sweeping political reforms, which, in consequence of bitter party strifes and the poverty and indebtedness of the small farmers or proprietors of Attica, were sorely needed. The Athenian like the Roman debtor had often sunk, under the legalized oppression of his creditor, into an actual slave, and had from time to time been sold and exported. Many poor creatures had fled away from home, and were supporting themselves by the labor of their hands in foreign countries. Many men who still clung to their little properties could, with all their pinching, barely keep their heads above water. The governing classes themselves felt that a crisis was at hand, and they appealed to Solon and made him practically dictator. Had he chosen to work on the popular discontent, he might have easily crushed the aristocracy and become a despot, or, as the Greeks called it, a tyrant, as many had done in other states of Greece by coming forward as champions of the people against the great ruling families. Solon obeyed a nobler impulse and aimed at saving his country without too violent a revolution. His first step was to give immediate relief to the poor debtor, to the wretchedly impoverished small farmer or proprietor, and to interpose between him and his creditor and landlord. On very many of the little properties of Attica were to be seen stone pillars with the name of the mortgagee and the amount of the mortgage inscribed on them. By a relief law, "a shaking-off of burdens" (σεισαχθεία), he annulled all mortgages, justifying no doubt so extreme a measure by the harshness of the contracts imposed by mortgagees on needy tenants and proprietors and by the urgent necessity of prompt release for the multitude of such small debtors. Thus the "mortgage pillars" were swept away and the land was once more free. Such a setting aside of the rights of property, expedient as it may have been under circumstances of acute public distress, must have inflicted a heavy loss on the wealthier class, and the landlord and the mortgagee would also have a fair claim for relief. This, it appears, Solon accomplished by a device which has been variously explained, a depreciation of the currency which relieved to a considerable extent—27 per cent., according to Grote's[2] calculation—the wealthier debtors of the landlord and mortgagee class. Grote here remarks that, had Solon cancelled all debts and contracts, there would have been no need to interfere with the currency and lower the standard of money. His relief law could not have been so sweeping and revolutionary as it has sometimes been represented. There was no redistribution or confiscation of the land, no universal remission of debts. For the great majority of the people indeed there was substantial relief. The land was free from incumbrance, and the small cultivator had a fresh start in life; there was no imprisonment or slavery for the debtor; and it would seem that debtors who had sought refuge abroad were purchased back and restored to their homes. Such on the whole appears to have been the character of Solon's first great reform, though some of the details remain obscure. The reconstruction of the political system on the principle that every citizen was to have a share in the government was Solon's next work. A few noble families, Eupatrids, as they were called, had hitherto had all the power in their own hands. Solon made property the measure of political power, and confined the higher offices of state to the wealthiest citizens; but election to these offices was to be made by the whole body of the people, the tenure of office was limited as to time, and an account had to be rendered publicly as to its exercise. The citizens were distributed into four classes according to a graduated scale of property, the first class being alone eligible to the archonship or highest office and to military and naval commands. The actual administration of public affairs was thus restricted to the wealthy few. The second class were the knights or horsemen—the men who could keep a war-horse for the service of the state; these were assessed at three-fifths of the amount of the first class. The third class answered to our yeomen, and had to serve as heavy-armed infantry. These three classes were subject to direct taxation in the form of a graduated income tax, which was, however, simply an extraordinary tax, levied only in special emergencies at varying amounts per cent. on a citizen's ratable property, as set down in a public schedule. The fourth and lowest and most numerous class, which supplied light troops and sailors for the fleet, was exempt from all direct taxation, but paid indirect taxes; it would be made up of small farmers, tradesmen, and artisans, and consist in fact of quite the poorest and humblest class of citizens. Its members could not hold any office; but they had a large amount of political power through their votes in the popular assembly which elected the magistrates and called them to account, and through the very great judicial powers with which they were intrusted, and in virtue of which the Athenian juror practically decided questions both of fact and of law. Solon's constitution thus gave the people ample means of protecting themselves from misgovernment and oppression, every magistrate being directly responsible to them. Not that Solon himself contemplated anything like pure democracy; there is every reason to believe he shrank from it; but pure democracy was pretty sure to follow as soon as the people distinctly realized their power. Solon's council of 400, taken exclusively from the first three classes, must have been meant to furnish the popular assembly with political guidance, and this it did by preparing and introducing measures for discussion and superintending its meetings and exercising some direction over its proceedings. It is impossible for us to define its peculiar functions precisely. It was, however, ultimately under the control of the popular assembly, by which probably it was annually elected, and to which it had annually to render an account. We are not to suppose that either the council or the popular assembly originated with Solon. What he really did was to put them on a new footing, and to the latter, which previously in all probability had hardly any weight or influence, he gave greatly enlarged powers. The archons and magistrates and the council itself were elected by the popular assembly, and were responsible to it for good behavior during their term of office. In this assembly met the citizens of all four classes, and consequently the great majority of its members would be poor men and almost peasants. The voting was by show of hands; every voter was allowed to speak; and in the voting there was no distinction of classes, all being on a perfectly equal footing. Although theoretically they could not originate any measure, but had to accept for discussion what had been prepared for them by the council, they had an absolute power of veto; and, as the election of the council was in their hands, it must have been easy for them to get that body to bring forward any proposal which they might wish to discuss. Thus it may be truly said that Solon laid the foundation of the future democracy. And through the Heliæa, as it was called,—a body of 6000 citizens annually elected by lot to act as jurors for the trial specially of political offences,—the people acquired a complete control over public affairs. There was but one proviso: the Athenian juror must be upwards of thirty years of age. In the Athenian courts which were formed out of these 6000 citizens the functions of judge and jury were united in one and the same person, and political questions were continually decided when, as often happened, a citizen was put on his trial for some alleged illegal or unconstitutional proposal. By such means popular rights and privileges were effectually protected, and the democratic character of the constitution enlarged and confirmed, as we see in the subsequent history of Athens. Solon, indeed, retained (he did not create) the famous senate of the Areopagus, and aimed at making it respected and capable of exercising a general superintendence over the morals and social life of the citizens. It was to be an aristocratic body, consisting only of archons who had acquitted themselves well and honorably during their year of office. It seems that he did not attempt to prescribe to it any special or particular duties, but that he rather trusted to its making its influence felt from the fact that it was, as every one knew, composed of men of acknowledged merit and ability. Consequently, as Thirlwall observes (*Hist. of Gr.*, ch. xi.), "it could only exercise its powers with advantage as long as it retained the confidence of its fellow-citizens; when that was lost it became time that its legal authority should cease." Solon evidently felt that, for a time at least, there must be checks on popular government. Had it been hinted to him that under his constitution power must finally drift down to the lowest social stratum, he would perhaps have replied that he had endeavored to supply the entire people with a political training which should by degrees qualify them for absolute self-government.

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[1] The dates of his birth and death are approximately 638 and 559

[2] *History of Greece*, ch. xi.

[a] [Germany in 1890 had the northern group of these islands, including Bougainville, Choiseul, and Isabella, under the jurisdiction of the governor of Kaiser Wilhelm's Land, and Great Britain had put the southern group under the Commissioner to Fiji. —AM. ED.]

Solon encouraged commerce and manufacturing industry, and drew a number of settlers from foreign parts to Athens, on condition of their paying an annual tax and putting themselves under the protection of a citizen who was to be their legal representative—their "patronus," according to Roman phrase. These settlers (*μετοίκοι*, "metics") had none of the political privileges of the Athenian citizen, and they could not acquire landed property. Many of them, however, flourished and grew rich, and had every reason to be satisfied with their position, which, in a kindly and tolerant community like that of Athens, was continually improving. Solon, too, like all the legislators of antiquity, endeavored to regulate every department of life, compelling the attendance of the youths from sixteen to eighteen at the public gymnastic schools, and requiring them to serve the next two years on garrison duty. Restraints were put upon women as to their appearance in public, and even as to their mourning at funerals. Solon's punishments were for the most part rather lenient, and indicated a humane and generous temper. It is of course not to be supposed that all the details of his legislation were maintained, but they undoubtedly left their mark on the Athenian character.

Having done his work, Solon left Athens and travelled for ten years in Egypt, Cyprus, and Asia, gathering fresh stores of knowledge for himself and giving counsel to others. One would like to believe the beautiful story Herodotus tells of his interview with Crœsus, king of Lydia, whom he warned with the memorable saying that "we must not pronounce any man happy till we have seen his end." Unfortunately, Crœsus did not begin to reign till several years after Solon's travels, and with Grote we must be content to take the story as merely an "illustrative fiction." On his return to Athens in his old age he found the old feuds once more raging, and Pisistratus, his kinsman, and his friend in past days, intriguing for power. The two men had, it seems, a sincere respect for one another, but Solon protested against the complete surrender of the government to Pisistratus, the danger of which he publicly pointed out, though without effect. The crisis ended in the rule, in many respects an enlightened and beneficent rule, of Pisistratus and his sons, of which Solon lived only to see the first beginning. He died, soon after having made his honorable protest, at the age of eighty, leaving behind him the good effects of a work which only a man of rare intelligence and wide sympathies could have accomplished. He was something of a poet, and several fragments of his poems, written generally with a practical purpose, have come down to us, and throw light on his political aims and sentiments.

Grote and Thirlwall in their histories of Greece give a full account of Solon's legislation. Plutarch's life of Solon, not a very critical performance, is our chief original authority. (W. J. B.)

SOLOTHURN. See SOLEURE.

SOMÂLI, SOMÂL, a Hamitic people of east Central Africa, mainly confined to the eastern "horn" of the continent, which from them takes the name of Somâli Land, probably the Punt of the Egyptian records. Here they are conterminous towards the northwest with the kindred Afars (Dankali), and elsewhere with the more closely related Gallas, from whom they are separated on the southwest by the river Juba. Tajurra Bay, with the lower course of the Hawash, is usually given as the northwest frontier; but, according to the recent explorations of Abargues de Sostén in eastern Abyssinia, there appears to be here an overlapping of of the three peoples, the Isa Somâli encroaching on the Afar domain north of Tajurra Bay nearly to the parallel of Asab Bay (13° N.), while the Dawari Gallas penetrate between this Somâli tribe and the lower Hawash eastwards to the coast at Obok (12° N.). A line drawn from the Strait of Bab-el-Mandeb through the Harrar district and the headwaters of the Haines river (Webbe-Shebeyli or "Leopard river") southwards to the equator at the mouth of the Juba will roughly define the landward frontier of the Somâli territory, which is elsewhere sea-girt,—by the Gulf of Aden on the north, by the Indian Ocean from Cape Guardafui to the equator.

Our first contact with the Somâli people may be said to date from the English occupation of Aden in 1839. But, notwithstanding the early visits of Cruttenden, Ch. H. Johnson, Captain Burton, and one or two others, very little was known about them before the seizure of Berberah by the Egyptians in 1874. This event led to the establishment of permanent relations with the coast tribes, and was followed by several excursions into the interior, of which the most fruitful in results have been those of Sacconi, Revoil, F. L. James, Paulitschke, Von Hardegger, and Josef Menge, the last three bringing our information down to the year 1885. From the reports of these observers the true relations of the Somâli have been gradually determined and we now know that they form a distinct branch of the eastern ("Ethiopic") Hamitic stock, of which the other chief members are the neighboring Gallas and Afars, the Abyssinian Agau, and the Bejas (Bishari) of the steppe lands between the Nubian Nile and the Red Sea. Their close affinities both in physical type and in speech with the surrounding Gallas are obvious, and like them they are described as a fine race,[1] tall, active, and robust, with fairly regular features, but not free from an infusion of Negro blood, as shown both in their dark, often almost black complexion, and still more in their kinky and even woolly hair, sometime short, sometimes long enough to be plaited in tresses hanging down to the shoulders.[2] Like the Gallas also they are still in the tribal state, broken up into an endless number of clans and septs, variously grouped by different writers. According to Captain Guillian[3] there are three main divisions—the Aji on the north and northeast coast, the Hawiya on the southeast coast, and the Rahhanwin in the interior. But these are reduced by James to two, Isak and Darode (apparently the Edur and Darrud of older observers), with several main branches as under:

Isak	Habr Gerhaji, south from Berberah, beyond the coast range.
	Habr Tjaleh, east from Berberah, north of the coast range.
	Habr Awâl, Berberah district.
Darode	Mejertain, east coast from Guardafui to 4° north.
	Dolbohanti, Nogal River.
	Warsangueli, north coast, west from Guardafui.
	Marehan, between the Mejertain and Ogadain.
	Ogadain, Webbe basin, and widespread in interior.

To these, however, must be added the powerful Gadabirsi west from Berberah and the Isa (Issa) of the Hawash basin, besides the three low-caste tribes dispersed amongst the others,—Tomal (ironworkers), Ebir (dealers in charms), and Midgan (ostrich breeders).

The Somâli, who are mainly Mohammedans of a somewhat fanatical type, are a fierce lawless people, impatient of control, and yielding a reluctant obedience even to their own rulers. Hence the tribal chiefs enjoy little more than a nominal authority, although some of the more powerful amongst them affect the title of sultan. At present the great Habr Gerhaji nation appears to be split into two sections, each under a chief claiming this rank. All go armed with spear, shield, and short sword, the latter exactly like that of the ancient Egyptians, whom the Somâli are otherwise said to resemble more than any other African people. The weapons are freely used in their disputes, although the tribal laws against homicide are severe, heavy fines of camels or other property being imposed, which must be paid either by the criminal or the community. They are great talkers, keenly sensitive to ridicule, and quick-tempered, although amenable to reason if they can be induced to argue the point. According to the character of the soil and climate they live a settled or nomad life, in some places breeding numerous herds of camels, goats, and fat-tailed sheep, in others growing large crops, especially of durrah, or collecting the gums—frankincense and myrrh—for which the land has always been famous. The Marehan (properly Murreyhan) tribe is said to have given its name to the myrrh, which is obtained in the greatest perfection in their district, although the term seems too old to admit of this derivation, and is more probably connected with a Semitic root *mar*, *mur* = bitter. Through the ports of Berberah and Zeyla, a considerable export trade to Arabia, Egypt, and India is carried on with these articles and the other natural products of the country, such as hides, horns, ostrich feathers, coffee of a very fine quality, indigo, salt. But the natives take little part in this movement, which from remote times has been in the hands of the Indian banians settled at various points on the coast. In 1879–80 the total value of the exports was estimated at about £140,000 [$680,400].

Like many other Mohammedan peoples, the Somâli claim Arab descent, their progenitor having been a certain Sherif Ishak b. Ahmad, who crossed over from Hadramaut with forty followers about five hundred years ago. Other traditions go farther back, tracing their origin to the Himyaritic chiefs Sanhâj and Samamah, said to have been coeval with a King Afrikus, who is supposed to have conquered Africa about 400 A.D. These legends should perhaps be interpreted as pointing at a series of Arab immigrations, the last two of which are referred to the 13th and 15th centuries. But these intruders seem to have been successively absorbed in the Somâl stock; and it is remarkable that the Arabs never succeeded in establishing permanent settled or nomad communities in this region, as they have done in so many other parts of the continent. Their influence has been very slight even on the Somâl language, whose structure and vocabulary are essentially Hamitic, with marked affinities to the Galla on the one hand and to the Dankali (Afar) on the other. Captain Hunter's *Grammar*, with exercises and vocabularies (Bombay, 1880), utilizing the materials published by General Rigby in the *Proceedings* of the Bombay Geographical Society (1849), is the only comprehensive treatise on the language, which appears to be spoken with great uniformity throughout the whole of Somâli Land. Hunter mentions an eastern and a western dialect, differing, however, but little from one another, which is the more remarkable that there is no written standard and little oral literature, beyond some proverbial sayings, short stories inculcating certain moral teachings, and some simple love-songs. Although the rhythm is defective, these chants are not lacking in poetical ideas, and often betray an unexpected refinement of feeling not inferior to that of similar compositions amongst more civilized peoples. (A. H. K.)

SOMERS, John (1652–1716), was born on March 4, 1652, at Worcester,—the eldest son of John Somers, an attorney in large practice in that town who had formerly fought on the side of the Parliament, and of Catherine Ceaverne of Shropshire. After being at school at Worcester he was entered as a gentleman commoner at Trinity College, Oxford, and afterwards studied law under Sir Francis Winnington, who became solicitor-general, and joined the Middle Temple. He appears, in addition to his legal studies, to have written several poems and pamphlets. He soon became intimate with the leaders of the country party, especially with Essex, Russell, and Algernon Sidney, but never entered into their plans so far as to commit himself beyond recall. He was the author of the *History of the Succession of the Crown of England, collected out of Records, etc.*, and was reputed to have written the *Just and Modest Vindication of the Two Last Parliaments*, which was put forward as the answer to Charles II.'s famous declaration of his reasons for dissolving them. This, however, was by

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[1] Captain Wharton, who has been recently surveying the Somâli seaboard, describes the coast tribes near the equator as "the handsomest race of men and women he had ever seen," black in color, but with magnificent physique (*Proc. Roy. Geog. Soc.*, Oct. 1885). Captain F. M. Hunter also describes them as a tall, fine-looking people, with oval face, high rounded forehead, full lips, strong regular teeth, bright restless eye, but lower limbs seldom well developed (*A Grammar of the Somal Language*, Bombay, 1880).

[2] The occasional presence of "steatopyga" (Topinard) shows that all these features are undoubtedly due to Negro intermixture.

[3] *Documents sur l'histoire, etc., de l'Afrique Orientale*, 1856–59.

Sidney, though probably Somers was responsible for the final draft. When the grand jury of Middlesex threw out the bill against Shaftesbury, and were vehemently attacked for so doing, Somers wrote in defence of the rights of grand juries. In 1683 he was counsel for the sheriffs Pilkington and Shute before the Court of King's Bench, and secured a reputation which continually increased until the trial of the seven bishops, in which he was junior counsel. "Somers rose last. He spoke little more than five minutes, but every word was full of weighty matter; and when he sat down his reputation as an orator and a constitutional lawyer was established." In the secret councils of those who were planning the revolution Somers took a leading part, and in the Convention Parliament was elected a member for his native town. He was immediately appointed one of the managers for the Commons in the conferences between the Houses, and in arguing the questions whether James II. had left the throne vacant by abdication and whether the Acts of the Convention Parliament were legal—that parliament having been summoned without the usual writs—he displayed great learning and legal subtlety. He was further distinguished by being made chairman of the committee which drew up the celebrated Declaration of Right. On May 9, 1689, Somers was made solicitor-general. He now became William III.'s most confidential adviser. In the controversy which arose between the Houses on the question of the legality of the decision of the Court of King's Bench regarding Titus Oates, and of the action of the Lords in sustaining this decision, Somers was again the leading manager for the Commons, and has left a clear and interesting account of the debates. He was next employed in January, 1690, as chairman of the select committee of the House of Commons on the Corporation Bill, by which those corporations which had surrendered their charters to the crown during the last two reigns were restored to their rights; but he refused to associate himself with the violent measures of retaliation which the Whigs on that occasion endeavored to include in the bill. In April a speech by him carried through the Lower House, without opposition, the bill which declared all the laws passed by the Convention Parliament to be valid. As solicitor-general he had to conduct the prosecution of Preston and Ashton in 1691, and did so with a moderation and humanity which were in marked contrast to the customs of the former reigns. He was shortly appointed attorney-general, and in that capacity strongly opposed the bill for the regulation of trials in cases of high treason. On March 23, 1693, the great seal having meanwhile been in commission, Somers was appointed lord-keeper, with a pension of £2000 [$9720] a year from the day on which he should quit his office, and at the same time was made a privy councillor. He had previously been knighted. Somers now became the most prominent member of the Junto, the small council which comprised the chief members of the Whig party. When William left in May, 1695, to take command of the army in the Netherlands, Somers was made one of the seven lords-justices to whom the administration of the kingdom during his absence was intrusted; and he was instrumental in bringing about a reconciliation between William and the princess Anne.

The question of improving the currency now became pressing, and Somers was the author of the bold suggestion that a proclamation should be issued simultaneously all over the country, announcing that henceforth all clipped and hammered coins were to be reckoned only by weight. But all possessors of such coins might, by delivering them up on a certain day, receive a note entitling them to draw from the treasury at a future time the difference between the actual and nominal values. The difficulties of the plan, however, rendered its adoption impossible. In April, 1697, Somers was made lord chancellor, and was created a peer by the title of Baron Somers of Evesham. When the discussion arose on the question of disbanding the army, he summed up the case against disbanding, in answer to Trenchard, in a remarkable pamphlet called "The Balancing Letter." In August, 1698, he went to Tunbridge Wells for his health. While there he received the king's letter announcing the first Partition Treaty, and at once replied with a memorandum representing the necessity in the state of feeling in England of avoiding further war. When the king, on the occasion of the Disbanding Bill, expressed his determination to leave the country, Somers boldly remonstrated, while he clearly expressed in a speech in the Lords the danger of the course that was being taken. Hitherto Somers's character had kept him free from attack at the hands of political opponents; but his connection in 1699 with the notorious Kidd,[1] who, being sent out to put down the pirates in the Indian Ocean, turned pirate himself, and to the defraying of whose expedition Somers had given £1000 [$4860], afforded an opportunity; the vote of censure, however, proposed upon him in the House of Commons, for giving Kidd a commission under the great seal, was rejected by 199 to 131. The attack was renewed shortly on the ground of his having accepted grants of crown property to the amount of £1600 [$7776] a year, but was again defeated. On the subject of the Irish forfeitures a third attack was made in 1700, a motion being brought forward to request the king to remove Somers from his counsels and presence forever; but this again was rejected by a large majority. In consequence, however, of the incessant agitation, William now requested Somers to resign; this he refused to do, but gave up the seals to William's messenger. In 1701 he was impeached by the Commons on account of the part he had taken in the negotiations relating to the Partition Treaty in 1698, and defended himself most ably before the House, answering the charges *seriatim*. The impeachment was voted and sent up to the Lords, but was there dismissed. On the death of the king Somers retired almost entirely into private life. He was, however, active in 1702 in opposing the Occasional Conformity Bill, and in 1706 was one of the managers of the union with Scotland. In the same year he carried a bill regulating and improving the proceedings of the law courts. He was made president of the council in 1708 upon the return of the Whigs to power, and retained the office until their downfall in 1710. From this time his powers of mind rapidly declined, and after being almost imbecile for six years he died of apoplexy on April 26, 1716. Somers was never married, but left two sisters, of whom the eldest, Mary, married Charles Cocks, whose grandson, Sir Charles Cocks, Bart., became the second Lord Somers in 1784.

For a contemporary character of Somers Addison's paper in the *Freeholder* for May 14, 1716, should be referred to; and there is in Macaulay's *History* (vol. iv. p. 53) an eloquent and worthy tribute to his stainless character and comprehensive learning. A catalogue of his publications will be found in Walpole's *Royal and Noble Authors*. (O. A.)

SOMERSET, a maritime county in the southwest of England, bounded E. by Wiltshire, S.E. by Dorset, S.W. and W. by Devonshire, N.W. by the Bristol Channel, and N. by Gloucestershire. The total area of land and water is 1,049,815 acres, or 1640 square miles.

Plate III.

The shape of the county is determined by the nearly rectangular bend taken by the coast not far from Bridgewater. It falls into three natural divisions, which answer remarkably to the three waves of West-Saxon conquest and to the parliamentary divisions as they stood till the latest changes. The range of Mendip, breaking off from the high ground in the east of the county, completely shuts off the northern part, between Mendip and Bristol, itself hilly. Mendip itself, running slightly northwestward towards the

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[1] [Born in Scotland, William Kidd was unfairly hanged in London, May 24, 1701, for alleged murder.—AM. ED.]

Channel, has for its summit a tableland sloping much more gently to the north than to the south. Its most striking though not its highest points are towards the Channel, where it ends in the promontory of Brean Down, while the Steep Holm stands as an outpost between the hills of Somerset and those of Glamorgan. The sides of Mendip are broken by many passes or *combes*, the most marked of which are Ebber rocks, near Wells, and the greater pass of Cheddar cliffs, whose varied outlines, in the many turns of the pass, are probably the most noteworthy of their kind in England. Between Mendip and the region of loftier hills in the south lies a great alluvial plain, known generally as Sedgemoor, but with different names in different parts. This plain, intersected by ditches known as *rhines*, and in some parts rich in peat, is broken by isolated hills and lower ridges, of which the most conspicuous are Brent Knoll, near Burnham, the Isle of Avalon, rising with Glastonbury Tor as its highest point, and the long, low ridge of Polden ending to the west in a steep bluff. In the south is Blackdown on the border of Devonshire, the higher range of Quantock (highest point 1262 feet), stretching to the sea, and to the west again the mountainous region of Brendon and Exmoor, commonly believed by tourists to be part of Devonshire. Here are hills of much greater height and bolder outline, the highest point being that of Dunkery (1709 feet) above Porlock. The two principal rivers are the Lower Avon and the Parret. The Avon, after forming for a short distance the boundary with Wilts, crosses the northeastern corner of the county, encircling Bath, and forms the boundary with Gloucestershire till it reaches the sea 6 miles beyond Bristol. It is navigable for barges as far as Bath. The Parret from South Perrott in Dorset, on the borders of Somerset, crosses the centre of the county northwestwards by Bridgewater, receiving the Ivel or Yeo and Cary on the right, and the Isle and Tone on the left. Among other streams are the Axe, which rises at Wookey Hole in the Mendips and flows northwestward along their base to the Bristol Channel near Blackrock; the Brue, which rises to the east of Bruton, near the borders of Wiltshire, and enters the Bristol Channel near the mouth of the Parret; and the Exe (with its tributary the Barle), which rises in Exmoor forest and passes southward into Devon.

The diversified surface of the county is accounted for by the variety and complexity of its geological structure. The Old Red Sandstone, composed of sandbanks and mudbanks of a land-locked lake, is met with in the Mendip Hills and on the banks of the Avon, but presents no feature of importance. The Devonian rocks, after plunging beneath the Triassic strata of the low ground between Williton and Taunton, rise again to the surface in the well-wooded Quantock Hills. The Carboniferous strata occupy a considerable area between Bristol and the Mendip Hills, forming a portion of the Bristol and Somerset coalfield. The Carboniferous limestone, built up mainly of petrified shells and corals, forms a truncated arch in the Mendip Hills, which owe their steepness and rugged contours to its compact and jointed structure, and their ravines and caves to atmospheric influences and to streams acting on the formation at and below the surface. It overlaps to the south the plain of Somerset, and plunges northwards under the coal-measures and Triassic rocks, reappearing in isolated and picturesque masses. The coal-measures, which have a thickness of about 7000 feet, include an upper and a lower series, separated by beds of grit about 2000 feet in thickness, also containing beds of coal (see COAL, vol. vi. p. 50). It is supposed that similar beds underlie the marshes to the south at a depth of from 1000 to 1200 feet. A large portion of the Carboniferous rocks are covered unconformably with the New Red Sandstone and Liassic and Oolitic strata. Triassic rocks prevail over the whole western area, from the Mendips to Exmoor. The highly fossiliferous Rhætic strata rest on the gray marls of the Trias, and constitute the lower part of the bold scarp of the Lias limestone and clays of the ranges from the sea to the Poldens. Plunging beneath the Oolitic strata, they occupy a large but scattered area in the east between Yeovil and Bath; and these in their turn pass under the Cretaceous strata of the serried Blackdown Hills. A large extent of the county is occupied by alluvial deposits. Caves are common in the body of the hills, among which the greatest are the bone cave near Banwell, the stalactite caves at Cheddar, and Wookey Hole. Hard by the last-named is the hyena cave discovered in 1852, and explored in 1857–63, when, besides animal remains belonging to a great variety of species, flint and chert implements were also discovered.

Minerals.—Though the exposed area of the coalfield of Somerset is only about 14 square miles, it is estimated to extend over 238 square miles. The amount of coal raised within the county in 1884 was 843,437 tons, valued at £295,202 [$1,434,681.72]. Spathose iron ore has been long worked in the Brendon Hills, but the industry is declining, —26,041 tons, valued at £13,021 [$63,282.06], having been obtained in 1858 and only 3582 tons, valued at £2619 [$12,728.34] in 1884. Lead mining has been carried on in the Mendips from time immemorial, but the industry is of much less importance than it was in earlier times, the amount of dressed lead ore obtained in 1884 being only 664 tons, of lead obtained in smelting 178 tons, of silver obtained from the lead 2760 ounces, and the value of the ore at the mines £1055 [$5,127.30]. Next to coal the most important mineral production is freestone from the Oolitic strata, the largest quarries being in the neighborhood of Bath. Copper and manganese are obtained in small quantities, as well as fuller's earth, marl, cement from the Lias, and ochre.

Railways.—The county is so completely intersected by branches of the Great Western Railway in the north and west, and of the South Western in the south and east, that there is perhaps no hamlet more than seven miles from a railway station.

Manufactures.—Woollen and worsted goods are manufactured in a large number of towns; silk at Frome, Taunton and Shepton Mallet; gloves at Yeovil, Taunton, and other places; crape at Dulverton and Shepton Mallet. There are large potteries at Bridgewater and Weston-super-Mare; at the former town and at Bath there are extensive carriage-works; and there are paper-mills on several of the streams. Most of the commerce of the county passes through Bristol, which is situated mainly in Gloucestershire.

Agriculture.—In the hilly districts much of the land is uncultivated and barren, although affording some pasturage for sheep. There are large tracts of rich meadow land along the banks of the rivers, and the vale of Taunton is well adapted for wheat. On account of the extensive damage frequently caused in the lower grounds by floods, the Somerset Drainage Act was passed by parliament 11th June, 1877, providing for the appointment of commissioners to take measures for the drainage of lands in the valleys of the Parret, Ile, Yeo, Brue, Axe, Cary, and Tone, where extensive damage is frequently caused by floods. The following table gives a classification of the holdings in 1875 and 1880:

	50 Acres and under.		From 50 to 100 Acres.		From 100 to 300 Acres.		From 300 to 500 Acres.		From 500 to 1000 Acres.		Above 1000 Acres.		Total.	
	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.
1875	11,999	136,068	1.812	132,687	2,354	396,215	341	127,111	62	37,966	4	6,354	16,572	836,401
1880	13,300	140,912	1,750	129,838	2,349	402,421	358	132,745	72	43,168	4	5,786	17,833	854,870

Out of a total area of 1,049,815 acres there were 867,469 acres in 1885 under culture, of which 625,957 acres, or nearly three-fourths, were in permanent pasture, 58,863 under clover and rotation grasses, 115,005 under corn crops, 61,650 green crops, 560 flax, and 5434 fallow. Of the corn crops the largest area—49,199 acres—was occupied by wheat, barley occupying 27,934 acres, oats 24,783, beans 11,349, pease 1576, and rye 164. About one-half of the area under green crops was occupied by turnips, which covered 30,891 acres, mangold coming next with 10,867 acres, while vetches occupied 8881, potatoes only 7517, and carrots 212. Horses in 1885 numbered 34,848, of which 23,229 were used solely for purposes of agriculture. The number of cattle was 236,899, of which 110,068 were cows and heifers in milk or in calf. Cattle-feeding and dairy-farming are the principal branches of husbandry. Large numbers of cattle are brought from Devon to be grazed on the rich Somersetshire meadows. The district east and west of Wells, with that of Cheddar, is famed for the cheese of that name, and cheese is also extensively made in other districts. Sheep, chiefly Leicesters and Southdowns, are grazed, the number in 1885 being 601,020. The number of pigs in 1885 was 111,719, and of poultry 414,803. In the extent of its orchards, chiefly apple trees, Somerset comes next among the counties of England to Hereford and Devon, the area in 1885 being 23,660 acres. The apples are principally made into cider, which is the common drink of the peasantry. The area under market gardens was 759 acres, and under nursery grounds 170 acres. There were 39,850 acres in 1881 under wood.

According to the Landowners Return Somerset in 1873 was divided among 32,765 owners, possessing 940,483 acres, at an annual value of £2,705,393, 18s. [$13,148,214.35], or an average value all over of about £2, 17s. 6d. [$13.97] per acre. There were 20,370 proprietors, or about 62 per cent., who possessed less than one acre, and 19,246 acres were common land. The following possessed over 9000 acres each: Viscount Portman, 24,171; Sir T. D. Acland, 16,320; Sir J. H. G. Smyth, 13,543; Earl of Ilchester, 13,169; G. F. Luttrell, 12,732; Earl of Carnarvon, 12,732; Earl Poulett, 10,118; A. G. Lethbridge, 9103; and Sir A. A. Hood, 9008.

Administration and Population.—Somerset comprises forty hundreds, two liberties (Hampton and Claverton, Mells and Leigh), the cities of Bath (population 51,814 in 1881) and Wells (4634), part (38,131) of the city of Bristol, and the municipal boroughs of Bridgewater (12,007), Chard (2411), Glastonbury (3719), Taunton (16,614), and Yeovil (8479). For parliamentary purposes the county, which was formerly divided into East, Mid, and West Somerset, was by the Act of 1885 parted out in seven separate divisions—North, South, East, West (or Wellington), Bridgewater, Frome, and Wells. The borough of Frome was in 1885 merged in its county district. The city of Bath returns two members, and a portion of the East Division of Bristol is within the limits of the county. In addition to the boroughs the following urban sanitary districts are situated within the county: Burnham (1904), Clevedon (4869), a rising watering-place, Frome (9377), Midsomer-Norton (4422), Radstock (3074), Shepton Mallet (5322), Street (2514), Wellington (6360), Weston-super-Mare (12,884), a favorite watering-place, and Wiveliscombe (1624). The county has one court of quarter sessions, and is divided into twenty-two petty and special sessional divisions. The city of Bath and the borough of Bridgewater have commissions of the peace and separate courts of quarter sessions; and the city of Wells and the borough of Yeovil have commissions of the peace. The county contains 489 civil parishes, with parts of three others. Ecclesiastically it corresponds closely to the diocese of Bath and Wells. From 273,577 in 1801 the population had increased in 1831 to 403,795, in 1851 to 443,916, in 1871 to 463,483, and in 1881 to 469,109, of whom 220,582 were males and 248,527 females. The number of persons to an acre in 1881 was 0.45 and of acres to a person 2.24.

History.—Somerset, the land of the *Sumorsætan*, is one of the West-Saxon shires which grew by gradual conquest from the Welsh, as opposed to the Mercian shires mapped out round a town and called by its name. The name may well enough be what it seems at first sight, as it is called in Welsh *Wlad-yr-haf*, and in Latin sometimes *æstiva regio*. Anyhow the land bears the name of the folk. There has never been any central town or acknowledged capital, though Somerton bears a name cognate with the land. Assizes, elections, and the like have been held at different places at different times. There is no distinct name for the land earlier than the English conquest; it does not preserve the name of any British tribe, like the neighboring Damnonii and Durotriges. But there are abundance of remains both of prehistoric and of Roman times, beginning with the stones which have given their name to Stanton Drew and the great giant's chamber at Wellow. Many of the hills are crowned with camps, as Cadbury, seven acres in extent, the remains on Hampton Down, near Bath, the fortress of Maesbury Castle, remarkably well preserved, the camp on Worlebury Hill, containing a number of hut circles, Dolbury camp on the Mendips, of great extent and surrounded by a stone ditch and rampart, and Norton Fitzwarren, near Taunton. At Bath the Romans had an important city, *Aquæ Sulis*, on the line of the "fosse" which crossed the centre of Somerset, skirting the eastern ridges of the Mendips by Shepton Mallet and Ilchester (*Ichalis*) to the ancient *Moridunum*. From Ilchester another Roman road passed to *Durnovium* (Dorchester). From Brean Down, where there was a Roman port, a road crossed southeastwards by the Mendips and Shepton Mallet to *Sorbiodunum* (Salisbury). The completeness of the Roman occupation is evidenced not only by the variety and importance of the relics which have been discovered, but by the wide area over which they are spread. That lead was wrought by the Romans in the Mendips is evidenced by *laminæ* found at various places bearing the imperial stamp; from the remains of old pottery kilns that have been discovered it would appear that this industry then as now was of considerable importance; the foundations of Roman villas are very common, and there are many remarkably fine specimens of Roman pavements. After the withdrawal of the Roman power, the district formed part of the British kingdom of Damnonia or West Wales, and it plays its part in the legends of Arthur, which seem to have grown out of the history of that kingdom. The religious history gathers round the Isle of Avalon and its monastery, known in Welsh as Ynysvitrin and in English as Glastonbury, names of somewhat uncertain origin and use, and which must not be pressed too strongly. Wild legends connect the place with Joseph of Arimathæa and a crowd of saints from Ireland and elsewhere. It is enough to say that it undoubtedly was a religious house, though perhaps of no very great antiquity, before the English conquest reached so far, and that it was the one great church (as Exeter was the one great city) which lived on uninterruptedly through the English conquest. That conquest began in 577 with the campaign of Ceawlin, when, after the battle of Deorham, he took Gloucester, Cirencester, and Bath and advanced his frontier to the Axe. This was the last heathen conquest; before the second advance under Cenwealh the West-Saxons had become Christians. His two victories in 652 and 658 carried the English frontier to the Parret, and took in Glastonbury. The later stages are less clear; Centwine in 672 "drove the Bretweales to the sea," and Ine fought with the Welsh king Gerest in 710 and made Taunton a border fortress at some time before 722. By this time the conquest was complete. In the Danish wars Ælfred in 878 found shelter at Athelney and then went forth to his victory at Ethandun (Edington in Wiltshire), after which peace was made with the Danes at Wedmore. We hear of several later Danish invasions, but the Danes never made any settlements. Under Edward the Confessor Somerset formed part of the earldom, first of Swegen and then of Harold. It probably submitted to the Norman Conqueror after the taking of Exeter in 1068, and an English revolt in the next year was put down. In 1088 Ilchester stood a siege in the cause of William Rufus, and the county plays its part in the wars of Stephen. During the Middle Ages onward to the period of the civil war the historical events of Somerset—with the exception of the episode of Perkin Warbeck, who seized and abandoned Taunton in 1497—are chiefly associated with **Bristol** (*q.v.*). The great mass of the people, especially those in the towns, took the Parliament side in the great conflict, but from 1643 to 1645 the shire was in the hands of the Royalists, with the exception of Taunton, which held out heroically under Blake till relieved by Fairfax on the 11th May of the latter year, which was followed by other successes until the whole district was regained by the Cromwellian party. The continuance of a strong Puritan feeling in the district was evidenced forty years later by the support given to the Monmouth rebellion, the latest historical event of special importance connected with the county.

The history of the county and its existing remains of antiquity have been largely affected by its ecclesiastical history. First part of the single bishopric of Wessex at Winchester, then of that of Sherborne, the land of Sumorsætan became a distinct diocese in 909 with its bishopstool at Wells. The seat and style of the bishop have changed several times, but the boundaries of the diocese have changed remarkably little. Nowhere except in Sussex have the shire and the diocese been so nearly the same thing at all times. The great possessions of the bishopric and of the abbey of Glastonbury led to a remarkable lack of castles in the mid part of the county, and also tended to overshadow all other ecclesiastical foundations. Even in the other parts of the county castles are not a prominent feature, and no monastic church remains perfect except those of Bath and its cell Dunster. To Bath the bishopstool was removed in 1088, and after some shiftings, including a transfer to Glastonbury, the double style of Bath and Wells was established, the monks of Bath and the canons of Wells forming two separate chapters for the bishop. At the dissolution of

monasteries Bath was suppressed, Wells became the sole chapter, but the name of Bath was still kept in the bishop's style. The monastery of Glastonbury was destroyed, as were most of the smaller monasteries also. Of those which have left any remains, Woodspring, Montacute (Cluniac), Cleeve (Cistercian), and Michelney are the most remarkable. Athelney, founded by Ælfred on the spot where he found shelter, has utterly perished. Montacute and Dunster fill a place in both ecclesiastical and military history. The castle of Robert of Mortain, the Conqueror's brother, was built on the peaked hill (*mons acutus*) of Leodgaresburh, where the holy cross of Walthem was found. The priory arose at the foot. Dunster, one of the few inhabited castles in England, stands on a hill crowned by an English mound. Besides these there are also remains at Nunney and Castle Carey; but castles are not a strong point in Somerset antiquities. In ecclesiastical architecture the two great churches of Wells and Glastonbury supply a great study of the development of the earlier Pointed style out of Romanesque. But the architectural strength of the county lies in its great parish churches, chiefly in the Perpendicular style, of which they present a characteristic variety. In the same style among greater churches are Bath abbey, Sherborne minster in Dorset, and Saint Mary Redcliff at Bristol (locally in Somerset and till lately in the diocese), a parish church on the type of a minster. Of earlier work there is little Norman, and hardly any Primitive Romanesque, but there is a characteristic local style in some of the smaller buildings of the 14th century. The earlier churches were often cruciform, and sometimes with side towers. In domestic remains no district is richer; Somerset stands alongside of Northamptonshire owing to the abundance of good stone in both. Clevedon Court is a very fine inhabited manor-house of the 14th century, and the houses, great and small, of the 15th, 16th, and 17th centuries are endless. Indeed, the style has never quite gone out, as the gable and the mullioned window have lingered on to this day. Barrington Court in the 16th century and Montacute House in the 17th are specially fine examples. There are also some very fine barns, as at Glastonbury, Wells, and Pilton.

Among the more illustrious natives of Somersetshire are Dunstan, Roger Bacon, John Locke, Admiral Blake, Pym, Bishop Ken, Fielding, Cudworth, and the poet Daniel.

See Collinson, *History of Somersetshire*, 3 vols., 1791; Phelps, *Modern Somersetshire*, 1839; *Proceedings of the Somersetshire Archæological and Natural History Society*; Eyton, *Somerset Survey*, 2 vols., 1880; Hunt, *Diocesan History of Bath and Wells*, 1885; Freeman, *English Towns and Districts*, pp. 103 *sq.*

SOMERSET, Edward Seymour, Duke of (*c.* 1500–1552), eldest brother of Jane Seymour, Henry VIII.'s third wife, was created earl of Hertford in 1537, on the birth of his nephew, afterwards Edward VI. In 1544 he commanded in the war with Scotland, and sacked Edinburgh. Next year he again commanded against the Scots; and he was employed by Henry in many important negotiations throughout the latter part of his reign. On the accession of Edward VI. he was made protector by the council, and was soon afterwards created duke of Somerset. He at once made use of his power to encourage the extreme Reformers, and a general destruction of ecclesiastical works of art was the result. In September, 1547, finding the Scots unwilling to listen to his proposals for a marriage between Edward and Mary Stuart, he marched an army into Scotland and won the battle of Pinkie Cleugh,—a worthless victory, which only threw Scotland into the arms of France. War with that country followed, and the result was the loss of Boulogne. Equally disastrous was the protector's domestic policy. He was animated by a dislike of arbitrary government, and by a desire to improve the condition of the poor, but was at the same time a slave to his own ambition. He pushed on the Protestant Reformation with inconsiderate speed, repealed the Treason Acts of Henry VIII.'s reign, and issued a commission to inquire into agricultural distress. The agitation into which these measures threw the country produced insurrections in the west and east, which were with some difficulty suppressed. Irritated by his arrogance, rashness, and incapacity, the council, in October, 1549, turned against him, deprived him of the protectorate, and confined him in the Tower. Released in 1550, he recovered much of his influence through the misgovernment of his successors, and contemplated a return to power at their expense. His plans being discovered, he was tried on a charge of felony, and executed on January 22, 1552. His popularity was immense, and in some respects deserved; but he aspired to a tyranny, and had he retained or recovered power he would have gone far towards ruining the nation.

Authorities.—Holinshed's *Chronicle*; *Calendars of State Papers for the Reign of Edward VI.*; Strype's *Memorials*; Froude's *History of England.*

SOMERSET, Robert Carr, Earl of (*c.* 1590–1645), came of a good Scottish family, the Kers of Ferniehurst. The date of his birth seems uncertain, but he was a lad when James I. ascended the English throne. When this event occurred Carr gave up the position which he had hitherto occupied as page at the Scottish court, and sought for a time to make his fortune in France. Returning to England he entered the service of Lord Hay, and soon attracted the attention of the king. Entirely devoid of all higher qualities, Carr was endowed with good looks, excellent spirits, and considerable personal accomplishments. These advantages were sufficient for James, who knighted the young man and at once took him into favor. In 1607 an opportunity enabled the king to confer upon him a more substantial mark of his affection. Sir W. Raleigh had through his attainder forfeited his life-interest in the manor of Sherborne, but he had previously executed a conveyance by which the property was to pass on his death to his eldest son. This document was, unfortunately, rendered worthless by a flaw which gave the king eventual possession of the property. Acting on Salisbury's suggestion, James resolved to confer the manor on Carr. The case was argued at law, and judgment was in 1609 given for the crown. Lady Raleigh received some compensation, apparently inadequate, and Carr at once entered on possession. His influence was already such that in 1610 he persuaded the king to dissolve the parliament, which had shown signs of attacking the Scottish favorites. Next year Carr was made an English peer, and took his seat in the House of Lords as Viscount Rochester. Shortly afterwards he became a privy councillor, and in the autumn of 1613 he was created earl of Somerset. In 1614 he became lord chamberlain.

He was now at the zenith of his power, but the event had already occurred which was to prove his ruin. Before 1609, while still only Sir Robert Carr, he had commenced an intrigue with Lady Essex. In 1613 that lady set about procuring a divorce from her husband, with the object of afterwards marrying Carr. James favored the cause of Lady Essex; the court pronounced a decree of divorce; and in December, 1613, she married the earl of Somerset. Ten days before the court gave judgment, Sir Thomas Overbury, who apparently knew facts concerning Lady Essex which would have been fatal to her success, was poisoned in the Tower. No idea seems to have been entertained at the time that Lady Essex and her future husband were implicated. For two years more Somerset continued to exercise a paramount influence over James, and it was not till 1615 that his arrogant behavior began to alienate the king. His fall was due, however, not to the loss of the king's favor nor to the combination at court against him, but to the discovery of the circumstances of Overbury's death. In July, 1615, Somerset obtained a full pardon from the king for all offences which he might have committed. Soon afterwards the truth about the murder came out. Coke and Bacon were set to unravel the plot. After four of the principal agents had been convicted and punished, the earl and countess were brought to trial. The latter confessed, and of her guilt there can be no doubt. Somerset's share is far more difficult to discover, and probably will never be fully known. The evidence against him rested on mere presumption, and he consistently declared himself innocent. Probabilities are on the whole in favor of the hypothesis that he was not more than an accessory after the fact. James let matters take their course, and both earl and countess were found guilty. The sentence was not carried into effect against either culprit. The countess was pardoned immediately. The earl appears to have refused to buy forgiveness by concessions, and it was not till 1624 that he obtained his pardon. Thenceforward he disappears from public view. He died, without heirs, in 1645.

Authorities.—State Trials; Carew Letters; Life and Letters of Bacon, ed. Spedding; Spedding, *Studies in English History;* Gardiner, *History of England.*

SOMERVILLE, previous to its recent incorporation[1] with Boston a city of the United States, in Middlesex county, Massachusetts, lying on Mystic river, 2 miles northwest of the Boston state-house. It was named in honor of Richard Somers, a naval officer, and was incorporated as a city in 1872. The population was 24,933 in 1881. Glass-works, bottle-works, flour-mills, a bleachery, and a brass-tubing factory are among the industrial establishments.

SOMERVILLE, MARY (1780–1872), scientific writer, was the daughter of Admiral Sir William George Fairfax, and was born 26th December, 1780, in the manse of Jedburgh, the house of her mother's sister, wife of Dr. Thomas Somerville, author of *My Own Life and Times*, whose son was her second husband. She received a rather desultory education, and mastered algebra and Euclid in secret after she had left school, and without any extraneous help. In 1804 she married her cousin Captain Samuel Greig, who died in 1806; and in 1812 she married another cousin, Dr. William Somerville, inspector of the army medical board, who encouraged and greatly aided her in the study of the physical sciences. After her marriage she made the acquaintance on the Continent and in London of the most eminent scientific men of the time, among whom her talents had attracted attention before she had acquired general fame, Laplace paying her the compliment of stating that she was the only woman who understood his works. Having been requested by Lord Brougham to translate for the Society for the Diffusion of Useful Knowledge the *Mécanique Céleste* of Laplace, she greatly popularized its form, and its publication in 1831 under the title of *The Mechanism of the Heavens* at once made her famous. She was elected an honorary member of the Royal Astronomical Society, and her bust by Chantrey was placed in the hall of the Royal Society of London. Her other works are the *Connection of the Physical Sciences* (1834), *Physical Geography* (1848), and *Molecular and Microscopic Science* (1869). Much of the popularity of her writings is due to their clear and crisp style, and the underlying enthusiasm for her subject which pervades them. In 1835 she received a pension of £300 from Government. She died at Naples, 28th November, 1872. In the following year there appeared her *Personal Recollections*, consisting of reminiscences written during her old age, and of great interest both for what they reveal of her own character and life and the glimpses they afford of the literary and scientific society of bygone times.

SOMME, a department of northern France, formed in 1790 of a large part of the province of Picardy (comprising Vermandois, Santerre, Amiénois, Ponthieu, Vimeu, and Marquenterre) and a small portion of Artois. It is bounded on the N. by Pas-de-Calais and Nord, E. by Aisne, S. by Oise, and S.W. by Seine-Inférieure, and its sea-coast extends 28 miles along the English Channel. Two streams flowing into the Channel—the Authie on the north and the Bresle on the southwest—bound it in these directions. The surface consists of great rolling plains, generally well-cultivated and very fertile. The highest point, hardly 700 feet above the sea, lies in the southwest, not far from Aumale. From the mouth of the Authie to the Bay of Somme the coast is lined with a belt of sand-dunes about 2 miles broad, behind which is the Marquenterre, a tract of 50,000 acres reclaimed from the sea by means of dykes and traversed by drainage canals. The Bay of the Somme, obstructed by dangerous sand-banks, but containing the three ports of Crotoy in the north, St. Valery in the south, and Hourdel in the southwest, has also been considerably encroached upon by the same methods. Next come the shingle banks, behind which the low fields of Cayeux (25,000 acres) have been reclaimed; and then at the hamlet of Ault commence the chalk cliffs, which continue onwards into Normandy. The river Somme traverses the department from southeast to northwest for a distance of 125 miles, through a marshy valley abounding in peat. Commanded by Ham, Péronne, Amiens, and Abbeville, this valley forms a northern line of defence for Paris. Apart from the water-power it supplies, the Somme is of great commercial value, being accompanied by a canal all the way from its source wherever it is not itself navigable. From Abbeville to St. Valery its lower course forms a maritime canal 165 feet wide, 13 feet deep, and 8 to 9 miles long, capable of bearing at high tide vessels of 300 tons burden. From St. Valery to the open sea the channel is bounded on the south by a towing-path embankment 2 miles long, and on the north by a dyke, capable of being laid under water, 1 mile long, and there the current hollows out a very variable bed accessible at certain tides for vessels of 500 tons. The most important affluents of the Somme—the Ancre from the northeast by way of Albert and Corbie, the Avre from the southeast by Roye, and the Selle from the south by Conty—join the main stream at Amiens. The Authie and the Bresle are respectively 65 and 45 miles long. The latter ends in a maritime canal about 14 feet deep between Eu and Treport. The mean temperature is lower than that of Paris (49° Fahr. at Abbeville). Rain falls on 175 days per annum (33 inches at Abbeville).

Of the total area of 1,522,520 acres, 1,178,184 acres are under tillage, 68,844 are under meadows and pasture land, 133,837 are occupied by wood, while 30,514 acres are heaths or uncultivated tracts. In 1881 the live stock included 78,069 horses, 940 mules, 6125 asses, 140,512 cattle, 449,675 sheep (wool-clip 1117 tons), 82,755 pigs, 21,726 goats: there were also 27,902 hives (116 tons of honey and 36 of wax). The department, especially in the northeast, is one of the best-cultivated in France. Beetroot for sugar is the staple crop of the Péronne arrondissement; cereals, fodder, oil plants (especially the poppy), hemp, and potatoes are grown throughout the department, the latter more largely on the seaboard. No wine is grown, but the cider harvest of 1883 amounted to 8,904,100 gallons, and beer is a common beverage. In 1884 there were grown 7,072,106 bushels of wheat, 1,810,437 of meslin, 1,008,932 of rye, 1,789,089 of barley, 4207 of buckwheat, 11,197,392 of oats, 4,930,067 of potatoes, 1,161,665 tons of beetroot for sugar, and 208,686 tons of beetroot for fodder, 40 tons of hops, 242 tons of hempseed, 651 tons of hemp fibre, 1123 tons of flax, 5245 tons of colza seed, and 240,311 tons of fodder. Peat-cutting (84,335 tons in 1882) gives employment to 2640 hands, the best qualities and the deepest workings being in the valley of the Somme, between Amiens and Abbeville. The peat of inferior quality is burned on the spot and the ashes used as manure. Textile industries employ 36,000 hands. The linen and hemp manufacture is carried on in dressing establishments and spinning and weaving factories with 50,000 spindles, 2250 power-looms, and 4000 hand-looms, and the manufactures comprise canvas for packing and sail-making, and linen (including damask). Cotton is spun by 72,800 spindles, and woven by 745 power-looms and 5000 hand-looms. Moleskins and velvets for upholstery and other purposes are among the articles manufactured. Wool is wrought in 44 establishments with 124,000 spindles, 120 power-looms, and 400 hand-looms, producing yarns of all kinds, "Scotch cashmeres," "China satins," serges, merinos, repps, poplins, etc. Tulles, embroidery, laces, ribbons, plush, carpets, cotton, and woollen hose are also manufactured. The last industry employs half the population of Santerre. About 6400 workmen are engaged in the iron and copper industries, steam-engine and boiler making, and the production of spinning-mill machinery, railway plant, and umbrella frames. The arrondissement of Abbeville is the centre of a great lock-manufacture, employing from 4000 to 5000 workmen. There are also chemical factories, bleacheries, tanneries, paper-mills 470 hands, product 6108 tons in 1881), saw-mills, and soap and candle works. Beetroot sugar is manufactured in 66 establishments (5090 horse-power and 6450 workmen). In 1881 53,177 tons of sugar were produced and 2,247,146 gallons of spirit distilled from the molasses and the beet. The total number of hands employed in the industries of the department is 64,000, and the total horse-power 13,181. Thirty-seven decked boats with 400 hands are engaged in the deep-sea fisheries, in the coast fishery 132 small boats with 300 hands. Cereals, horses of the Boulogne or Norman breed, cattle, hemp and linen, and the manufactured goods are the exports of the department. Vegetables and other food-stuffs are sent to England, and shingle for the manufacture of earthenware. Besides the raw materials for the manufacturing industries, wines, timber, dye-stuffs, and coal (727,783 tons in 1882) are imported. There are 385 miles of national and 5033 miles of local roads, 119 miles of navigable river or canal, and 379 miles of railway. Administratively the department comprises 5 arrondissements (Amiens, Abbeville, Doullens, Montdidier, and Péronne), 41 cantons, and 836 communes. The population in 1881 was 550,837. The department constitutes the diocese of Amiens, which city (population in 1881, 67,874) is also the seat of a court of appeal and the headquarters of the 2d corps d'armée, in which the department is included.

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[1] [A suburb, but not a part of Boston.—Am. Ed.]

SOMMERFELD, an industrial town of Prussia, in the province of Brandenburg, lies on the Lubis, 40 miles to the southeast of Frankfort-on-the-Oder. Its manufactures of woollen cloth are important,—the annual value of the goods produced being upwards of half a million sterling; and it also contains finishing and dye works, an iron foundry, boiler works, etc. The population in 1885 was 11,364, almost all Protestants.

SOMNABULISM. See Sleep, *supra*, p. 167.

SOMNÁTH, an ancient but decayed city of peninsular Guzerat, India, with a population in 1881 of 6644, mostly Mohammedans, is situated on a bay of the Arabian Sea, in 20° 53′ N. lat. and 70° 24′ E. long. The port, which is called Verâwal, is distinct from the city proper (Deva-Pattan, Somnâth-Pattan, or Prabhas). The latter occupies a prominence on the south side of the bay, is surrounded by massive fortifications, and retains in its ruins and numerous tombs many traces of its former greatness as a commercial port. But the city was most famous for the temple just outside its walls in which stood the great idol or rather columnar emblem of Mahadeo called Somnâth (Moon's lord), which was destroyed by Mahmúd of Ghazni; see the details in vol. xv. p. 289. For the so-called "gates of Somnâth," now at Agra, see Ghazni, vol. x. p. 501. The temple was again plundered by Alá el-Dín in 1300, and appears to have been converted into a mosque. See Yule's edition of Marco Polo, vol. ii. p. 389 *sq*.

SONDERSHAUSEN. See Schwarzburg-Sondershausen.

SONNET (Ital. *Sonetto*, dim. of *Suono*, Fr. *Sonnet*). The sonnet in the literature of modern Europe is a brief poetic form of fourteen rhymed verses, ranged according to prescription. It does not, however, belong to what has been called, properly perhaps, under Rondeau (*q.v.*), the poetry of ingenuity. Although in a language like the English it does no doubt require considerable ingenuity to construct a satisfactory sonnet of octave and sestet running upon four rhymes, this ingenuity is only a means to an end, the end being properly that a single wave of emotion, when emotion is either too deeply charged with thought, or too much adulterated with fancy, to pass spontaneously into the movements of pure lyric, shall be embodied in a single metrical flow and return. Whether any given sonnet be composed like that of Pier delle Vigne (of two quatrains with rhymes running a, b, a, b, a, b, a, b, and of two tercets with rhymes running c, d, e, c, d, e), or whether the verses be arranged (on the authority of Shakespeare and Drayton) in three quatrains of alternate rhymes clinched by a couplet, or, as in the sonnet of Petrarch, in an octave of two rhymes and a sestet of either two or three rhymes,—in each case the peculiar pleasure which the ear derives from the sonnet as a metrical form lies in the number and arrangements of the verses being *prescribed*, and distinctly recognizable as being prescribed. That the impulse to select for the rendering of single phases of feeling or reflection a certain recognized form is born of a natural and universal instinct is perhaps evidenced by the fact that even when a metrical arrangement discloses no structural law demanding a prescriptive number and arrangement of verses, the poet will nevertheless, in certain moods, choose to restrict himself to a prescribed number and arrangement, as in the cases of the Italian *stornello*, the Welsh *triban*, and the beautiful rhymeless short ode of Japanese poetry, for the knowledge of which we are indebted to Mr. Chamberlain. And perhaps, if space permitted us to probe the matter deeply, we should find that the recognized prescription of form gives a sense of oneness that nothing else save the refrain can give to a poem which, being at once too long for a stanza in a series and too short to have the self-sustaining power of the more extended kinds of poetic art, suffers by suggesting to the ear a sense of the fragmentary and the inchoate. It is not then merely the number of the verses, it is also their arrangement as to rhymes,—an arrangement leading the ear to expect a prescribed sequence and then satisfying that expectation,—which entitles a form of fourteen verses to be called a sonnet.

Hence the so-called irregular sonnets of S. T. Coleridge, which lead the ear of the reader to expect the pleasure of a prescribed arrangement when what they have to offer is a pleasure of an exactly opposite kind—the pleasure of an absolute freedom from prescribed arrangement—are unsatisfactory, while (as the present writer has often pointed out) the same poet's fourteen-line poem, "Work without Hope," in which the reader expects and gets freedom from prescription, is entirely satisfactory. This same little poem of Coleridge's also affords an excellent illustration of another point in connection with the sonnet. If we trace the history and the development of the sonnet from Pier delle Vigne to Rossetti we shall find that the poet's quest from the very first has been to write a poem in fourteen verses so arranged that they should, better than any other number and arrangement of verses, produce a certain melodic effect upon the ear, and an effect, moreover that should bear iteration and reiteration in other poems similarly constructed. Now if we ask ourselves whether, beautiful as is this poem, "Work without Hope," taken as a single and original metrical arrangement, we should get out of a series of poems modelled line for line upon it that pleasure of iteration which we get out of a series of Petrarchan sonnets, we shall easily see why the regular sonnet of octave and sestet on the one hand, and what is called the Shakespearean sonnet on the other, have survived all other competing forms.

In modern Europe the sonnet has always had a peculiar fascination for poets of the first class—poets, that is, in whom what we have called poetic energy (see Poetry) and plastic power are equally combined. It would seem that the very fact that the sonnet is a recognized structure suggestive of mere art—suggestive in some measure, indeed, of what Schiller would call "sport" in art—has drawn some of the most passionate poets in the world to the sonnet as the medium of their sincerest utterances. Without being coldly artificial, like the rondeau, the sestina, the *ballade*, the *villanelle*, etc., the sonnet is yet so artistic in structure, its form is so universally known, recognized, and adopted as being artistic, that the too fervid spontaneity and reality of the poet's emotion may be in a certain degree veiled, and the poet can whisper, as from behind a mask, those deepest secrets of the heart which could otherwise only find expression in purely dramatic forms.

That the sonnet was invented, not in Provence as French critics pretend, but in Italy in the 13th century, is pretty clear, but by whom is still perhaps an open question. Mr. S. Waddington (*Sonnets of Living Writers*) and several other contemporary critics attribute to Fra Guittone the honor of having invented the form. But Mr. J. A. Symonds has reminded us that the sonnet beginning *Però ch' amore*, attributed to Pier delle Vigne, secretary of state in the Sicilian court of Frederick, has claims which no student of early Italian poetry can ignore.

As regards English sonnets, whether the Petrarchan and the Shakespearean are really the best of all possible forms we need not inquire. But, inasmuch as they have become so vital and so dominant over other sonnet forms that whenever we begin to read the first verse of an English sonnet we expect to find one or other of these recognized rhyme-arrangements, any departure from these two arrangements, even though the result be such a magnificent poem as Shelley's "Ozymandias," disappoints the expectation, baffles the ear, and brings with it that sense of the fragmentary and the inchoate to which we have before alluded. If, however, some writer should arise with sufficient originality of metrical endowment and sufficient poetic power to do what Keats, in a famous experiment of his tried to do and failed,—impress the public ear with a new sonnet structure, impress the public ear so powerfully that a new kind of expectance is created the moment the first verse of a sonnet is recited,—then there will be three kinds of English sonnets instead of two.

With regard to the Petrarchan sonnet, all critics are perhaps now agreed that, while the form of the octave is invariable, the form of the sestet is absolutely free, save that the emotions should govern the arrangement of the verses. But as regards the division between octave and sestet, Mr. Mark Pattison says, with great boldness, but perhaps with truth, that by blending octave with sestet Milton missed the very object and end of the Petrarchan scheme. Another critic, however, Mr. Hall Caine, in his preface to *Sonnets of Three Centuries*, contends that by making "octave flow into sestet without break of music or thought" Milton consciously or unconsciously invented a new form of sonnet; that is to say, Milton, in his use of the Petrarchan octave and sestet for the embodiment of intellectual substance incapable of that partial disintegration which Petrarch himself always or mostly sought, invented a species of sonnet which is English in impetus, but Italian, or partially Italian, in structure. Hence this critic like Mr. William Sharp (*Sonnets of this Century*), divides all English sonnets into four groups: (1) sonnets of Shakespearean structure; (2) sonnets of octave and sestet of Miltonic structure; (3) sonnets of contemporary structure, *i.e.*, all sonnets on the Petrarchan model in which the metrical and intellectual "wave of flow and ebb" (as originally formulated by the present writer in a sonnet on the sonnet, which has appeared in most of the recent anthologies) is strictly observed, and in which, while the rhyme-arrangement of the octave is invariable, that of the sestet is free; (4) sonnets of miscellaneous structure.

With regard to what is called the contemporary form,—a Petrarchan arrangement with the sestet divided very sharply from the octave,—the crowning difficulty and the crowning triumph of the sonnet writer has always been to so handle the rhythm of the prescribed structure as to make it seem in each individual sonnet the inevitable and natural rhythm demanded by the emotion which gives the individual sonnet birth, and this can perhaps only be achieved when the richness and apparent complexity of the rhyme-arrangement is balanced by that perfect lucidity and simplicity of syntax which is the special quest of the "sonnet of flow and ebb."

The wave theory has found acceptance with most recent students of the sonnet, such as Rossetti and the late Mark Pattison, Mr. J. A. Symonds, Mr. Hall Caine, and Mr. William Sharp. Mr. Symonds, indeed, seems to hint that the very name given by the Italians to the two tercets, the volta or turn, indicates the metrical meaning of the form. "The striking metaphorical symbol," says he, "drawn from the observation of the swelling and declining wave can even in some examples be applied to sonnets on the Shakespearean model; for, as a wave may fall gradually or abruptly, so the sonnet may sink with stately volume or with precipitate subsidence to its close. Rossetti furnishes incomparable examples of the former and more desirable conclusion; Sydney Dobell, in *Home in War Time*, yields an extreme specimen of the latter."

And now as to the Shakespearean sonnet. Some very acute critics have spoken as if this form were merely a lawless succession of three quatrains clinched by a couplet, and as if the number of the quatrains might just as well have been two or four as the present prescribed number of three. If this were so, it would unquestionably be a serious impeachment of the Shakespearean sonnet, for save in the poetry of ingenuity no metric arrangement is otherwise than bad unless it be the result of a deep metrical necessity.

If the prescriptive arrangement of *three* quatrains clinched by a couplet is not a metrical necessity, if it is not demanded in order to prevent the couplet from losing its power, such an arrangement is idle and worse than idle; just as, in the case of the Petrarchan sonnet, if it can be shown that the solid unity of the outflowing wave can be maintained as completely upon three rhymes as upon two, then the restriction of the octave to two rhymes is simple pedantry. But he who would test the metrical necessity of the arrangement in the Shakespearean sonnet has only to make the experiment of writing a poem of two quatrains with a couplet, and then another poem of four quatrains with a couplet, in order to see how inevitable is the metrical necessity of the Shakespearean number and arrangement for the achievement of the metrical effect which Shakespeare, Drayton, and others sought. While in the poem of two quatrains the expected couplet has the sharp epigrammatic effect of the couplet in ordinary stanzas (such as that of *ottava rima*, and as that of the *Venus and Adonis* stanza), destroying that pensive sweetness which is the characteristic of the Shakespearean sonnet, the poem of four quatrains is just sufficiently long for the expected pleasure of the couplet to be dispersed and wasted.

The quest of the Shakespearean sonnet is not, like that of the sonnet of octave and sestet, sonority, and, so to speak, metrical counterpoint, but sweetness; and the sweetest of all possible arrangements in English versification is a succession of decasyllabic quatrains in alternate rhymes knit together and clinched by a couplet—a couplet coming not so far from the initial verse as to lose its binding power, and yet not so near the initial verse that the ring of epigram disturbs the "linked sweetness long drawn out" of this movement, but sufficiently near to shed its influence over the poem back to the initial verse. A chief part of the pleasure of the Shakespearean sonnet is the expectance of the climacteric rest of the couplet at the end (just as a chief part of the pleasure of the sonnet of octave and sestet is the expectance of the answering ebb of the sestet when the close of the octave has been reached); and this expectance is gratified too early if it comes after two quatrains, while, if it comes after a greater number of quatrains than three, it is dispersed and wasted altogether.

The French sonnet has a regular Petrarchan octave with a sestet of three rhymes beginning with a couplet. The Spanish sonnet is also based on the pure Italian type, and is extremely graceful and airy. The same may be said of the Portuguese sonnet—a form of which the illustrious Cameons has left nearly three hundred examples. (T. W.)

SOPHIA DOROTHEA (1666–1726), the daughter and heiress of Duke George William of Brunswick-Lüneburg-Celle, was born on September 15, 1666. On

November 21, 1682, she was married to Prince George Louis of Hanover, afterwards George I. of England, to whom she bore in 1683 a son, afterwards King George II., and in 1687 a daughter, Sophia Dorothea, afterwards the wife of Frederick William I. of Prussia and the mother of Frederick the Great. For her illicit relations with Count Philip Christopher von Königsmark (see vol. x. p. 378) Sophia Dorothea was divorced from her husband the elector in December, 1694, and the remainder of her life was spent in a dignified captivity under a military guard at her ancestral seat of Ahlden. She died on November 13, 1726. Her correspondence with Königsmark was discovered at Lund by Prof. Palmblad, and published by him in 1847; see also the Count von Schulenburg's *Herzogin von Ahlden* (Leipsic, 1852).

SOPHISTS. Sophist, or "man of wisdom," was the name given by the Greeks about the middle of the 5th century B.C. to certain teachers of a superior grade who, distinguishing themselves from philosophers on the one hand and from artists and craftsmen on the other, claimed to prepare their pupils, not for any particular study or profession, but for civic life. For nearly a hundred years the sophists held almost a monopoly of general or liberal education. Yet, within the limits of the profession, there was considerable diversity both of theory and of practice. Four principal varieties are distinguishable, and may be described as the sophistries of culture, of rhetoric, of politics, and of eristic or disputation. Each of these predominated in its turn, though not to the exclusion of others, the sophistry of culture beginning about 447, and leading to the sophistry of eristic, and the sophistry of rhetoric taking root in central Greece about 427, and merging in the sophistry of politics. Further, since Socrates and the Socratics were educators, they too might be, and in general were, regarded as sophists; but, as they conceived truth—so far as truth was attainable—rather than success in life, in the law court, in the assembly, or in debate, to be the right end of intellectual effort, they were at variance with their rivals, and are commonly ranked by historians, not with the sophists, who confessedly despaired of knowledge, but with the philosophers, who, however unavailingly, continued to seek it. With the establishment of the great philosophical schools—first, of the Academy, next of the Lyceum—the philosophers took the place of the sophists as the educators of Greece.

The sophistical movement was then primarily an attempt to provide a general or liberal education which should supplement the customary instruction in reading, writing, gymnastic and music. But, as the sophists of the first period chose for their instruments grammar, style, literature and oratory, while those of the second and third developments were professed rhetoricians, sophistry exercised an important influence upon literature. Then again, as the movement, taking its rise in the philosophical agnosticism which grew out of the early physical systems, was itself persistently skeptical, sophistry may be regarded as an interlude in the history of philosophy. Finally, the practice of rhetoric and eristic, which presently became prominent in sophistical teaching, had, or at any rate seemed to have, a mischievous effect upon conduct; and the charge of seeking, whether in exposition or in debate, not truth but victory—which charge was impressively urged against the sophists by Plato—grew into an accusation of holding and teaching immoral and unsocial doctrines, and in our own day has been the subject of eager controversy. In the present article the matters above indicated will be dealt with under the following heads: (1) the genesis and development of sophistry; (2) the relations of sophistry to education, literature and philosophy (3) the theory of Grote.

(1) *Genesis and Development of Sophistry.*—Sophistry arose out of a crisis in philosophy. The earlier Ionian physicists—Thales, Anaximander, and Anaximenes—in their attempts to trace the multiplicity of things to a single material element, had been troubled by no misgivings about the possibility of knowledge. But, when Heraclitus, to the assumption of fire as the single material cause added the doctrine that all things are in perpetual flux, he found himself obliged to admit that things cannot be known. Thus, though, in so far as he asserted his fundamental doctrine without doubt or qualification, he was a dogmatist, in all else he was a skeptic. Again, the Eleatic Parmenides, deriving from the theologian Xenophanes the distinction between *ἐπιστήμη* and *δόξα*, conceived that, whilst the One exists, and is the object of knowledge the Multiplicity of things becomes, and is the object of opinion; but, when his successor Zeno provided the system with a logic, the consistent application of that logic resolved the fundamental doctrine into the single proposition "One is One," or, more exactly, into the single identity "One One." Thus Eleaticism, though professedly dogmatic, was inconsistent in its theory of the One and its attributes, and openly skeptical in regard to the world of nature. Lastly, the philosophers of the second physical succession—Empedocles and Anaxagoras—not directly attacking the great mystery of the One and the Many, but in virtue of a scientific instinct approaching it through the investigation of phenomena, were brought by their study of sensation to perceive and to proclaim the inadequacy of the organs of sense. Thus they too, despite their air of dogmatism, were in effect skeptics. In short, from different standpoints, the three philosophical successions had devised systems which were in reality skeptical, though they had none of them recognized the skeptical inference.

Towards the middle of the 5th century, however, Protagoras of Abdera, taking account of the teaching of the first, and possibly of the second, of the physical successions, and Gorgias of Leontini, starting from the teaching of the metaphysical succession of Elea, drew that skeptical inference from which the philosophers had shrunk. If, argued Protagoras in a treatise entitled *Truth*, all things are in flux, so that sensation is subjective, it follows that "Man is the measure of all things, of what is, that it is, and of what is not, that it is not"; in other words, there is no such thing as objective truth. Similarly, Gorgias, in a work *On Nature, or on the Nonent*, maintained (*a*) that nothing is, (*b*) that, if anything is, it cannot be known, (*c*) that if anything is and can be known, it cannot be expressed in speech; and the summaries which have been preserved by Sextus Empiricus (*Adv. Math.*, vii. 65–87) and by the author of the *De Melisso*, etc. (cc. 5, 6), show that, in defending these propositions, Gorgias availed himself of the arguments which Zeno had used to discredit the popular belief in the existence of the Many; in other words, that Gorgias turned the destructive logic of Zeno against the constructive ontology of Parmenides, thereby not only reducing Eleaticism to nothingness, but also, until such time as a better logic than that of Zeno should be provided, precluding all philosophical inquiry whatsoever. Thus, whereas the representatives of the three successions had continued to regard themselves as philosophers or seekers after truth, Protagoras and Gorgias, plainly acknowledging their defeat, withdrew from the ungrateful struggle.

Meagre as were the results which the earlier thinkers had obtained, the extinction of philosophy just at the time when the liberal arts became more technical, and consequently less available as employments of leisure, threatened to leave a blank in Hellenic life. Accordingly Protagoras, while with the one hand he put away philosophy, with the other offered a substitute. Emphasizing the function of the teacher, which with the philosophers had been subordinate, and proclaiming the right end of intellectual endeavor to be, not "truth" (*ἀλήθεια*) or "wisdom" (*σοφία*), which was unattainable, but "virtue" or "excellence" (ἀρετή), he sought to communicate, not a theory of the universe, but an aptitude for civic life. "The lesson which I have to teach," Plato makes him say (*Prot.*, 318 E), "is prudence or good counsel, both in respect of domestic matters, that the man may manage his household aright, and in respect of public affairs, that he may be thoroughly qualified to take part, both by deed and by word in the business of the state. In other words, I profess to make men good citizens." As instruments of education Protagoras used grammar, style, poetry, and oratory. Thus, whereas hitherto the young Greek, having completed his elementary training in the schools of the γραμματιστής, the κιθαριστής and the παιδοτρίβης, was left to prepare himself for his life's work as best he might, by philosophical speculation, by artistic practice, or otherwise, one who passed from the elementary schools to the lecture-room of Protagoras received from him a "higher education." The programme was exclusively literary, but for the moment it enabled Protagoras to satisfy the demand which he had discovered and evoked. Wherever he went his lecture-room was crowded with admiring pupils, whose homage filled his purse and enhanced his reputation.

After Protagoras the most prominent of the literary sophists was Prodicus of Ceos. Establishing himself at Athens, he taught "virtue" or "excellence," in the sense attached to the word by Protagoras, partly by means of literary subjects, partly in discourses upon practical ethics. It is plain that Prodicus was an affected pedant. Yet his simple conventional morality found favor, and Plato (*Rep.*, 600 C) couples him with Protagoras in his testimony to the popularity of the sophists and their teaching.

At Athens, the centre of the intellectual life of Greece, there was soon to be found a host of sophists: some of them strangers, others citizens; some of them bred under Protagoras and Prodicus, others self-taught. In the teaching of the sophists of this younger generation two points are observable. First, their independence of philosophy and the arts being assured, though they continued to regard "civic excellence" as their aim, it was no longer necessary for them to make the assertion of its claims a principal element in their exposition. Secondly, for the sake of novelty they extended their range, including scientific and technical subjects, but handling them, and teaching their pupils to handle them, in a popular way. In this stage of sophistry then, the sophist, though not a specialist, trenched upon the provinces of specialists; and accordingly Plato (*Prot.*, 318 E), makes Protagoras pointedly refer to sophists who, "when young men have made their escape from the arts, plunge them once more into technical study, and teach them such subjects as arithmetic, astronomy, geometry, and music." The sophist of whom the Platonic Protagoras is here thinking was Hippias of Elis, who gave popular lectures, not only upon the four subjects just mentioned, but also upon grammar, mythology, family history, archæology, Homerology, and the education of youth. In this polymath we see at once the degradation of the sophistry of culture and the link which connects Protagoras and Prodicus with the eristics, who at a later period taught, not, like Hippias, all branches of learning, but a universally applicable method of disputation.

Meanwhile, Gorgias of Leontini, who, as has been seen, had studied and rejected the philosophy of western Greece, gave to sophistry a new direction by bringing to the mother country the technical study of rhetoric,—especially forensic rhetoric (Plato, *Gorg.*, 454 B; *cf.* Aristotle, *Rhet.*, 1354 b 26),—which study had begun in Sicily with Corax and Tisias nearly forty years before. Gorgias was already advanced in years and rich in honors when, in 427, he visited Athens as the head of an embassy sent to solicit aid against Syracuse. Received with acclamation, he spent the rest of his long life in central Greece, winning applause by the display of his oratorical gifts and acquiring wealth by the teaching of rhetoric. There is no evidence to show that at any period of his life he called himself a sophist; and, as Plato (*Gorg.*, 449 A) makes him describe himself as a ῥήτωρ, it is reasonable to suppose that he preferred that title. That he should do so was only natural, since his position as a teacher of rhetoric was already secure when Protagoras made his first appearance in the character of a sophist; and, as Protagoras, Prodicus, and the rest of the sophists of culture offered a comprehensive education, of which oratory formed only a part, whilst Gorgias made no pretence of teaching "civic excellence" (Plato, *Meno*, 95 C), and found a substitute for philosophy, not in literature generally, but in the professional study of rhetoric alone, it would have been convenient if the distinction between sophistry and rhetoric had been maintained. But, though, as will be seen hereafter, these two sorts of education were sometimes distinguished, Gorgias and those who succeeded him as teachers of rhetoric, such as Thrasymachus of Chalcedon and Polus of Agrigentum, were commonly called by the title which Protagoras had assumed and brought into familiar use.

Rhetorical sophistry, as taught by Gorgias with special reference to the requirements of the law courts, led by an easy transition to political sophistry. During the century which had elapsed since the expulsion of the Pisistratids and the establishment of the democracy, the Athenian constitution had developed with a rapidity which produced an oligarchical reaction, and the discussion of constitutional principles and precedents, always familiar to the citizen of Athens, was thus abnormally stimulated. The Peloponnesian War too not only added a deeper interest to ordinary questions of policy, but also caused the relations of dissentient parties, of allied and belligerent states, of citizens and aliens, of bond and free, of Greeks and barbarians, to be eagerly debated in the light of present experience. It was only natural then that some of those who professed to prepare young Athenians for public life should give to their teaching a distinctively political direction; and accordingly we find Isocrates recognizing teachers of politics, and discriminating them at once from those earlier sophists who gave popular instruction in the arts and from the contemporary eristics. To this class, that of the political sophists, may be assigned Lycophron, Alcidamas, and Isocrates himself. For, though that celebrated personage would have liked to be called, not "sophist," but "political philosopher," and tried to fasten the name of "sophist" upon his opponents the Socratics, it is clear from his own statement that he was commonly ranked with the sophists, and that he had no claim, except on the score of superior popularity and success, to be dissociated from the other teachers of political rhetoric. It is true that he was not a political sophist of the vulgar type, that as a theorist he was honest and patriotic, and that, in addition to his fame as a teacher, he had a distinct reputation as a man of letters; but he was a professor of political rhetoric, and, as such, in the phraseology of the day, a sophist. He had already reached the height of his fame when Plato opened a rival school at the Academy, and pointedly attacked him in the *Gorgias*, the *Phædrus*, and the *Republic*. Thenceforward there was a perpetual controversy between the rhetorician and the philosopher, and the struggle of educational systems continued until, in the next generation, the philosophers were left in possession of the field.

While the sophistry of rhetoric led to the sophistry of politics, the sophistry of culture led to the sophistry of disputation. It has been seen that the range of subjects recognized by Protagoras and Prodicus gradually extended itself, until Hippias professed himself a teacher of all branches of learning, including in his list subjects taught by artists and professional men, but handling them from a popular or non-professional point of view. The successors of the polymath claimed to possess and to communicate, not the knowledge of all branches of learning, but an aptitude for dealing with all subjects, which aptitude should make the knowledge of any subject superfluous. In other words, they cultivated skill in disputation. Now skill in disputation is plainly a valuable accomplishment; and, as the Aristotelian logic grew out of the regulated discussions of the eristics and their pupils, the disputant sophistry of the 4th century deserves more attention and more respect than it usually receives from historians of Greek thought. But when men set themselves to cultivate skill in disputation, irrespective of the matter debated,—when men regard the matter discussed, not as a serious issue, but as a thesis upon which to practice their powers of controversy,—they learn to pursue, not truth, but victory: and, their criterion of excellence having been thus perverted, they presently prefer ingenious fallacy to solid reasoning, and the applause of bystanders to the consciousness of honest effort. Indeed, the sophists generally had a predisposition to error of this sort, not only because sophistry was from the beginning a substitute for the pursuit of truth, but also because the successful professor, travelling from city to city, or settling abroad, could take no part in public affairs, and thus was not at every step reminded of the importance of the "material" element of exposition and reasoning. Paradox, however, soon becomes stale, and fallacy wearisome. Hence, despite its original popularity, eristical sophistry could not hold its ground. The man of the world who had cultivated it in his youth regarded it in riper years as a foolish pedantry, or at best as a propædeutic exercise; while the serious student, necessarily preferring that form of disputation which recognized truth as the end of this as of other intellectual processes, betook himself to one or other of the philosophies of the revival.

In order to complete this sketch of the development of sophistry in the latter half of the 5th century and the earlier half of the 4th, it is necessary next to take account of Socrates and the Socratics. A foe to philosophy and a renegade from art, Socrates took his departure from the same point as Protagoras, and moved in the same direction, that of the education of youth. Finding in the cultivation of "virtue" or "excellence" a substitute for the pursuit of scientific truth, and in disputation the sole means by which "virtue" or "excellence" could be attained, he resembled at once the sophists of culture and the sophists of eristic. But, inasmuch as the "virtue" or "excellence" which he sought was that of the man rather than that of the official, while the disputation which he practiced had for its aim not victory, but the elimination of error, the differences which separated him from the sophists of culture and the sophists of eristic were only less considerable than the resemblances which he bore to both; and further, though his whole time and attention were bestowed upon the education of young Athenians, his theory of the relations of teacher and pupil differed from that of the recognized professors of education, inasmuch as the taking of fees seemed to him to entail a base surrender of the teacher's independence. The principal characteristics of Socrates's theory of education were accepted, *mutatis mutandis*, by the leading Socratics. With these resemblances to the contemporary professors of education, and with these differences, were Socrates and the Socratics sophists or not? To this question there is no simple answer, yes or no. It is certain that Socrates's contemporaries regarded him as a sophist; and it was only reasonable that they should so regard him, because in opposition to the physicists of the past and the artists of the present he asserted the claims of higher education. But, though according to the phraseology of the time he was a sophist, he was not a typical sophist,—his principle that, while scientific truth is unattainable by man, right opinion is the only basis of right action, clearly differentiating him from all the other professors of "virtue." Again, as the Socratics—Plato himself, when he established himself at the Academy, being no exception—were, like their master, educators rather than philosophers, and in their teaching laid especial stress upon discussion, they too were doubtless regarded as sophists, not by Isocrates only, but by their contemporaries in general; and it may be conjectured that the disputatious tendencies of the Megarian school made it all the more difficult for Plato and others to secure a proper appreciation of the difference between dialectic, or discussion with a view to the discovery of truth, and eristic, or discussion with a view to victory. Changing circumstances, however, carry with them changes in the meaning and application of words. Whereas, so long as philosophy was in abeyance Socrates and the Socratics were regarded as sophists of an abnormal sort, as soon as philosophy revived it was dimly perceived that, in so far as Socrates and the Socratics dissented from sophistry, they preserved the philosophical tradition. This being so, it was found convenient to revise the terminology of the past, and to include in the philosophical succession those who, though not philosophers, had cherished the sacred spark. As for Socrates, he ranked himself neither with the philosophers, who professed to know, nor with the sophists, who professed to teach; and, if he sometimes described himself as a φιλόσοφος, he was careful to indicate that he pretended to no other knowledge than that of his own limitations.

It would seem then, (1) that popular nomenclature included under the term "sophist" all teachers—whether professors, or, like Socrates, amateurs—who communicated, not artistic skill, nor philosophical theory, but a general or liberal education; (2) that, of those who were commonly accounted sophists, some professed culture, some forensic rhetoric, some political rhetoric, some eristic, some (*i.e.*, the Socratics) dialectic; (3) that the differences between the different groups of sophists were not inconsiderable, and that in particular the teaching of the rhetoricians was distinct in origin, and, in so far as its aim was success in a special walk of life, distinct in character, from the more general teaching of the sophists of culture, the eristics, and the dialecticians, while the teaching of the dialecticians was discriminated from that of the rest, in so far as the aim of the dialecticians was truth, or at least the bettering of opinion; and, consequently, (4) that, in awarding praise and blame to sophistry and its representatives, the distinctive characteristics of the groups above enumerated must be studiously kept in view.

Lapse of time and change of circumstances brought with them, not merely changes in the subjects taught, but also changes in the popular estimate of sophistry and sophists. The first and most obvious sentiment which sophistry evoked was an enthusiastic and admiring interest. The sophist seemed to his youthful hearers to open a new field of intellectual activity and thereby to add a fresh zest to existence. But in proportion to the fascination which he exercised upon the young was the distrust which he inspired in their less pliable elders. Not only were they dismayed by the novelty of the sophistical teaching, but also they vaguely perceived that it was subversive of authority, of the authority of the parent over the child as well as of the authority of the state over the citizen. Of the two conflicting sentiments, the favor of the young, gaining as years passed away, naturally prevailed; sophistry ceased to be novel, and attendance in the lecture-rooms of the sophists came to be thought not less necessary for the youth than attendance in the elementary schools for the boy. The lively enthusiasm and the furious opposition which greeted Protagoras had now burnt themselves out, and before long the sophist was treated by the man of the world as a harmless, necessary pedagogue.

That sophistry must be studied in its historical development was clearly seen by Plato, whose dialogue called the *Sophist* contains a formal review of the changing phases and aspects of sophistical teaching. The subject which is discussed in that dialogue and its successor the *Statesman* being the question "Are sophist, statesman, and philosopher identical or different?" the Eleate who acts as protagonist seeks a definition of the term "sophist" by means of a series of divisions or dichotomies. In this way he is led to regard the sophist successively—(1) as a practitioner of that branch of mercenary persuasion in private which professes to impart "virtue" and exacts payment in the shape of a fee, in opposition to the flatterer who offers pleasure, asking for sustenance in return; (2) as a practitioner of that branch of mental trading which purveys from city to city discourses and lessons about "virtue," in opposition to the artist who similarly purveys discourses and lessons about the arts; (3) and (4) as a practitioner of those branches of mental trading, retail and wholesale, which purvey discourses and lessons about "virtue" within a city, in opposition to the artists who similarly purvey discourses and lessons about the arts; (5) as a practitioner of that branch of eristic which brings to the professor pecuniary emolument, eristic being the systematic form of antilogic, and dealing with justice, injustice, and other abstractions, and antilogic being that form of disputation which uses question and answer in private, in opposition to forensic, which uses continuous discourse in the law-courts; (6) as a practitioner of that branch of education which purges away the vain conceit of wisdom by means of cross-examination, in opposition to the traditional method of reproof or admonition. These definitions being thus various, the Eleate notes that the sophist, in consideration of a fee, disputes, and teaches others to dispute, about things divine, cosmical, metaphysical, legal, political, technical,—in fact, about everything,—not having knowledge of them, because universal knowledge is unattainable; after which he is in a position to define the sophist (7) as a conscious impostor who, in private, by discontinuous discourse, compels his interlocutor to contradict himself, in opposition to the δημολογικός, who, in public, by continuous discourse, imposes upon crowds.

It is clear that the final definition is preferred, not because of any intrinsic superiority, but because it has a direct bearing upon the question "Are sophist, statesman, and philosopher identical or different?" and that the various definitions represent different stages or forms of sophistry as conceived from different points of view. Thus the first and second definitions represent the founders of the sophistry of culture, Protagoras and Prodicus, from the respective points of view of the older Athenians, who disliked the new culture, and the younger Athenians, who admired it; the third and fourth definitions represent imitators to whom the note of itinerancy was not applicable; the fifth definition represents the earlier eristics, contemporaries of Socrates, whom it was necessary to distinguish from the teachers of forensic oratory; the sixth is framed to meet the anomalous case of Socrates, in whom many saw the typical sophist, though Plato conceives this view to be unfortunate; and the seventh and final definition, having in view eristical sophistry fully developed, distinguishes it from δημολογική, *i.e.*, political rhetoric, but at the same time hints that, though σοφιστική and δημολογική may be discriminated, they are nevertheless near akin, the one being the ape of philosophy, the other the ape of statesmanship. In short, Plato traces the changes which, in less than a century, had taken place in the meaning of the term, partly through changes in the practice of the sophists, partly through changes in their surroundings and in public opinion, so as to show by a familiar instance that general terms which do not describe natural kinds cannot have a stable connotation.

Now it is easy to see that in this careful statement Plato recognizes three periods. The first four definitions represent the period of Protagoras, Prodicus, and their immediate successors, when the object sought was "virtue," "excellence," "culture," and the means to it was literature. The fifth and sixth definitions represent the close of the 5th century, when sophistry handled eristically, and perhaps, though Plato demurs to the inclusion, dialectically, questions of justice, injustice, and the like, δικανική or forensic rhetoric being its proximate rival. The seventh definition represents the first half of the 4th century, when sophistry was eristical in a wider field, having for its rival, not forensic rhetoric, but the rhetoric of the assembly. Plato's classification of educational theories is then substantially the classification adopted in this article, though, whereas here, in accordance with well-attested popular usage, all the educational theories mentioned are included under the head of sophistry, Plato allows to rhetoric, forensic and political, an independent position, and hints that there are grounds for denying the title of sophist to the dialectician Socrates. Incidentally we gather two important facts,—(1) that contemporary with the dialectic of Socrates there was an eristic, and (2) that this eristic was mainly applied to ethical questions. Finally, we may be sure that, if Plato was thus careful to distinguish the phases and aspects of sophistical development, he could never have fallen into the modern error of bestowing upon those whom the Greeks called sophists either indiscriminate censure or indiscriminate laudation.

(2) *Relations of Sophistry to Education, Literature, and Philosophy.*—If then the sophists, from Protagoras to Isocrates, were before everything educators, it becomes necessary to inquire whether their labors marked or promoted an advance in educational theory and method. At the beginning of the 5th century B.C. every young Greek of the better sort already received rudimentary instruction, not only in music and gymnastics, but also in reading and writing. Further, in the colonies, and especially the colonies of the West, philosophy and art had done something for higher education. Thus in Italy the Pythagorean school was, in the fullest sense of the term, an educational institution; and in Sicily the rhetorical teaching of Corax and Tisias was presumably educational in the same sense as the teaching of Gorgias. But in central Greece, where, at any rate down to the Persian Wars, politics, domestic and foreign, were all-engrossing, and left the citizen little leisure for self-cultivation, the need of a higher education had hardly made itself felt. The overthrow of the Persian invaders changed all this. Henceforward the best of Greek art, philosophy, and literature gravitated to Athens, and with their concentration and consequent development came a general and growing demand for teaching. As has been seen, it was just at this period that philosophy and art ceased to be available for educational purposes, and accordingly the literary sophists were popular precisely because they offered advanced teaching which was neither philosophical nor artistic. Their recognition of the demand and their attempt to satisfy it are no small claims to distinction. That, whereas before the time of Protagoras there was little systematic education in the colonies and less in central Greece, after his time attendance in the lecture-rooms of the sophists was the customary sequel to attendance in the elementary schools, is a fact which speaks for itself.

But this is not all. The education provided by the sophists of culture had positive merits. When Protagoras included in his course grammar, style, interpretation of the poets, and oratory, supplementing his own continuous expositions by disputations in which he and his pupils took part, he showed a not inadequate appreciation of the requisites of a literary education; and it may be conjectured that his comprehensive programme, which Prodicus and others extended, had something to do with the development of that versatility which was the most notable element in the Athenian character.

There is less to be said for the teachers of rhetoric, politics, and eristic, who, in limiting themselves each to a single subject,—the rhetoricians proper or forensic rhetoricians to one branch of oratory, the politicians or political rhetoricians to another, and the eristics to disputation,—ceased to be educators and became instructors. Nevertheless, rhetoric and disputation, though at the present day strangely neglected in English schools and universities, are, within their limits, valuable instruments; and, as specialization in teaching does not necessarily imply specialization in learning, many of those who attended the lectures and the classes of a rhetorician or an eristic sought and found other instruction elsewhere. It would seem then that even in its decline sophistry had its educational use. But in any case it may be claimed for its professors that in the course of a century they discovered and turned to account most of the instruments of literary education.

With these considerable merits, normal sophistry had one defect, its indifference to truth. Despairing of philosophy,—that is to say, of physical science,—the sophists were prepared to go all lengths in skepticism. Accordingly the epideictic sophists in exposition, and the argumentative sophists in debate, one and all, studied, not matter but style, not accuracy but effect, not proof but persuasion. In short, in their hostility to science they refused to handle literature in a scientific spirit. That this defect was serious was dimly apprehended even by those who frequented and admired the lectures of the earlier sophists; that it was fatal was clearly seen by Socrates, who, himself commonly regarded as a sophist, emphatically reprehended, not only the taking of fees, which was after all a mere incident, objectionable because it seemed to preclude independence of thought, but also the fundamental disregard of truth which infected every part and every phase of sophistical teaching. To these contemporary censures the modern critic cannot refuse his assent.

To literature and to oratory the sophists rendered good service. Themselves of necessity stylists, because their professional success largely depended upon skilful and effective exposition, the sophists both of culture and of rhetoric were professedly teachers of the rules of grammar and the principles of written and spoken discourse. Thus, by example as well as by precept, they not only taught their hearers to value literary and oratorical excellence, but also took the lead in fashioning the style of their time. Their influence in these respects was weighty and important. Whereas when sophistry began prose composition was hardly practiced in central Greece, the sophists were still the leaders in literature and oratory when Plato wrote the *Republic*, and they had hardly lost their position when Demosthenes delivered the *Philippics*. In fact, it is not too much to say that it was the sophists who provided those great masters with their consummate instrument, and it detracts but little from the merit of the makers if they were themselves unable to draw from it its finer tones.

The relation of sophistry to philosophy was throughout one of pronounced hostility. From the days of Protagoras, when this hostility was triumphant and contemptuous, to the days of Isocrates, when it was jealous and bitter, the sophists were declared and consistent skeptics. But, although Protagoras and Gorgias had examined the teaching of their predecessors so far as to satisfy themselves of its futility and to draw the skeptical inference, their study of the great problem of the day was preliminary to their sophistry rather than a part of it; and, as the overthrow of philosophy was complete and the attractions of sophistry were all-powerful, the question, "What is knowledge?" ceased for a time to claim or to receive attention. There is then no such thing as a "sophistical theory of knowledge." Similarly, the recognition of a "sophistical ethic" is, to say the least, misleading. It may have been that the sophists' preference of seeming to reality, of success to truth, had a mischievous effect upon the morality of the time; but it is clear that they had no common theory of ethics, and there is no warrant for the assumption that a sophist, as such, specially interested himself in ethical questions. When Protagoras asserted "civic excellence" or "virtue" to be the end of education, he neither expressed nor implied a theory of morality. Prodicus in his platitudes reflected the customary morality of the time. Gorgias said plainly that he did not teach "virtue." If Hippias, Polus, and Thrasymachus defied conventional morality, they did so independently of one another, and in this, as in other matters, they were disputants maintaining paradoxical theses, rather than thinkers announcing heretical convictions. The morality of Isocrates bore a certain resemblance to that of Socrates. In short, the attitude of the sophists towards inquiry in general precluded them, collectively and individually, from attachment to any particular theory. Yet among the so-called sophists there were two who had philosophical leanings, as appears in their willingness to be called by the title of philosopher. First, Socrates, whilst he conceived that the physicists had mistaken the field of inquiry, absolute truth being unattainable, maintained, as has been seen, that one opinion was better than another, and that consistency of opinion, resulting in consistency of action, was the end which the human intellect properly proposes to itself. Hence, though an agnostic, he was not unwilling to be called a philosopher, in so far as he pursued such truth as was attainable by man. Secondly, when sophistry had begun to fall into contempt, the political rhetorician Isocrates claimed for himself the time-honored designation of philosopher, "herein," says Plato, "resembling some tinker, bald-pated and short of stature, who, having made money, knocks off his chains, goes to the bath, buys a new suit, and then takes advantage of the poverty and desolation of his master's daughter to urge upon her his odious addresses" (*Rep.*, vi. 495 E). It will be seen, however, that neither Socrates nor Isocrates was philosopher in any strict sense of the word, the speculative aims of physicists and metaphysicians being foreign to the practical theories both of the one and of the other.

As for the classification of sophistical methods, so for their criticism, the testimony of Plato is all-important. It may be conjectured that, when he emerged from the purely Socratic phase of his earlier years, Plato gave himself to the study of contemporary methods of education and to the elaboration of an educational system of his own, and that it was in this way that he came to the metaphysical speculations of his maturity. It may be imagined further that, when he established himself at the Academy, his first care was to draw up a scheme of education, including arithmetic, geometry (plane and solid), astronomy, harmonics, and dialectic, and that it was not until he had arranged for the carrying out of this programme that he devoted himself to the special functions of professor of philosophy. However this may be, we find amongst his writings,—intermediate, as it would seem, between the Socratic conversations of his first period of literary activity and the metaphysical disquisitions of a later time,—a series of dialogues which, however varied their ostensible subjects, agree in having a direct bearing upon education. Thus the *Protagoras* brings the educational theory of Protagoras and the sophists of culture face to face with the educational theory of Socrates, so as to expose the limitations of both; the *Gorgias* deals with the moral aspect of the teachings of the forensic rhetorician Gorgias and the political rhetorician Isocrates, and the intellectual aspect of their respective theories of education is handled in the *Phædrus*; the *Meno* on the one hand exhibits the strength and the weakness of the teaching of Socrates, and on the other brings into view the makeshift method of those who, despising systematic teaching, regarded the practical politician as the true educator; the *Euthydemus* has for its subject the eristical method; finally, having in these dialogues characterized the current theories of education, Plato proceeds in the *Republic* to develop an original scheme. Plato's criticisms of the sophists are then, in the opinion of the present writer, no mere *obiter dicta*, introduced for purposes of literary adornment or dramatic effect, but rather the expressions of profound and reasoned conviction, and, as such, entitled at any rate to respect. For the details of Plato's critique, the reader should go, not to the summaries of commentators, but to the dialogues themselves. In this place it is sufficient to say that, while Plato accounts no education satisfactory which has not knowledge for its basis, he emphatically prefers the skepticism of Socrates, which, despairing of knowledge, seeks right opinion, to the skepticism of the sophists, which, despairing of knowledge, abandons the attempt to better existing beliefs.

(3) *The Theory of Grote.*—The post-Platonic historians and critics, who, while they knew the earlier sophistry only through tradition, were eye-witnesses of the sophistry of the decadence, were more alive to the faults than to the virtues of the movement. Overlooking the differences which separated the humanists

from the eristics, and both of these from the rhetoricians, and taking no account of Socrates, whom they regarded as a philosopher, they forgot the services which Protagoras and Prodicus, Gorgias and Isocrates, had rendered to education and to literature, and included the whole profession in an indiscriminate and contemptuous censure. This prejudice, establishing itself in familiar speech, has descended from antiquity to modern times, coloring, when it does not distort, the narratives of biographers and the criticisms of commentators. "The sophists," says Grote, "are spoken of as a new class of men, or sometimes in language which implies a new doctrinal sect or school, as if they then sprang up in Greece for the first time—ostentatious impostors, flattering and duping the rich youth for their own personal gain, undermining the morality of Athens, public and private, and encouraging their pupils to the unscrupulous prosecution of ambition and cupidity. They are even affirmed to have succeeded in corrupting the general morality, so that Athens had become miserably degenerated and vicious in the latter years of the Peloponnesian War, as compared with what she was in the time of Miltiades and Aristeides"; and, although amongst the pre-Grotian scholars there were some who saw as clearly as Grote himself that "the sophists are a much-calumniated race" (G. H. Lewes), it is certain that historians of philosophy, and editors of Plato, especially the "acumen plumbeum Stallbaumii," had given ample occasion for the energetic protest contained in the famous sixty-seventh chapter of Grote's *History of Greece.* Amongst the many merits of that admirable scholar, it is one of the greatest that he has laid "the fiend called *die Sophistik,*" that is to say, the theory that sophistry was an organized conspiracy against law and morals. Nevertheless, in this matter he is always an advocate; and it may be thought that, while he successfully disposes of the current slander, his description of his clients needs correction in some important particulars. Hence the following paragraphs, while they will resume and affirm his principal results, will qualify and impugn some of his positions.

In so far as he is critical, Grote leaves little to be desired. That the persons styled sophists "were not a sect or school, with common doctrines or method," is clear. Common doctrine, that is to say, common doctrine of a positive sort, they could not have, because, being skeptics, they had nothing which could be called positive doctrine; while there was a period when even their skepticism was in no wise distinctive, because they shared it with all or nearly all their contemporaries. Neither were they united by a common educational method, the end and the instruments of education being diversely conceived by Protagoras, Gorgias, and Isocrates, to say nothing of the wider differences which separate these three from the eristics, and all the four normal types from the abnormal type represented by Socrates.

Again, it is certain that the theoretical and practical morality of the sophists, regarded as a class, was "neither above nor below the standard of the age." The taking of fees, the pride of professional success, and the teaching of rhetoric are no proofs either of conscious charlatanism or of ingrained depravity. Indeed, we have evidence of sound, if conventional, principle in Prodicus's apologue of the "Choice of Heracles," and of honorable, though eccentric, practice in the story of Protagoras's treatment of defaulting pupils. But, above all, it is antecedently certain that defection from the ordinary standard of morality would have precluded the success which the sophists unquestionably sought and won. In fact, public opinion made the morality of the sophists, rather than the sophists the morality of public opinion. Hence, even if we demur to the judgment of Grote that "Athens at the close of the Peloponnesian War was not more corrupt than Athens in the days of Miltiades and Aristeides," we shall not "consider the sophists as the corrupters of Athenian morality," but rather with Plato lay the blame upon society itself, which, "in popular meetings, law-courts, theatres, armies, and other great gatherings, with uproarious censure and clamorous applause" (*Rep.*, vi. 492), educates young and old, and fashions them according to its pleasure.

Nor can we regard "Plato and his followers as the authorized teachers of the Greek nation and the sophists as the dissenters." On the contrary, the sophists were in quiet possession of the field when Plato, returning to Athens, opened the rival school of the Academy; and, while their teaching in all respects accommodated itself to current opinion, his, in many matters, ran directly counter to it.

But if thus far Grote's protest against prevalent assumptions carries an immediate and unhesitating conviction, it may be doubted whether his positive statement can be accounted final. "The appearance of the sophists," he says, "was no new fact. . . . The paid teachers—whom modern writers set down as the sophists, and denounce as the modern pestilence of their age—were not distinguished in any marked or generic way from their predecessors." Now it is true that before 447 B.C., besides the teachers of writing, gymnastic, and music, to whom the young Greek resorted for elementary instruction, there were artists and artisans who not only practiced their crafts but also communicated them to apprentices and pupils, and that accordingly the Platonic Protagoras recognizes in the gymnast Iccus, the physician Herodicus, and the musicians Agathocles and Pythoclides forerunners of the sophists. But the forerunners of the sophists are not to be confounded with the sophists themselves, and the difference between them is not far to seek. Though some of those who resorted to the teachers of rudiments and the artists derived from them such substitute for "higher education" as was before 447 generally obtainable, it was only incidentally that the teachers of rudiments and the artists communicated anything which could be called by that name. Contrariwise, the sophists were always and essentially professors of the higher education; and, although in process of time specialization assimilated sophistry to the arts, at the outset at any rate, its declared aim—the cultivation of the civic character—sufficiently distinguished sophistical education both from rudimentary instruction and from artistic training. It is true too that in some of the colonies philosophy had busied itself with higher education; but here again the forerunners of the sophists are easily distinguished from the sophists, since the sophists condemned, not only the scientific speculations of their predecessors, but also their philosophical aims, and offered to the Greek world a new employment for leisure, a new intellectual ambition.

Nor is it altogether correct to say that "the persons styled sophists had no principles common to them all and distinguishing them from others." Various as were the phases through which sophistry passed between the middle of the 5th century and the middle of the 4th, the sophists—Socrates himself being no exception—had in their declared antagonism to philosophy a common characteristic; and, if in the interval, philosophical speculation being temporarily suspended, skepticism ceased for the time to be peculiar, at the outset, when Protagoras and Gorgias broke with the physicists, and in the sequel, when Plato raised the cry of "back to Parmenides," this common characteristic was distinctive.

Further, it may be doubted whether Grote is sufficiently careful to distinguish between the charges brought against the sophists personally and the criticism of their educational methods. When the sophists are represented as conscious impostors who "poisoned and demoralized by corrupt teaching the Athenian moral character," he has, as has been seen, an easy and complete reply. But the question still remains—Was the education provided by Protagoras, by Gorgias, by Isocrates, by the eristics, and by Socrates good, bad, or indifferent? And, though the modern critics will not be prepared with Plato to deny the name of education to all teaching which is not based upon an ontology, it may nevertheless be thought that normal sophistry—as opposed to the sophistry of Socrates—was in various degrees unsatisfactory, in so far as it tacitly or confessedly ignored the "material" element of exposition or reasoning.

And if Grote overlooks important agreements he seems also to understate important differences. Regarding Protagoras, Gorgias, and Isocrates as types of one and the same sophistry (pp. 487, 493, 495, 499, 544, 2d edition), and neglecting as slander or exaggeration all the evidence in regard to the sophistry of eristic (p. 540), he conceives that the sophists' undertook "to educate young men so as to make them better qualified for statesmen or ministers," and that "that which stood most prominent in the teaching of Gorgias and the other sophists was, that they cultivated and improved the powers of public speaking in their pupils." Excellent as a statement of the aim and method of Isocrates, and tolerable as a statement of those of Gorgias, these phrases are inexact if applied to Protagoras, who, making "civic virtue" his aim, regarded statesmanship and administration as parts of "civic virtue," and consequently assigned to oratory no more than a subordinate place in his programme, while to the eristics—whose existence is attested, not only by Plato, but also by Isocrates and Aristotle—and to Socrates—whom Grote himself accounts a sophist—the description is plainly and palpably inappropriate.

Grote's note about the eristical sophists is perhaps the least satisfactory part of his exposition. That "there were in Athens persons who abused the dialectical exercise for frivolous puzzles" he admits; but "to treat Euthydemus and Dionysodorus as samples of 'The Sophists' is," he continues, "altogether unwarrantable." It would seem then that, while he regards rhetoric as the function of normal sophistry, taking indifferently as his types Protagoras, Gorgias, and Isocrates, he accounts Euthydemus and Dionysodorus (together with Socrates) as sophists, but as sophists of an abnormal sort, who may therefore be neglected. Now this view is inconsistent with the evidence of Plato, who, in the *Sophist*, in his final and operative definition, gives prominence to the eristical element, and plainly accounts it the main characteristic, not indeed of the sophistry of the 5th century, but of the sophistry of the 4th. It must be presumed then that, in virtue of his general suspicions of the Platonic testimony, Grote in this matter leaves the *Sophist* out of account. There is, however, another theory of the significance of Plato's allusions to eristical sophistry, that of Prof. H. Sidgwick, whose brilliant defence of Grote is an indispensable supplement to the original document. Giving a hearty general assent to Grote's theory, Sidgwick nevertheless introduces qualifications similar to some of those which are suggested in this article. In particular he allows that "there was at any rate enough of charlatanism in Protagoras and Hippias to prevent any ardor for their historical reputation," that the sophists generally "had in their lifetime more success than they deserved," that it was "antagonism to their teaching which developed the genius of Socrates," and, above all, that, "in his anxiety to do justice to the Sophist, Grote laid more stress than is at all necessary on the partisanship of Plato." Now this last admission precludes Sidgwick from neglecting, as Grote had done, the evidence of the *Euthydemus*. Pointing out that the sophists of that dialogue "profess εἰς ἀρετῆς ἐπιμέλειαν προτρέψαι by means of dialogue," that "they challenge the interlocutor ὑπέχειν λόγον," that "their examples are drawn from common objects and vulgar trades," that "they maintain positions that we know to have been held by Megarians and Cynics," he infers that "what we have here presented to us as 'sophistic' is neither more nor less than a caricature of the Megarian logic;" and further, on the ground that "the whole conception of Socrates and his effect on his contemporaries, as all authorities combine to represent it, requires us to assume that his manner of discourse was quite novel, that no one before had systematically attempted to show men their ignorance of what they believed themselves to know," he is "disposed to think that the art of disputation which is ascribed to sophists in the *Euthydemus* and the *Sophistes* (and exhaustively analyzed by Aristotle in the περὶ Σοφιστικῶν Ἐλέγχων) originated entirely with Socrates, and that he is altogether responsible for the form at least of this socond species of sophistic." To this theory the present writer is unable to subscribe. That Plato was not careful to distinguish the Megarians and the Cynics from the eristical sophists, and that the disputants of the 4th century affected some of the mannerisms of the greatest disputant of the 5th century, he willingly concedes. But he cannot allow either that the Megarians and the Cynics were the only eristics, or that eristical sophistry began with Socrates. Plainly this is not the place for a full examination of the question; yet it may be remarked: (1) that the previous history of the sophists of the *Euthydemus*, who had been professors of tactics (Xenophon, *Mem.*, iii. 1, 1), swordsmanship, and forensic argumentation, implies that they came to eristic, not from the sophistry of Socrates, but from that of the later humanists, polymaths of the type of Hippias; (2) that the fifth and sixth definitions of the *Sophist*, in which "that branch of eristic which brings pecuniary gain to the practitioner" is opposed to the "patience-trying, purgative elenchus" of Socrates, indicate that contemporary with Socrates there were eristics whose aims were not his; (3) that, whereas the sophist of the final definition "disputes, and teaches others to dispute, about things divine, cosmical, metaphysical, legal, political, technical, in fact, about all things," we have no ground for supposing that the Megarians and the Cynics used their eristic for any purpose except the defence of their logical heresies.

Nor is it possible to accept the statements that "the splendid genius, the lasting influence, and the reiterated polemics of Plato have stamped the name sophist upon the men against whom he wrote as if it were their recognized, legitimate, and peculiar designation," and that "Plato not only stole the name out of general circulation, in order to fasten it specially upon his opponents the paid teachers, but also connected with it express discreditable attributes which formed no part of its primitive and recognized meaning and were altogether distinct from, though grafted upon, the vague sentiment of dislike associated with it." That is to say, Grote supposes that for at least eight and forty years, from 447 to 399, the paid professors had no professional title; that, this period having elapsed, a youthful opponent succeeded in fastening an uncomplimentary title, not only upon the contemporary teachers, but also, retrospectively, upon their predecessors; and that, artfully enhancing the indignity of the title affixed, he thus obscured, perverted, and effaced the records and the memories of the past. Manifestly all three propositions are antecedently improbable. But more than this: whereas in the nomenclature of Plato's contemporaries Protagoras, Gorgias, Socrates, Dionysodorus, and Isocrates were all of them sophists, Plato himself in his careful investigation summarized above limits the meaning of the term so that it shall include the humanists and the eristics only. Now, if his use of the term was stricter than the customary use, he can hardly be held answerable for the latter.

Nor is Grote altogether just in his account of Plato's attitude towards the several sophists, or altogether judicious in his appreciation of Plato's testimony. However contemptuous in his portraiture of Hippias and Dionysodorus, however severe in his polemic against Isocrates, Plato regards Protagoras with admiration and Gorgias with respect. While he emphasizes in the later sophists the consequences of the fundamental error of sophistry,—its indifference to truth,—he does honor to the genius and the originality of the leaders of the movement. Indeed, the author of this article finds in the writings of Plato a grave and discriminating study of the several forms of sophistry, but no trace whatsoever of that blind hostility which should warrant us in neglecting his clear and precise evidence.

In a word, the present writer agrees with Grote that the sophists were not a sect or school with common doctrine or method; that their theoretical and practical morality was neither above nor below that of their age, being, in fact, determined by it; and that Plato and his followers are not to be regarded as the authorized teachers of the Greek nation, nor the sophists as the dissenters, but *vice versa*. At the same time, in opposition to Grote, he maintains that the appearance of the sophists marked a new departure, in so far as they were the first professors of "higher education" as such; that they agreed in the rejection of "philosophy"; that the education which they severally gave was open to criticism, inasmuch as, with the exception of Socrates, they attached too much importance to the form, too little to the matter, of their discourses and arguments; that humanism, rhetoric, politic, and disputation were characteristic, not of all sophists collectively, but of sections of the profession; that Plato was not the first to give a special meaning to the term "sophist" and to affix it upon the professors of education; and, finally, that Plato's evidence is in all essentials trustworthy.

Bibliography.—On the significance of the sophistical movement, see E. Zeller, *Philosophie d. Griechen*, 4th ed., Leipsic, 1876, i. 932–1041 (*Presocratic Philosophy*, London, 1881, ii. 394–516); G. Grote, *History of Greece*, London, 1851, etc., ch. lxvii.; E. M. Cope, "On the Sophists," and "On the Sophistical Rhetoric," in *Jour. Class. and Sacr. Philol.*, Cambridge, ii. 1855, and iii. 1857, an erudite but inconclusive reply to Grote; H. Sidgwick, "The Sophists," in *Jour. of Philol.*, Cambridge, iv. 1872, and v. 1874, a brilliant defence of Grote; A. W. Benn, *The Greek Philosophers*, London, 1882, i. 53–107. Compare ETHICS, vol. viii. p. 508. For lists of treatises upon the life and teaching of particular sophists, see Ueberweg, *Grundriss d. Gesch. d. Philos.*, i. §§ 27–32 (*History of Philosophy*, London, 1880). On the later use of the term "sophist," see RHETORIC. (H. JA.)

SOPHOCLES, the most perfect, and next to Æschylus the greatest, of Greek tragic poets, was born 495 B.C. and died 406 B.C. As in the case of other Athenian celebrities, various particulars of his life are handed down, few of which, however, deserve much attention, even the reports attributed to contemporaries being mostly trivial if not puerile. He is known to have reached old age, and his career as a dramatist is believed to have extended over more than sixty years (468–406). His father's name was Sophillus, of the deme Colonus Hippius, the aristocratic quarter, where the Government of the Four Hundred was afterwards constituted. The family burial-place is said by the anonymous biographer to have been ten stadia from the city, on the Decelean Way. These facts run counter to the tradition, which seems to have been already discredited by Alexandrian critics, that Sophillus was an artisan. The date assigned for the poet's birth is in accordance with the tale that young Sophocles, then a pupil of the musician Lamprus, was chosen to lead the chorus of boys (*ἠΐθέων λεκτοί*, *Œd. Tyr.*, 18) in the celebration of the victory of Salamis (480 B.C.). The time of his death is fixed by the allusions to it in the *Frogs* of Aristophanes and in the *Muses*, a lost play of Phrynichus, the comic poet, which were both produced in 405 B.C., shortly before the capture of the city. And the legend which implies that Lysander allowed him funeral honors is one of those which, like the story of Alexander and Pindar's house at Thebes, we can at least wish to be founded on fact, though we should probably substitute Agis for Lysander. Apart from tragic victories, the event of Sophocles's life most fully authenticated is his appointment at the age of fifty-five as one of the generals who served with Pericles in the Samian War (440–439 B.C.). Conjecture has been rife as to the possibility of his here improving acquaintance with Herodotus, whom he probably met some years earlier at Athens (see HERODOTUS). But the distich quoted by Plutarch—

'Ωιδὴν 'Ηροδότῳ τεῦξεν Σοφοκλῆς ἐτέων ὢν
Πέντ' ἐπὶ πεντήκοντα—

is a slight ground on which to reject the stronger tradition according to which Herodotus was ere this established at Thurii; and the coincidences in their writings may be accounted for by their having drawn from a common source. The fact of Sophocles's generalship is the less surprising if taken in connection with the interesting remark of his biographer (whose *Life*, though absent from the earliest MS. through some mischance, bears marks of an Alexandrian origin) that he took his full share of civic duties, and even served on foreign embassies: *Καλῶς τ' ἐπαιδεύθη καὶ ἐτράφη ἐν εὐπορίᾳ, καὶ ἐν πολιτείᾳ καὶ ἐν πρεσβείαις ἐξητάζετο.* The large acquaintanceship which this implies, not only in Athens, but in Ionic cities generally, is a point of main importance in considering the opportunities of information at his command. And, if we credit this assertion, we are the more at liberty to doubt the other statement, though it is not incredible, that his appointment as general was due to the political wisdom of the *Antigone*.

The testimony borne by Aristophanes to the amiability of the poet's temper (*ὁ δ' εὔκολος μὲν ἐνθάδ', εὔκολος δ' ἐκεῖ*) agrees with the record of his biographer that he was universally beloved. And the anecdote recalled by Cephalus in Plato's *Republic*, that Sophocles welcomed the release from the passions which is brought by age, accords with the spirit of his famous Ode to Love in the *Antigone*. The Sophocles who, according to Aristotle (*Rhet.*, iii. 18), said of the Government of the Four Hundred that it was the better of two bad alternatives (probably the same who was one of the *probuli*) may or may not have been the poet. Other gossiping stories are hardly worth repeating,—as that Pericles rebuked his love of pleasure and thought him a bad general, though a good poet; that he humorously boasted of his own "generalship" in affairs of love; or that he said of Æschylus that he was often right without knowing it, and that Euripides represented men as they are, not as they ought to be. Such trifles rather reflect contemporary or subsequent impressions of a superficial kind than tell us anything about the man or the dramatist. The gibe of Aristophanes (*Pax*, 695 *sq.*), that Sophocles in his old age was become a very Simonides in his love for gain, may turn on some perversion of fact,[1] without being altogether fair to either poet. It is certainly irreconcilable with the remark (*Vit. Anon.*) that in spite of pressing invitations he refused to leave Athens for kings' courts. And the story of his indictment by his son Iophon for incompetence to manage his affairs,—to which Cicero has given some weight by quoting it in the *De Senectute*,—appears to be really traceable to Satyrus (*flor.* c. 200 B.C.), the same author who gave publicity to the most ridiculous of the various absurd accounts of the poet's death,—that his breath failed him for want of a pause in reading some passage of the *Antigone*. Satyrus is at least the sole authority for the defence of the aged poet, who, after reciting passages from the *Œd. Col.*, is supposed to have said to his accusers, "If am Sophocles I am no dotard, and if I dote I am not Sophocles." On the other hand, we need not the testimony of biographers to assure us that he was devoted to Athens and renowned for piety. He is said to have been priest of the hero Alcon (or Halon) in his old age, and himself to have received divine honors after death.

That the duty of managing the actors as well as of training the chorus belonged to the author is well known. But did Æschylus act in his own plays? This certainly is implied in the tradition that Sophocles, because of the weakness of his voice, was the first poet who desisted from doing so. In his *Thamyras*, however, he is said to have performed on the lyre to admiration, and in his *Nausicaa* (perhaps as coryphæus) to have played gracefully the game of ball. Various minor improvements in decoration and stage carpentry are attributed to him,—whether truly or not who can tell? It is more interesting, if true, that he wrote his plays having certain actors in his eye; that he formed an association (θίασον) for the promotion of liberal culture; and that he was the first to introduce three actors on the stage.[1] It is asserted on the authority of Aristoxenus that Sophocles was also the first to employ Phrygian melodies. And it is easy to believe that *Aj.*, 693 *sq.*, *Trach.*, 205 *sq.*, were sung to Phrygian music, though there are strains in Æschylus (*e.g.*, *Choeph.*, 152 *sq.*, 423 *sq.*), which it is hard to distinguish essentially from these. Ancient critics had also noted his familiarity with Homer, especially with the *Odyssey*, his power of selection and of extracting an exquisite grace from all he touched (whence he was named the "Attic Bee"), his mingled felicity and boldness, and, above all, his subtle delineation of human nature and feeling. They observed that the balanced proportions and fine articulation of his work are such that in a single half line or phrase he often conveys the impression of an entire character. Nor is this verdict of antiquity likely to be reversed by modern criticism. The object of the present article, however, is not to praise Sophocles, but rather to describe him. And it is time to turn from Alexandrian or Byzantine fancies and judgments to the poet's extant works.

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[1] If any of Sophocles's elegies or odes were "pot-boilers," this might be due rather to his easy temper (*εὐκολία*) in yielding to a prevalent habit of the time than to any meanness (*βαναυσία* or *γλισχρότης*).

His minor poems, elegies, pæans, etc., have all perished, and of his hundred and odd dramas only seven remain. These all belong to the period of his maturity (he had no decline); and not only the titles (as Lessing said) but some scanty fragments of more than ninety others have been preserved. Several of these were, of course, satyric dramas. And this recalls a point of some importance, which has been urged on the authority of Suidas, who says that "Sophocles began the practice of pitting play against play, instead of the tetralogy." If it were meant that Sophocles did not exhibit tetralogies, this statement would have simply to be rejected. For the words of Suidas (950 A.D.) has no weight against quotations from the lists of tragic victories (διδασκαλίαι) which there is no other reason for discrediting. The remark might be due to the impression made on some critics by the greater complexity and completeness of a play of Sophocles—say the *Œdipus Tyrannus* or *Antigone*—as compared, say, with the *Persæ* or the *Septem contra Thebas*. It is distinctly asserted, for example, on the authority of the διδασκαλίαι, that the *Bacchæ* of Euripides, certainly as late as any play of Sophocles, was one of a trilogy or tetralogy. And if the custom was thus maintained for so long it was clearly impossible for any single competitor to break through it. But it seems probable that the trilogy had ceased to be the continuous development of one legend or cycle of legends,—"presenting Thebes or Pelops' line,"—if, indeed, it ever was so exclusively; and if, as Schöll and others have suggested, a Sophoclean tetralogy was still linked together by some subtle bond of tragic thought or feeling, this would not affect the criticism of each play considered as an artistic whole. At the same time it appears that the satyric drama lost its grosser features and became more or less assimilated to the milder form of tragedy. And these changes, or something like them, may have given rise to the statement in Suidas.[2]

If the diction of Sophocles sometimes reminds his readers of the *Odyssey*, the subjects of his plays were more frequently chosen from those later epics which subsequently came to be embodied in the epic cycle,—such as the *Æthiopis*, the *Little Iliad*, the *Iliupersis*, the *Cypria*, the *Nosti*, the *Telegonia* (all revolving round the tale of Troy), the *Thebaica*, the Οἰχαλίας ἅλωσις, and others, including probably, though there is no mention of such a thing, some early version of the Argonautic story. In one or other of these heroic poems the legends of all the great cities of Hellas were by this time embodied; and, though there must also have been a cloud of oral tradition floating over many a sacred spot, the dramatic poet does not seem, unless in the *Œdipus Coloneus*, to have directly drawn from this. He was content to quarry from the epic rhapsodies the materials for his more concentrated art, much as Shakespeare made use of Hollinshed or Plutarch, or as the subjects of Tennyson's *Idylls of the King* have been taken from Sir Thomas Malory. As Sophocles has been accused of narrowing the range of tragic sympathy from Hellas to Athens, it deserves mention here that, of some hundred subjects of plays attributed to him, fifteen only are connected with Attica, while exactly the same number belong to the tale of Argos, twelve are Argonautic, and thirty Trojan: Even Corinthian heroes (Bellerophon, Polyidus) are not left out. It seems probable on the whole that, within the limits allowed by convention, Sophocles was guided simply by his instinctive perception of the tragic capabilities of a particular fable. This was evidently Lessing's view, and may be confirmed by quoting his striking remarks upon the subject of one of the lost tragedies, the *Thyestes at Sicyon*:

> "Nach der abscheulichen Mahlzeit, die ihm sein Bruder bereitete, flog er nach Sicyon. Und hier war es wo er, auf Befragung des Orakels, wie er sich an seinem Bruder rächen sollte, die Antwort bekam, er sollte seine eigne Tochter entehren. Er überfiel dies auch unbekannter Weise; und aus diesem Beischlafe ward Ægisth, der den Atreus hernach umbrachte, erzeugt. Die Verzweiflung einer geschändeten Prinzessin! Von einem Unbekannten! In welchem sie endlich ihren Vater erkennt! Eine von ihrem Vater entehrte Tochter! Und aus Rache entehrt! Geschändet, einen Mörder zu gebären! Welche Situationen! welche Scenen!"

To say that subsidiary or collateral motives were never present to Sophocles in the selection of a subject would, however, be beyond the mark. His first drama, the *Triptolemus*, must have been full of local coloring; the *Ajax* appealed powerfully to the national pride; and in the *Œdipus Coloneus* some faint echoes even of oligarchical partisanship may be possibly discerned. But, even where they existed, such motives *were* collateral and subsidiary: they were never primary. All else were subordinated to the dramatic, or, in other words, the purely human, interest of the fable. This central interest is even more dominant and pervading in Sophocles than the otherwise supreme influence of religious and ethical ideas. The idea of destiny, for example, was of course inseparable from Greek tragedy. Its prevalence was one of the conditions which presided over the art from its birth, and, unlike Æschylus, who wrestles with gods, our poet simply accepts it, both as a *datum* of tradition and a fact of life. But in the free handling of Sophocles even fate and providence are adminicular to tragic art. They are instruments through which sympathetic emotion is awakened, deepened, intensified. And, while the vision of the eternal and unwritten laws was holier yet, for it was not the creation of any former age, but rose and culminated with the Sophoclean drama, still to the poet and his Periclean audience this was no abstract notion, but was inseparable from their impassioned contemplation of the life of man—so great and yet so helpless, aiming so high and falling down so far, a plaything of the gods and yet essentially divine. This lofty vision subdued with the serenity of awe the terror and pity of the scene, but from neither could it take a single tremor or a single tear. Emotion was the element in which Greek tragedy lived and moved, albeit an emotion that was curbed to a serene stillness through its very depth and intensity.

The final estimate of Sophoclean tragedy must largely depend upon the mode in which his treatment of destiny is conceived. That Æschylus had risen on the wings of faith to a height of prophetic vision, from whence he *saw* the triumph of equity and the defeat of wrong as an eternal process moving on toward one divine event,—that he realized sin, retribution, responsibility, as no other ancient did,—may be gladly conceded. But it has been argued[1] that because Sophocles is saddened by glancing down again at actual life,—because in the fatalism of the old fables he finds the reflection of a truth,—he in so far takes a step backward as a tragic artist. Now is this altogether just? His value for what is highest in man is none the less because he strips it of earthly rewards, nor is his reverence for eternal law less deep because he knows that its workings are sometimes pitiless. Nor, once more, does he disbelieve in providence, because experience has shown him that the end towards which the supreme powers lead forth mankind is still unseen. We miss something of the exultant energy of the Marathonian man, but under the grave and gentle guidance of his successor we lose nothing of the conviction that, "because right is right, to follow right were wisdom in the scorn of consequence." Not only the utter devotion of Antigone, but the lacerated innocence of Œdipus and Deianira, the tempted truth of Neoptolemus, the essential nobility of Ajax, leave an impress on the heart which is ineffaceable, and must elevate and purify while it remains. In one respect, however, it must be admitted that Sophocles is not before his age. There is an element of unrelieved vindictiveness, not merely inherent in the fables, but inseparable from the poet's handling of some themes, which is only too consistent with the temper of the "tyrant city." Æschylus represents this with equal dramatic vividness, but he associates it, not with heroism, but with crime.

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[1] If this was so, it must have been previous to the appearance of the Orestean trilogy.

[2] The advantages and defects of the trilogy as a dramatic form are admirably stated by G. Günther, *Grundzüge der Tragischen Kunst*, Berlin, 1885. The small number of victories attributed to Sophocles, in proportion to the number of his plays, is only intelligible on the supposition that these were presented in groups.

Sophocles is often praised for skilful construction. But the secret of his skill depends in large measure on the profound way in which the central situation in each of his fables has been conceived and felt. Concentration is the distinguishing note of tragedy, and it is by greater concentration that Sophocles is distinguished from other tragic poets. In the *Septem contra Thebas*, or the *Prometheus*, there is still somewhat of epic enlargement and breadth; in the *Hecuba*, and other dramas of Euripides, separate scenes have an idyllic beauty and tenderness which affect us more than the progress of the action as a whole, a defect which the poet sometimes tries to compensate by some novel denouement or catastrophe. But in following a Sophoclean tragedy we are carried steadily and swiftly onward, looking neither to the right nor to the left; the more elaborately any scene or single speech is wrought, the more does it contribute to enhance the main emotion, and if there is a deliberate pause it is felt either as a welcome breathing space or as the calm of brooding expectancy.

The result of this method is the union, in the highest degree, of simplicity with complexity, of largeness of design with absolute finish, of grandeur with harmony. Superfluities are thrown off without an effort through the burning of the fire within. Crude elements are fused and made transparent. What look like ornaments are found to be inseparable from the organic whole. Each of the plays is admirable in structure, not because it is cleverly put together, but because it is so completely alive.

The spectator of a Sophoclean tragedy was invited to witness the supreme crisis of an individual destiny, and was possessed at the outset with the circumstances of the decisive moment. Except in the *Trachiniæ*, where the retrospective soliloquy of Deianira is intended to emphasize her lonely position, this exposition is effected through a brief dialogue, in which the protagonist may or may not take part. In the *Œdipus Tyrannus* the king's entrance and his colloquy with the aged priest, introduce the audience at once to the action and to the chief person. In the *Ajax* and *Philoctetes* the entrance or discovery of the hero is made more impressive by being delayed. Immediately after the prologos the chorus enter, numbering fifteen, either chanting in procession, as in the *Antigone* and *Œd. Tyr.*, or dispersedly as in the *Œd. Col.* and *Philoctetes*, or, thirdly, as in the *Electra*, where, after entering silently during the monody of the heroine, and taking up their position in the orchestra, they address her one by one. With a remarkable exception, to be noted presently, the chorus having once entered remain to the end. They always stand in some carefully adjusted relation to the principal figure. The elders of Thebes, whose age and coldness throw into relief the fervor and the desolation of Antigone, are the very men to realize the calamity of Œdipus, and, while horror-stricken, to lament his fall. The rude Salaminian mariners are loyal to Ajax, but cannot enter into his grief. The Trachinian maidens would gladly support Deianira, who has won their hearts, but they are too young and inexperienced for the task. The noble Argive women can sympathize with the sorrows of Electra, but no sympathy can soothe her distress.

The parodos of the chorus is followed by the first scene or epeisodion, with which the action may be said to begin. For in the course of this the spectator's interest is strongly roused by some new circumstance involving an unforseen complication,—the awakening of Ajax (*Aj.*), the burial of Polynices (*Ant.*), the dream of Clytæmnestra (*El.*), the dark utterance of Tiresias (*Œd. Tyr.*), the arrival of Lichas with Iole (*Trach.*), the report of Ismene announcing Creon's coming (*Œd. Col.*), the sudden entreaty of Philoctetes crossed by the entrance of the pretended mariner (*Phil.*). The action from this point onwards is like a steadily-flowing stream into which a swift and turbulent tributary has suddenly fallen, and the interest advances with rapid and continuous climax until the culmination is reached and the catastrophe is certain. The manner in which this is done, through the interweaving of the *ῥήσεις* and *στιχομυθία* of the dialogue with the *στάσιμα* of the chorus, and the *κομμοί* and *κομματικά* (where there is interchange between the chorus and the persons), is very different in different dramas, one of the principal charms of Sophocles being his power of ingenious variation in the employment of his resources. Not less admirable is the strength with which he sustains the interest after the *peripeteia*,[2] whether, as in the *Antigone*, by heaping sorrow upon sorrow, or, as in the first *Œdipus*, by passing from horror to tenderness and unlocking the fountain of tears. The extreme point of boldness in arrangement is reached in the *Ajax*, where the chorus and Tecmessa, having been warned of the impending danger, depart severally in quest of the vanished hero, and thus leave not only the stage but the orchestra vacant for the soliloquy that precedes his suicide.

No such general description as has been here attempted can give even a remote impression of the march of Sophoclean tragedy,—by what subtle yet firm and strongly marked gradations the plot is unfolded; how stroke after stroke contributes to the harmonious totality of feeling; what vivid interplay, on the stage, in the orchestra, and between both, builds up the majestic, ever-moving spectacle. Examine, for example, the opening scene or *πρόλογος* of the *Œdipus Tyrannus*. Its function is merely to propound the situation; yet it is in itself a miniature drama. First there is the silent spectacle of the eager throng of suppliants at the palace gate,—young children, youths, and aged priests. To them the king appears, with royal condescension and true public zeal. The priest expresses their heartfelt loyalty, describes the distress of Thebes, and, extolling Œdipus's past services, implores him to exercise his consummate wisdom for the relief of his people. The king's reply unveils yet further his incessant watchfulness and anxious care for his subjects. And he discloses a new object to their expectancy and hope. Creon, a royal person, had been sent to Delphi, and should ere then have returned with the response of Apollo. At this all hearts are trembling in suspense, when a figure is seen approaching. He is wreathed with Apollo's laurel; he looks cheerful. What has Phœbus said? Another moment of suspense is interposed. Then the oracle is repeated,—so thrilling to the spectator who understands the story, so full of doubt and hope and dread to all the persons of the drama: "It is for the blood of Laius—his murderers are harbored in the land of Thebes. The country must be purged." That is the culminating point of the little tragedy. While Œdipus asks for information, while in gayety of heart he undertakes the search, while he bids the folk of Cadmus to be summoned thither, the spectators have just time to take in the full significance of what has passed, which every word that is uttered sends further home. All this in 150 lines!

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[1] Günther, *op cit.*

[2] A tragic action has five stages, whence the five acts of the modern drama: the start, the rise, the height, the change, the close.

Or, once more, consider the employment of narrative by this great poet. The *Tyrannus* might be again adduced, but let us turn instead to the *Antigone* and the *Trachiniæ*. The speech of the messenger in the *Antigone*, the speeches of Hyllus and the Nurse in the *Trachiniæ*, occur at the supreme crises of the two dramas. Yet there is no sense of any retardation in the action by the report of what has been happening elsewhere. Much rather the audience are carried breathlessly along, while each speaker brings before their mental vision the scene of which he had himself been part. It is a drama within the drama, an action rising from its starting point in rapid climax, swift, full, concentrated, until that wave subsides, and is followed by a moment of thrilling expectation. Nor is this all. The narrative of the messenger is overheard by Eurydice, that of Hyllus is heard by Deianira, that of Nurse by the chorus of Maidens. And in each case a poignancy of tragic significance is added by this circumstance, while the *ῥῆσις* in the *Antigone*, and that of Hyllus in a yet higher degree, bind together in one the twofold interest of an action which might otherwise seem in danger of distracting the spectator.

So profound is the contrivance, or, to speak more accurately, such is the strength of central feeling and conception, which secures the grace of unity in complexity to the Sophoclean drama.

The proportion of the lyrics to the level dialogue is considerably less on the average in Sophocles than in Æschylus, as might be expected from the development of the purely dramatic element, and the consequent subordination of the chorus to the protagonist. In the seven extant plays the lyrical portion ranges from one-fifth to nearly one-third, being highest in the *Antigone* and lowest in the *Œdipus Tyrannus*. The distribution of the lyrical parts is still more widely diversified. In the *Electra*, for instance, the chorus has less to do than in the *Œdipus Tyrannus*, although in the former the lyrics constitute one-fourth, and in the latter only one-fifth of the whole. But then the part of Electra is favorable to lyrical outbursts, whereas it is only after the tragic change that Œdipus can appropriately pass from the stately senarius to the broken language of the dochmiac and the "lamenting" anapæst. The protagonists of the *Ajax* and the *Philoctetes* had also large opportunities for vocal display.

The union of strict symmetry with freedom and variety which is throughout characteristic of the work of Sophocles is especially noticeable in his handling of the tragic metres. In the iambics of his dialogue, as compared with those of Æschylus, there is an advance which may be compared with the transition from "Marlowe's mighty line" to the subtler harmonies of Shakespeare. Felicitous pauses, the linking on of line to line, trisyllabic feet introduced for special effects, alliteration both hard and soft, length of speeches artfully suited to character and situations, adaptation of the cæsura to the feeling expressed, are some of the points which occur most readily in thinking of his *senarii*. A minute speciality may be noted as illustrative of his manner in this respect. Where a line is broken by a pause towards the end, and the latter phrase runs on into the following line, elision sometimes takes place between the lines, *e.g.* (*Œd. Tyr.*, 332–3):

> Ἐγὼ οὔτ' ἐμαυτὸν οὔτε σ' ἀλγυνῶ. τί ταῦτ'
> ἄλλως ἐλέγχεις;

This is called *synapheia*, and is peculiar to Sophocles.

He differentiates more than Æschylus does between the metres to be employed in the *κομμοί* (including the *κομματικά*) and in the choral odes. The dochimus, cretic, and free anapæst are employed chiefly in the *κομμοί*. In the stasima he has greatly developed the use of logaœdic and particularly of glyconic rhythms, and far less frequently than his predecessor indulges in long continuous runs of dactyls or trochees. The light trochaic line –́⏑—⏑–́⏑—, so frequent in Æschylus, is comparatively rare in Sophocles. If, from the very severity with which the choral element is subordinated to the purely dramatic, his lyrics have neither the magnificent sweep of Æschylus nor the "linked sweetness" of Euripides, they have a concinnity and point, a directness of aim, and a truth of dramatic keeping, more perfect than is to be found in either. And even in grandeur it would be hard to find many passages to bear comparison with the second stasimon, or central ode, either of the *Antigone* (*εὐδαίμονες οἶσι κακῶν*) or the first *Œdipus* (*εἴ μοι ξυνείη φέροντι*). Nor does anything in Euripides equal in grace and sweetness the famous eulogy on Colonus (the poet's birthplace) in the *Œdipus Coloneus*.

Sophocles was edited (probably from the Venetian MSS.) by Aldus Manutius, with the help of Musurus, in 1502. The Juntine editions, in which the text of Aldus was slightly modified with the help of Florentine MSS., were published in 1522, 1547, respectively. An edition of the Scholia, very nearly corresponding to those on the margin of the Medicean or chief Laurentian MS. (La or L) had previously appeared at Rome in 1518. The first great modification of the text was due to Turnebus, who had access to the Parisian MSS.; but he was not fortunate in his selection. The earliest editors had been aware that the traditional arrangement of the metres was faulty, but little way had been made towards a readjustment. Now it so happens that the Parisian MS. T, which is a copy of the recension of Triclinius, an early 14th-century scholar, contains also the metrical views of the same editor; and, having found (as he erroneously supposed) a sound authority, Turnebus blindly adopted it, and was followed in this by H. Stephanus (1568), Capperonier, and Vauvillers in France, and Canter in Holland (who was the first to mark the correspondence of strophe and antistrophe). This error was to a large extent corrected by Brunck (1786), who rightly preferred Par. A (2712), a 13th-century MS., belonging, as it happened, to the same family with Ven. 467, which Aldus had mainly followed. Thus after nearly three centuries the text returned (though with many conjectural variations, some of which were due to Scaliger, Auratus, and other earlier scholars) into nearly the same channel as at first. Meanwhile the study of Greek metres had greatly advanced, and, while much license was given to conjecture (in which Valckenaer and Porson were especially happy), documentary evidence was also better weighed and sifted. The collation of the Laurentian MS. by Peter Elmsley in 1825 (with his transcription of the Scholia) may be said to mark the most important epoch in the textual criticism of Sophocles. But the great work of Gottfried Hermann, whose editions (1823–1830), which are critical in every sense of the word, are adorned with an ample Latin commentary, made perhaps the longest step in advance. Since Hermann the editors of Sophocles have been very numerous. The list, from Schneidewin to Wecklein and Pappageorgius amongst Continental scholars and from Linwood to Jebb (who is last, not least) amongst our own, is too long for insertion here. (L. C.)

SOPHRON of Syracuse, next to Epicharmus the greatest representative of Sicilian comedy, flourished about 430 B.C. He was the author of mimes, written in prose, containing both male and female characters

—*Μῖμοι ἀνδρεῖοι* and *Μῖμοι γυναικεῖοι*—and depicting scenes from the daily life of the Sicilian Greeks. From the extremely scanty fragments which remain of his writings we can only see that he used the local dialect, frequently sacrificing refinement to vigor; he sometimes reminds us of Plautus in his employment of bold and expressive figures and turns of expression. But we can judge of the dramatic power and vivacity of his compositions from the story that Plato first introduced them to Athens, and studied them in order to give animation to his own dialogues; and some idea of the general character of his mimes may be derived from the 2d and 15th idyls of Theocritus, which are said to have been imitated from the *'Ακέστριαι* and *'Ισθμιάζουσαι* of his Syracusan predecessor.

The fragments of Sophron, most of which have been preserved to illustrate some point of grammar or dialect, are collected in Ahrens, *De Græcæ Linguæ Dialectis*, vol. ii. pp. 464–476.

SOPRON. See OEDENBURG.

SORA, a city of Italy, at the head of a circondario in the province of Caserta (Terra di Lavoro), is built in a plain on the banks of the Garigliano and on the highway from Rome *via* Tivoli and Avezzano to Naples. It is the seat of important manufactures,—wool-spinning, cloth-weaving, and paper-making,—this last industry dating from the time of Murat. The original cathedral, consecrated by Pope Adrian IV. in 1155, was destroyed by the earthquake of 1634. The population of the city was 8768 in 1861 and 5411 (commune 13,208) in 1881.

Sora, an ancient Volscian town, was thrice captured by the Romans, in 345, 314, and 305 B.C., before they managed, in 303, by means of a colony 4000 strong, to confirm its annexation. In 209 it was one of the colonies which refused further contributions. By the lex Julia it became a municipium, but under Augustus it was colonized by soldiers of the 4th legion. The castle of Sorellà, built on the rocky height above the town, was in the Middle Ages a stronghold of some note; on one occasion it held out successfully against a whole year's vigorous siege by William II. of Sicily. Alfonso of Aragon made Sora a duchy for the Cantelmi; it was afterwards seized by Pius II., but, being restored to the Cantelmi by Sixtus IV., it ultimately passed to the Della Rovere of Urbino. Against Cæsar Borgia the city was heroically defended by Giovanni di Montefeltro. Captured by the marquis of Pescara for Charles V., it was by him bestowed on Carlo Ceares, duke of Croy and Aerschot, but, Ceares being afterwards bought out, the duchy was restored to the duke of Urbino. By Gregory XIII. it was purchased for 11,000 ducats [$24,948] and bestowed on his son Buoncompagni, the ancestor of the line of Buoncompagni-Ludovisi. In ancient times Sora was the birthplace of the Decii, Attilius Regulus, and Lucius Mummius; and of its modern celebrities Cardinal Baronius is one. The now ruined abbey church of San Domenico, founded in 1104 on the left bank of the Liri above the town, is believed to occupy the site of Cicero's family villa and birthplace. It consisted of a nave and two aisles, all ending in circular apses.

SORAU, an industrial town and railway junction in the south of Brandenburg, Prussia, is situated 54 miles to the southeast of Frankfort-on-the-Oder, and not far from the Silesian border. Said to be one of the oldest towns in Lower Lusatia, Sorau contains a number of ancient buildings, among which the most prominent are several of the churches (one dating from 1204), the town-house, built in 1260, and the old palace of 1207. The new palace was erected in 1711. The varied manufactures of the town comprise cloth, linen, wax candles, starch, bone-meal, etc. The population, 3764 in 1816, was 13,668 in 1885, upwards of 12,000 of them being Lutherans.

Sorau is said to have existed in 840 and to have belonged to the abbey of Fulda till the 12th century. It received town-rights in 1260. With the surrounding district, known as the barony of Sorau, it became the seat of successive noble families; and in 1400 it was united with the barony of Triebel. The last count of Promnitz, whose ancestor had purchased both baronies from Frederick of Bohemia in 1556, sold them to the elector of Saxony for an annuity of 12,000 thalers (£1800 [$8748]). In 1815 Saxony had to cede them to Prussia, after holding them for fifty years.

SORBONNE, the name formerly borne by the old faculty of theology in Paris, and now applied to the seat of the *académie* of that city and of the three faculties of theology, science, and literature. (See FRANCE, vol. ix. p. 479; PARIS, vol. xviii. p. 294; and UNIVERSITIES). The Sorbonne owes its origin and its name to Robert de Sorbon, a poor priest of Champagne, who, arriving in Paris about the beginning of the reign of St. Louis, attained high repute by his sanctity and eloquence, and was appointed by the king to be his chaplain. Assisted by royal liberality, he built upon Mont Sainte-Geneviève a modest establishment in which were accommodated seven priests charged with the duty of teaching theology gratuitously; to this he added a college of preparatory studies, all under the direction of a provisor, under whom was an annual prior who had the actual management. The new institution was authorized by letters patent of 1255, and canonically sanctioned by Pope Alexander IV. in 1259. Destined originally for poor students, the Sorbonne soon became a meeting-place for all the students of the university of Paris who resorted thither to hear the lectures of the most learned theologians of the period,—Guillaume de Saint-Amour, Eudes de Douai, Laurent l'Anglais, Pierre d'Ailly. At the close of the century it was organized into a full faculty of theology, and under this definitive form it conferred bachelor's, licentiate's, and doctor's degrees, and the severity of its examinations gave an exceptional value to its diplomas. The so-called "thèse Sorbonique," instituted towards the beginning of the 14th century, became the type of its order by the length and difficulty of its tests. Ultimately the professors of the Sorbonne came to be resorted to, not only for lectures and examinations, but also for dogmatic decisions and judgments in canon law; the clergy of France and of the whole Catholic world had recourse to them in difficult cases, and the Curia Romana itself more than once laid its doubts before them, giving them the title of "Concilium in Gallia subsistens." The Sorbonne took a leading part in the religious discussions which agitated France during the 16th and 18th centuries, and its influence thus inevitably extended to political questions. During the insanity of Charles VI. it helped to bring about the absolution of Jean Sans-Peur for the assassination of the duke of Orleans. Shortly afterwards it demanded and supported the condemnation of Joan of Arc; during the Reformation it was the animating spirit of all the persecutions directed against Protestants and unbelievers: without having advised the massacre of St. Bartholomew, it did not hesitate to justify it, and it inflamed the League by its vigorous anathemas against Henry III. and the king of Navarre, hesitating to recognize the latter even after his abjuration. From this point dates the beginning of its decadence, and, when Richelieu in 1629 ordered the reconstruction of its church and buildings, the following prophetic couplet was circulated—

> Instaurata ruet jamjam Sorbona. Caduca
> Dum fuit, inconcussa stetit; renovata peribit.

The declaration of the clergy in 1682, which it subscribed, proved fatal to its authority with the Curia Romana; it revived for a short time under Louis XV. during the struggle against Jansenism, but this was its last exploit; it was suppressed like the old universities in 1790. To the Sorbonne belongs the glory of having introduced printing into France in 1469: within its precincts it assigned quarters for Ulric Gering and two companions in which to set up their presses.

When the university of France was organized in 1808 the Sorbonne became the seat of the *académie* of Paris; and between 1816 and 1821 the faculties of theology, science, and literature were installed there with their libraries. All the great university functions are held within its great amphitheatre. Since 1861 there has annually been held in the Sorbonne at Easter an official congress in which are represented the learned societies of the departments; there are five sections—those of archæology, history, the moral and political sciences, the physical sciences, geography,—which hold separate sittings. The fine arts form a sixth section, with a special organization.

A reconstruction of the buildings of the Sorbonne, projected by Napoleon III., was begun in 1884, under the architectural direction of Nénot. The old church containing the tomb of Richelieu is to be retained on account of its artistic merit.

SORGHUM. See MILLET, also SUGAR, p. 661.

SORIA, a province of Spain, in Old Castile, bounded on the N. by Logroño, E. by Saragossa, S. by Guadalajara, and W. by Segovia and Burgos; the area is 3836 square miles. It is a bleak and lofty region, being bounded on three sides by mountains. A range of low sierras on the north, and the great Sierra de Moncayo on the east, separate the valley of the Duero (Douro) from that of the Ebro, while on the south it is divided from that of the Tagus by a continuation of the Sierra Guadarrama. The whole of the province belongs to the region watered by the Duero and its affluents. This river rises in the northern mountains, and traverses the province in a circuitous course, first to the south and then to the west. The other rivers are mostly affluents of the Duero, such as the Tuerto, San Pedro, etc.; but a few of the tributaries of the Ebro have their sources within the limits of the province. The soil is not remarkable for fertility; on the contrary, a large proportion of the area is occupied with barren mountains, which are covered with snow for a great part of the year. There are, however, in some places extensive forests of pine, oak, and beech; while in others there are large tracts of pasture land, on which numbers of cattle, sheep, and swine are reared. Grain and vegetables are raised, but neither of very good quality nor in sufficient quantities to supply the wants of the population. The climate is cold and dry, and the scenery grand, but not very pleasing in its character. Most of the people are employed in farming and rearing cattle; but the cutting and sawing of timber and the preparation of charcoal also occupy a considerable number. There is a great want of roads in this part of the country; and commerce is consequently very limited. Fine wool was formerly an important production of the province; but of late years it has considerably fallen off. The only important article of trade at present is timber, which is sent to Madrid and Aragon. Soria is divided into five partidos judiciales and 345 ayuntamientos. The population was returned in 1877 as 153,654. There is a bishop (suffragan of Burgos), resident at Osma. The only town of more than 5000 inhabitants is Soria.

SORIA, the capital of the above province, on a hill on the right bank of the Duero, 113 miles northeast of Madrid, is an ancient town, still surrounded by walls which were built in the 13th century. It contains several squares, in one of which stand the court-house and prisons and in another the spacious palace of the dukes of Gomara. The churches of Santo Domingo and San Nicolas, the cloisters of the convent of San Juan, and several other ecclesiastical buildings are fine specimens of Romanesque work of the 12th and 13th centuries. The population is chiefly agricultural; but there are also flour-mills, tanneries, potteries, etc.; and some trade in timber, wool, and fruit is carried on. Three and a half miles distant is the site of the ancient Numantia. But few traces of the old city, however, remain. A railway has long been projected between Soria and Calatayud, upon the Madrid and Saragossa line. The population in 1877 was 6286.

SORREL. See HORTICULTURE, vol. xii. p. 300.

SORRENTO, a city of Italy, in the province of Naples, on the north side of the peninsula that separates the Bay of Naples from the Bay of Salerno, about 1½ miles to the east of Capo di Sorrento, crowned by the ruins of a temple of Neptune. Sorrento contains only a few unimportant remains of the magnificent buildings which made it in the time of Augustus a finer city than Naples; and its present prosperity depends mainly on the reputation it enjoys as a summer watering-place, with a delightful and healthy climate, and situated amid picturesque coast scenery. The chief local industry is the inlaying of wood. In ancient times the Surrentine wines had a great repute. The population was 4254 in 1861 and 6089 in 1881.

Surrentum was of very ancient origin, but it does not appear frequently in history. A famous temple of Minerva stood on the Promontorium Surrentinum (now Punta della Campanella). In 1558 the Corsair Pialy attacked the town and carried off 2000 prisoners. Statius celebrated the delights of the Surrentine villa owned by his friend Pollius Felix; it was at Sorrento that Bernardo Tasso wrote his *Amadigi;* and Torquato Tasso was born in the town in 1544.

SOSIGENES, the astronomer who was employed by Julius Cæsar to reform the Roman calendar, 46 B.C. (see CALENDAR). Of his life nothing further is known, with the exception of two references to him by Pliny, which show that he left some astronomical treatises. The chief one is as follows:

> "Tres autem fuere sectæ, Chaldæa Ægyptia, Græca. His addidit quartam apud nos Cæsar dictator annos ad solis cursum redigens singulos, Sosigene perito scientiæ ejus adhibito; et ea ipsa ratio postea comperto errore correcta est, ita ut XII. annis continuis non intercalaretur, quia cœperat sidera annus morari qui prius antecedebat. Et Sosigenes ipse trinis commentationibus, quamquam diligentior ceteris, non cessavit tamen addubitare ipse semet corrigendo."—*H. N.*, xviii. 25.

From another passage (*H. N.*, ii. 8) we infer that Sosigenes maintained that Mercury moved in an epicycle about the sun; this doctrine is referred to by his contemporary Cicero, and it was also that of the Egyptians (see PTOLEMY). Sosigenes is commonly called an Egyptian and a Peripatetic, but this has arisen from his having been confounded with a Peripatetic philosopher of the same name who lived in the 2d century of the Christian era, and who will be briefly noticed below. It is most probable, however, that he was a Greek of Alexandria, for the following reasons. (1) Cæsar had just returned victorious from his Alexandrian expedition, which occupied parts of the years 48 and 47 B.C., when, with the assistance of Sosigenes, he settled the chronological question. (2) We learn from Plutarch (*Cæs.*, 59) that "Cæsar laid the problem (viz., the correction of the calendar) before the ablest philosophers and mathematicians," and at that time the school of Alexandria was world-famous. (3) We know that Cæsar was himself a diligent student of astronomy. Lucan, in a passage which refers to his correction of the calendar, represents him as saying that even in the midst of his campaigns he had always found time for astronomical pursuits:

> "media inter prælia semper
> Stellarum cælique plagis superisque vacavi;
> Nec meus Eudoxi vincetur Fastibus annus."—x. 185-7.

(4) Macrobius says that Cæsar wrote a work on the motion of the stars, and expressly states, moreover, that he derived from the Egyptian schools his information on the subject, and also what he required for the correction of the calendar.[1] (5) Cæsar's arrangement was substantially the same as the reform of the Egyptian calendar in the year 238 B.C. under Ptolemy

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[1] "Nec mirum si hæc digeries morsum reprehensionis evasit, cui arcessita est ab Ægypto postremæ correctionis auctoritas. Nam Julius Cæsar, ut siderum motus, de quibus non indoctos libros reliquit, ab Ægyptiis disciplinis hausit, ita hoc quoque ex eadem institutione mutuatus est, ut ad solis cursum finiendi anni tempus extenderet."—*Sat.*, i. 16.

III. Euergetes, a fact which remained unknown until the discovery of the Decree of Canopus by Lepsius at Sanor Tanis in Egypt in the year 1866.

Zeller (*Phil. d. Gr.*, vol. iii. part 1, 2d ed., pp. 705–6, note of p. 703, and p. 694, note 3), and after him, but in a more complete manner, Th. H. Martin (*Annales* de la Faculté des Lettres de Bordeaux, 2e fasc., 1879), have shown, in opposition to the prevailing opinion, which had been formerly held by Zeller himself, that the subject of this article has nothing in common but the name with Sosigenes the Peripatetic philosopher, author of a work on restituent spheres (Σωσιγένης περὶ τῶν ἀνελιττουσῶν [σφαιρῶν]), which is referred to by Proclus (*Hypotyp.*, p. 111, ed. Halma) and followed by Simplicius in his *Commentary* on the treatise of Aristotle, *De Cœlo*, author also of some other works, and master of Alexander of Aphrodisias, who lived at the end of the 2d and beginning of the 3d century after Christ, and who was the most celebrated of the commentators on Aristotle.

SOTO. See De Soto.

SOUBISE, Benjamin de Rohan, Duc de (*c.* 1589–1641), was the second son of René II., Vicomte de Rohan, and Catherine de Parthenay, and the younger brother of the soldier-writer Henri de Rohan (*q.v.*). The seigneury of Soubise came to the Rohans through Catherine, and Benjamin took the title as her second son. The exact date of his birth does not seem to be known, but it is believed to be 1589. He served his apprenticeship as a soldier under Prince Maurice of Orange in the Low Countries. But he hardly becomes an historical character before 1621, when the religious wars once more broke out in France. He and his brother Rohan were the soul of the Huguenot party,—the elder brother chiefly taking command on land and in the south, Soubise in the west and along the sea-coast. His exploits in the conflict have been sympathetically related by his brother, who, if he was not quite an impartial witness, was one of the best military critics of the time. Soubise's chief performance was a singularly bold and well-conducted attack (in 1625) on the royalist fleet in the river Blavet (which included the cutting of a boom in the face of superior numbers after a style suggestive of the best days of the English navy) and the occupation of Oleron. Soubise commanded at Rochelle during the famous siege, and if we may believe his brother the failure of the defence and of the English attack on Rhé was mainly due to the alternate obstinacy of the townsfolk and the English commanders in refusing to listen to Soubise's advice. When surrender became inevitable he fled to England, which he had previously visited in quest of succor. He died in 1641, and his title afterwards served as the chief second designation (not for heirs-apparent, but for the chief collateral branch for the time being) of the house of Rohan-Chabot, into which the older Rohan honors were carried by his niece Marguerite four years after his death.

SOUBISE, Charles de Rohan Prince de (1715–1787), peer and marshal of France, grandson of the Princesse de Soubise, who is known to history as one of the mistresses of Louis XIV., was born in Paris on July 15, 1715. He accompanied Louis XV. in the campaign of 1744–48, and attained high military rank, which he owed more to his courtiership than to his generalship. Soon after the beginning of the Seven Years' War, through the influence of Madame de Pompadour, he was put in command of a corps of 24,000 men, and on 4th November, 1757, he sustained the crushing defeat of Rossbach (see vol. ix. pp. 518–19, where also some subsequent and more favorable episodes of his military career are briefly indicated). After 1763 he lived the life of an ordinary courtier in Paris, dying on July 4, 1787.

SOUDAN, or Súdán (Bilád es-Súdán, "Country of the Blacks"), a term applied by mediæval Arab geographers to the region of Africa south of the Sahara mainly inhabited by peoples of Negro blood, hence corresponding to the expressions Nigritia, Negroland, at one time current amongst European writers. It lies mainly between 5° and 18° N. lat., consequently entirely within the tropics, and in its widest sense stretches right across the continent from Cape Verd on the Atlantic to Massowah on the Red Sea. But the term is more usually restricted to the region bounded N. by the Sahara, S. by Upper Guinea and the lands draining to the Congo basin, W. and E. by Senegambia and the Abyssinian highlands respectively (see vol. i. plate II.). Within these limits it has an extreme length of about 3000 miles between the Senegal river and Abyssinia, extending southwards at some points 660 miles, with a total area of perhaps 2,000,000 square miles, and a population approximately estimated at from 80 to 90 millions. From the arid and sandy northern wastes to the well-watered and arable Soudanese lands the transition is effected by an intermediate zone of level grassy steppes, partly overgrown with mimosas and acacias, with a mean breadth of about 60 miles, between 17° and 18° N. lat., but towards the centre reaching as far south as 15° N. Excluding this somewhat uniform transitional zone, the Soudan, properly so called, may be described as a moderately elevated region, diversified with extensive open or rolling plains, level plateaus, and even true highlands, especially in the southwest. It constitutes three distinct hydrographic systems, corresponding to the three main physical divisions of Western Soudan, draining through the Niger southwards to the Atlantic; Central Soudan, draining to the great central depression and landlocked basin of Lake Tchad; and Eastern (Egyptian) Soudan, draining through the Nile northwards to the Mediterranean. Between these systems the chief waterpartings are—(1) the Marrah Mountains of Dar-Fur whence flow the Bahr es-Salámát west to the Shari, and numerous intermittent wadies east to the Nile; (2) the Monbuttu uplands (Mount Baginze) separating the western headstreams of the White Nile from the Welle (Bahr Kuta), which, according to the latest information, flows, not to the Shari as Schweinfurth supposed, but to the Congo through the Mbangi; (3) the so-called "Kong" Mountains, dividing the Niger basin from the Volta and other streams flowing in independent channels south to the Gulf of Guinea. The Adamawa highlands, culminating in Mount Alantika (9000 to 10,000 feet), do not form a divide, as was supposed, between the Binue (the main eastern tributary of the Niger) and the Logon and other streams flowing east to the Shari (the great southern affluent of Lake Tchad). Flegel, who has recently explored the upper course of the Binue, found that it sweeps right round the east foot of Mount Alantika, and is even navigable round this bend and some way southwards. On the other hand, the central hydrographic system of Lake Tchad has been greatly reduced in size since Lupton, Grenfell, and other recent explorers have made it evident that the Bahr-Kuta (Welle) flows not to the Shari but to the Congo basin. The Shari basin, which is now known not to reach farther south than about 6° N. lat., may even be almost considered, physically as well as politically, as subsidiary to the Niger hydrographic system, for there are indications that the Logon once flowed into the Binue by the Mayo-Kebbi. The Mayo-Kebbi is a long flat trough or valley in 9° 30′ N. lat., with a level swamp at the bottom receiving as a backwater the overflow of the Logon, and also draining through the Binue to the Niger. By canalizing the Mayo-Kebbi the Binue and Shari basins might be permanently connected, in which case the Niger system would afford a navigable waterway from the Gulf of Guinea to the southernmost limits of Baghirmi.

From the Kong highlands, some of whose peaks appear to attain elevations of 6000 to 7000 feet, Western Soudan falls gradually towards the north and northeast down to the Great Desert where the city of Timbuktu still maintains an altitude of 770 feet above sea-level (Lenz). Southeast of the Niger the land rises in terraces of 1000 and even 3000 feet, above which isolated crests range from 5000 to 9000 feet. This little known western highland region, comprised between the Binue and the lower Niger, and extending from Adamawa to the Cameroons on the Bight of Biafra, corresponds with the eastern highland region of Abyssinia, lying between the Blue Nile and the Tagazze and dominating the Red Sea. North of Adamawa the land falls rapidly down to the vast depression of Central Soudan, whose lowest part is flooded with the waters of Lake Tchad (Chad or Tsad), the largest area of inland drainage, next to the Aral-Caspian basin, in the eastern hemisphere. This freshwater lacustrine depression, usually 10,000 square miles in extent, expands to 40,000 and even 50,000 square miles when swollen by the flood-waters of its great feeders,—the Logon-Shari from the south and the Komadugu from the west. From the Tchad depression, which is still 1150 feet above the sea, the ground rises again eastwards in the direction of Wadai and Dar-Fur, to heights of 3000 feet and upwards, culminating in the volcanic Jebel Marrah (6000 feet), which forms the natural eastern limit of Central Soudan, and the great divide between the Tchad and Nile basins. But politically the line between Central and Eastern Soudan is usually drawn more to the west along the conventional frontiers of Wadai and Dar-Fur, the latter province, although never completely reduced, being claimed as part of Egyptian Soudan. This region constitutes two distinct physical divisions,—the first comprising the provinces of Dar-Fur and Kordofan, bounded E. by the White Nile and S. by the Bahr el-Arab, a tableland in which the steppe formation predominates, while the second is skirted east by the Bahr el-Jebel and stretches from the Bahr el-Arab southwards to the Monbuttu uplands, a vast plain watered by the numerous southwestern headstreams of the White Nile. This plain rises gradually towards the south and southwest to the highlands, which appear to culminate in Mount Baginze, and which form the water-parting between the Nile and Congo basins. Included in Eastern Soudan is also the extensive plain of Senaar, stretching from the Nile eastwards to the Abyssinian uplands, and rising southwards to the Fazokl and Berta highlands.

The prevailing geological formations are the crystalline rocks, such as granites, diorites, slates, gneiss, underlying the old and new alluvia of the plains, and found associated with sandstones in the highlands. In the Kong Mountains the granites underlie the sandstones, but in the Tagalé group (South Kordofan) they pass over to porphyries and syenites, interspersed with extensive diorites and auriferous quartz veins. Volcanic rocks (basalts, lavas, tufas) appear to be restricted to the isolated Defafaung and Alantika Mountains (Adamawa), although solfataras occur in the Tagalé district where sulphur abounds. Mineral waters are also found in Dar-Fur and Adamawa. The most widely diffused minerals are iron and copper, the oxides of iron occurring almost everywhere from the White Nile to the Niger, while pure copper is met especially in Dar-Fur and Fertit. Gold is chiefly restricted to the Tagalé and Kong Mountains, Bambarra, and Adamawa; and lead, antimony, and tin are confined to a few isolated districts. Characteristic is the apparently total absence of limestones, coal, salt, and natron, the supplies of salt being imported mainly from the Sahara. Report, however, speaks of a large lake in the Jebel Marrah, from which salt is obtained.

The climate of Soudan is distinctly tropical, with two well-defined seasons, hot and rainy from April or May to October, warm and dry for the rest of the year. The former is accompanied by tremendous thunderstorms and continuous downpours flushing all the khors, wadies, and other watercourses, flooding large tracts along the lower courses of the Shari, Logon, Komadugu, and Niger, and interrupting the communications for weeks together in Baghirmi and Bornu. Before the rains set in the glass seldom falls below 98° or 100° F., rising at noon to 104°, while the mean annual temperature at Kuka (Bornu) is about 82° F. But in the dry season it is often lowered to 58° or 60°, and under the influence of the cool northeast winds water often freezes on the uplands, snow falls in Dar-Fur, and fires are kept up in the houses in the central districts of Kano. The chief ailments are ague and other marsh fevers in the low-lying tracts subject to inundations, the Guinea-worm, cutaneous diseases, and leprosy. The fevers are dangerous alike to Europeans and natives.

An exuberant forest vegetation is favored by the rich alluvial soil and tropical heat wherever moisture abounds. Of large growths the most characteristic and widespread are —the baobab (*Adansonia*), reaching north to the 13th parallel and attaining a girth of 80 feet; the superb deleb palm, covering extensive tracts especially in the east, where it grows to a height of over 120 feet; the shea or butter tree (*Bassia butyracea*), in the Niger basin and Kong uplands; the cotton-tree, dum palm, tamarind, several varieties of euphorbias, acacias, and mimosas, the heglyg (*Balanites ægyptiaca*), and jerjak of Wadai, which yields a kind of vegetable honey. Owing to the absence of salt the date-palm is very rare. The chief cultivated plants are cotton, maize, several kinds of durrah (*Sorghum vulgare*, *S. cernuum*, etc.), hemp, tobacco, gourds, water-melons, indigo (of excellent quality and growing everywhere, wild and cultivated), and lastly the guru or kola nut (*Sterculia acuminata* and *S. macrocarpa*), which in Soudan takes the place of the coffee berry. Cotton of the finest quality has been raised on the rich alluvial plain of Taka and Senaar.

The beasts of prey, nowhere very numerous, are chiefly represented by the lion, panther, hyena, and jackal. Elephants in herds of 400 or 500 frequent the swampy districts about Lake Tchad, but are not found farther north than the 12th or 13th parallel. The ordinary African rhinoceros is common, and the rare one-horned species appears to have been met with in Wadai. The wild ass, zebra, giraffe, and antelopes in considerable variety abound on the eastern steppe lands, and endless species of monkeys in the forest districts. Crocodiles, some of great size, from 16 to 18 feet long, infest all the large rivers, the sangwai,—a web-footed variety, occurring in the Niger. The hippopotamus also abounds in these waters, which teem with fish, mostly of unknown species. These attract numerous flocks of water-fowl,—pelicans, spoonbills, cranes, ducks, and many unknown species. In the Tchad, Fittri, and other districts the fish are captured, dried, and exported in large quantities to Fezzan and the countries beyond the Niger. Flies and mosquitoes swarm in the marshy, and locusts in the dry districts; and in the woodlands insect life is represented by myriads of termites and some very large species of bees, wasps, and ants, besides beetles and butterflies in considerable variety.

The term Bílad es-Súdán is fully justified by the ethnical conditions of this region, which may be regarded as the true home of the Negro variety of mankind. Here this still everywhere forms the substratum of the population, constituting the distinct aboriginal element, in many places exclusively, in others intermingled with foreign intruders from the north and east. As far as can now be determined, these intruders belong to two separate branches of the Caucasic stock—the Hamitic and the Semitic. The Hamitic is represented by three divisions—Fulahs,[1] Tibus, and Berbers—all of whom arrived in remote prehistoric times; the Semitic by one division—the Arabs, who arrived at various periods since the spread of Islam in North Africa. The bulk of the Arab tribes appear to have penetrated from the Nile basin through Kordofan to Dar-Fur and Wadai, or from the Mediterranean seaboard through Fezzan and across the Sahara to the Tchad basin, and hence are still mostly restricted to the central and eastern districts. Owing to their later appearance and stronger racial sentiment they have kept more aloof from the surrounding populations than the Hamites, who have everywhere intermingled with the aboriginal Negro element. The result is that the present inhabitants of Soudan are of a very mixed character,—more or less pure Negro peoples predominating in the Niger basin, in Adamawa, Baghirmi, Wadai, parts of Dar-Fur and Kordofan, and in the Nile basin south of 10° north latitude; half-caste Negroes and Fulahs especially in Western Soudan; half-caste Negroes and Berbers in the northern districts of Western and Central Soudan; half-caste Negroes and Tibus (Dasas) mainly in Kanum and Bornu; true Fulahs scattered in isolated groups between the Niger and Tchad basins; true Berbers (Tuaregs) in the Timbuktu and Moassina districts; true Arabs chiefly in Baghirmi, Wadai, Dar-Fur, and Kordofan.

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[1] Most ethnologists, adopting Fr. Müller's general classification, group the Fulahs with the Nubians in a separate division ("Nuba-Fulah family"), and class the Tibus as Negroes. But more recent research has shown —(1) that the Fulahs and Nubians differ fundamentally in speech and physique, the former being of Caucasic and the latter of Negro type (Krause, Rüppel), and (2) that the true Tibus, the Tedas of Tibesti as distinguished from the Dasas or southern group, are not Negroes but Hamites, akin to the Taregs of the Western Sahara, although the two languages are totally distinct (Nachtigal). The Tibu language has been described as a Negro form of speech; but this is also a mistake. It forms an independent linguistic group, the oldest and purest branch of which is that of the Northern Tedas. From Tibesti it appears to have spread southwards to Kanem and Bornu, where the Dasa, Kanuri, and other dialects have been exposed to Negro influences. Had Tibu been originally a Negro language, its most primitive form would be found, not in Tibesti, but in Soudan, and its progress would have been thence northwards, not from the Sahara southwards.

In the subjoined table of the chief Soudanese races the Negro divisions have little more than a linguistic value.

Negro and Negroid Peoples.

Mandingoes: Mandinka, Malinka, and in the east Vangarawa, the dominant race between the Joliba (Upper Niger) and Kong Mountains, where their simple and harmonious speech is everywhere current as the chief medium of intercourse; fine Negro type, tall, very dark complexion from coffee-brown to black, long frizzly and woolly hair; agriculturists and traders; mostly Mohammedans outwardly; population six to eight millions. Chief subdivision the Bambarras, whose capital is Sego on the Joliba; population 2,000,000.

Sonrhai or *Songhai:* An historical race whose empire stretched in the 16th century from the northern bend of the Niger to the Atlantic and Morocco; speech of a monosyllabic type, still current in the Timbuktu district and oases of Western Sahara; population 2,000,000.

Tombo, Mosso, Gurma: Three little known Negro peoples west of the Niger within the great bend; affinities uncertain; form semi-independent petty states, apparently tributary to Moassina and Gando.

Nupe or *Nufe:* Large Negro nation along both sides of the Niger from Rabba to the Binue confluence, subject to Gando.

Yoruba: Powerful Negro people between lower Niger and Dahomey: capital Ilosin; Mohammedans, pagans, and Christians (Protestant).

Batta: The chief Negro people in Adamawa, now subject to the Fulahs; pagans, and Mohammedans.

Haussa: Largest, most widespread, and intelligent of all the Sudanese Negro peoples, mainly between the Niger and Bornu; speech very musical, the chief commercial medium in Western and Central Soudan, and current in parts of Tripolitana; shows distinct traces of Hamitic influences (Krause); mostly Mohammedans.

Mosgu or *Masa:* Widespread Negro family between Lake Tchad and Adamawa and stretching east to the Shari; chief sub-divisions: Mandara, Margi, Logon, Gamergu, Margomi, Keribina; mostly pagans and uncultured.

Yedina (*Buduma*) and *Kuri:* Predatory Negro tribes in the islands of Lake Tchad; appear to be related to the Kolokos or Mekari of Logon and Bornu; nominal Mohammedans; population 30,000.

Baghirmi: The dominant people in Baghirmi; cultured Mohammedans; very industrious and skilled weavers and dyers; population over a million.

Maba: The chief Negro nation in Wadai, mainly in the Wara and Abeshr districts, about the headstreams of the Batha.

Fúr or *For:* The dominant race in Dar-Fur, which takes its name from them; akin to the Nubas; chief subdivision Kuñjara.

Nubas: Large Negro nation; Jebel Nuba, and other parts of Kordofan, the original stock of the Nile Nubians; chief subdivisions: Kargo, Kulfan, Kolaji, Tumali.

Nilotic Negroes: Shiluks, Dinkas, Bongos, Baris, A-Madi (Mittu), and many others about the Bahr el-Jebel and southwestern tributaries of the White Nile.

Funj: A very mixed Negroid race, Senaar.

Hamites—Pure and Mixed.

Tuaregs: A main branch of the Berber race, dominant throughout the Western Sahara and southern steppes; powerful, especially in the Timbuktu district and on the north frontier of Bornu.

Sorinka or *Assuanek:* Called also Serekuli or Serrakolet, *i.e.*, "white people"; half-cast Tuareg and Negro nation scattered in small communities from the Niger to the Atlantic, and numerous especially in Senegambia and Moassina; cultured Mohammedans, and active traders.

Fulahs: The most powerful, intelligent, and widespread of all the Soudanese peoples; from their original home in Senegambia (Futa-Toro, Futa-Jallo) have spread since the 18th century throughout Western and Central Soudan, and as far east as Dar-Fur, everywhere propagating Islam, overthrowing the native Haussa and other states, and founding new kingdoms in the Niger basin, in Adamawa, and Central Soudan; are called Fellani by the Haussas, Fulán by the Arabs, Felláta by the Kanuri, the term meaning "fair" or "light colored"; pure type, distinctly Caucasic, regular features, long black hair, brown or ruddy complexion, slim well-proportioned figures; but the language, which presents several remarkable features, shows only faint traces of Berber influence, and appears on the whole to be essentially a Negro form of speech, adopted probably during residence from the remotest times in Negroland; population seven to eight millions.

Dasas: The southern branch of the Tibus, chiefly in Kanem and northern Bornu; type and speech show distinct Negro influences.

Kanembu: The people of Kanem, with settlements in eastern Bornu; also originally Tibus, but betraying still more decided Negro influence.

Kanuri: The ruling race in Bornu; speech a development of the Dasa and Kanem; type half-cast Tibu and Negro.

Zogháwa, Baele, Ennedi: Mixed Tibu and Negro tribes; northern Dar-Fur, originally from Borku and Wanganya, eastern Sahara; speech akin to Dasa.

Semites.

Auláď Soleimán Arabs: In Kanem.

Auláď Rashid Mahámid: Southeast of Borku, and in Dar-Fur.

Salámát, Auláď Hamed: Between the lower Shari and Bahr el-Ghazál.

Hamr, Hamrán: Kordofan.

Kababish: "Goatherds"; widespread along west side Nile, from Kordofan to Dongola.

Bakkára: "Cowherds"; south of the Kababish to left bank of Bahr el-Arab.

Politically Western and Central Soudan are divided into eight independent and semi-independent states, which in their order from west to east are as under:

Bambarra, divided into two nearly equal sections by the Joliba, which traverses it from southwest to northeast, is ruled by the Negro Bambarras of Mandingo stock. It has recently been brought under the influence of the French penetrating eastwards from their possessions on the Senegal. The capital is Sego, on the right bank of the Joliba.

Moassina, Gando, Sokoto, Adamawa, the four so-called "Fulah States," occupy the Niger basin between Bambarra and the Binue confluence, the whole of the Binue basin, and the region lying between the Niger and Bornu. *Moassina* (Massina) lies on both banks of the Niger from Bambarra to Kabara, the port of Timbuktu, and is peopled by Fulahs, Bambarras, and Sonrhais; capital Hamda-Alahi, on the right bank of the Niger, below Jenne, which is its chief trading place. Timbuktu, with surrounding district constitutes a separate territory governed by a kadia, or hereditary mayor, who lately sent an envoy to Paris for the purpose of seeking French protection against the rival Tuareg and Fulah tribes. *Gando*, so called from its capital on an eastern tributary of the Niger, stretches along the main stream southwards to the Binue confluence, including the Nufe territory and part of Yoruba. The lower part is extremely fertile, abounding in cotton, indigo, rice and all varieties of African grains. It comes within the limits of the region over which the British protectorate has recently been extended. Besides the capital, there are several large towns, such as Bida (30,000 to 50,000 inhabitants) in the north; Rabba (40,000 to 50,000), head of the steam navigation on the Niger, and a chief station on the great trade route running from Lagos on the Guinea Coast northwards to Gando and Sokoto; Egga (8000), on the left bank of the Niger, centre of the British trade; Lokoja, facing the Binue confluence, an English factory, headquarters of an Anglican mission and seat of a Negro bishop. *Sokoto*, sometimes spoken of as the "empire of Sokoto," is the largest and most powerful of all the Soudanese states, stretching from Gando to Bornu, and from the Binue northwards to the Sahara (see SOKOTO). In it are absorbed all the former "Haussa States," and to it Adamawa is also tributary. The inhabitants are chiefly Fulahs and Haussas, intermixed with many aboriginal Negro peoples, especially in the south and southeast. The land is generally fertile, yielding rich crops of cereals, cotton, tobacco, indigo, sugar, yams, black pepper, ginger, melons. The capital and residence of the sultan is Sokoto, in the extreme northwest. Other large towns are—Katsena, before the Fulah invasion a place of 100,000 inhabitants, now reduced to 7000; Kano, in Barth's time the "London of Soudan," and still with 50,000 souls (Matteucci); Wornu (15,000); Gombe, in the province of Calam (20,000); Yokoba, or Garu n-Bauchi (150,000); Keffi Abd es-Senga (30,000), in Zegzeg, a great centre of the ivory trade, and converging point of the two great caravan routes from the north (Kano) and the west (Egga). *Adamawa*, so named from its Fulah conqueror Adama and formerly known as Fumbina, or "Southland," is ruled by a Fulah vassal of Sokoto, who keeps in subjection the Battas and innumerable other Negro peoples; it lies between Sokoto, Bornu and Baghirmi, merging southwards in the unexplored equatorial region back of the Cameroons. The capital is Yola, at the northern foot of Mount Alantika. Adamawa appears to be one of the finest and healthiest regions in Africa, splendidly diversified with lofty highlands, fertile valleys, and grassy plains, overgrown in some places with forests of bananas, baobabs, and plantains, in others yielding abundant harvests of cereals, cotton, and indigo. The horses and cattle introduced by the Fulahs thrive well on the rich pastures, and elephants abound in the woodlands.

Bornu with *Kanem*, in the north, now reduced, and the tributary state of *Logon* in the south, completely encircles Lake Tchad, except at the southeast corner, where Baghirmi is wedged in between Logon and Wadai; it is mostly a flat, low-lying region with fertile plains yielding durrah, maize, cotton, and indigo, watered by the Komadugu, Logon, and Shari, all of which flood their banks for miles during the rainy season. The ruling race are the Kanuri, cultured but fanatical Mohammedans of mixed Tibu and Negro stock. The capital of Bornu is Kuka (50,000 to 60,000 inhabitants), near the west coast of Lake Tchad, a great centre of Soudanese trade with the Sahara and Tripolitana, and terminus of the main caravan route from Murzuk

(Fezzan) across the desert to the Tchad basin; the capital of Logon is Logon-birni, residence of a vassal prince. Population of Bornu estimated at 5,000,000.

Baghirmi, a Negro state, since 1871 tributary to Wadai, comprises the rich and well-watered plains of the lower Shari, with undefined southern limits. Capital Masena; population about 1,500,000, of whom three-fourths Baghirmi the rest Kotokos, Fulahs, and Arabs.

Wadai, a powerful Mohammedan state occupying the whole region between Baghirmi and Kanem in the west and Dar-Fur in the east, and claiming exclusive ivory and and slave-hunting rights in the southern (upper) Shari basin. The capital is Abeshr, on a head stream of the Batha. The country is mainly a hilly plateau rising to 3000 feet above the sea, and yielding good crops of maize, dukhn, durrah, cotton, indigo. Population four to six millions, chiefly Mabas and other Negroes, and numerous Arab tribes, with some scattered Baghirmi, Fulah, and Kanuri settlements.

Eastern Soudan, comprising Dar-Fur, Kordofan, Senaar, Taka, and the Negro countries on the White Nile and its southwestern tributaries, respectively called the Equatorial and Bahr-Gazal Provinces, belonged politically to Egypt till the rebellion of the late Mahdi. Since his death in 1885 most of these provinces appear to have lapsed into a state of anarchy and barbarism, in which few vestiges remain of the peace and order introduced by the European officers of the khedive. The Equatorial Province, however, and the Suakin district have been exempt from these troubles, —the former being still held till 1886 by the governor, Emin Bey, for the khedive, while in the latter the natives themselves succeeded in the same year in putting down the "rebels" or party of Osman Digma. For details of Eastern Soudan, see articles NILE, NUBIA, and SENAAR. (A. H. K.)

SOULT, NICOLAS JEAN DE DIEU, duke of Dalmatia and marshal of France (1769–1851), was born at Saint-Amans-la-Bastide (now in department of the Tarn), on March 29, 1769, and was the elder son of a country notary at that place. He was fairly well educated, and intended for the bar, but his father's death when he was still a boy made it necessary for him to seek his fortune, and he enlisted as a private in the regiment of royal infantry in 1785. His superior education insured his promotion to the rank of sergeant after six years' service, and in July, 1791, he became instructor to the first battalion of volunteers of the Bas-Rhin. He served with his battalion in 1792, and rapidly rose to the position of adjutant-general, colonel, and chief of the staff to General Lefebvre. Soult it was who practically directed the operations of Lefebvre's division in 1794, and after the battle of Fleurus he was promoted general of brigade by the representatives on mission. For the next five years he was constantly employed in Germany under Jourdan, Moreau, Kléber, and Lefebvre. The attack of the French left at the battle of Altenkirchen, which won the day, was directed by Soult, and in 1799 he was promoted general of division and ordered to proceed to Switzerland. It was at this time that he laid the foundations of his military fame, and he particularly distinguished himself in Masséna's great Swiss campaign, and especially at the battle of Zurich. He accompanied Masséna to Genoa, and acted as his principal lieutenant throughout the protracted siege of that city, during which he operated with a detached force without the walls, and after many successful actions he was wounded and taken prisoner at Monte Cretto on 13th April, 1800. The victory of Marengo restoring his freedom, he received the command of the southern part of the kingdom of Naples, and in 1802 he was appointed one of the four generals commanding the guard of the consuls. Though he was one of those generals who had served under Moreau, and who therefore, as a rule, disliked and despised Napoleon, Soult had the wisdom to show his devotion to the ruling power; in consequence he was in August, 1803, appointed to the command in chief of the camp of Boulogne, and in May, 1804, he was made one of the first marshals of France. When Napoleon decided to lead the troops of the camp of Boulogne into Germany, Soult took the command of the right wing, and it was by his capture of the heights of Pratzen that the great battle of Austerlitz was decided. He played a great part in all the famous battles of the grand army, except the battle of Friedland, and after the conclusion of the peace of Tilsit he returned to France and was created duke of Dalmatia. In the following year he was appointed to the command of the 2d corps of the army with which Napoleon intended to conquer Spain, and after winning the battle of Gamonal he was detailed by the emperor to pursue Sir John Moore, whom he only caught up at Coruña. For the next four years Soult remained in Spain, but it is impossible to do more than allude to his most important feats of arms. In 1809, after his defeat by Sir John Moore, he invaded Portugal and took Oporto, but, deluded by the idea of becoming king of Portugal, he neglected to advance upon Lisbon, and was eventually dislodged from Oporto by Sir Arthur Wellesley. After the battle of Talavera he was made major-general of French troops in Spain, and on 12th November, 1809, won the great victory of Ocaña. In 1810 he invaded Andalusia, which he speedily reduced, with the exception of Cadiz. In 1811 he marched north into Estremadura, and took Badajoz, and when the Anglo-Portuguese army laid siege to it he marched to its rescue, and fought the famous battle of Albuera (16th May). In 1812, however, he was obliged, after Wellington's great victory of Salamanca, to evacuate Andalusia, and was soon after recalled from Spain at the request of Joseph Bonaparte, with whom he had always disagreed. In March, 1813, he assumed the command of the 4th corps of the grand army and commanded the centre at Lützen and Bautzen, but he was soon sent, with unlimited powers, to the south of France to try and repair the damages done by the great defeat of Vittoria. His campaign there is the finest proof of his genius as a general, although he was repeatedly defeated by the English under Wellington, for his soldiers were but raw conscripts, while those of Wellington were the veterans of many campaigns.

Such was the military career of Marshal Soult. His political career was by no means so creditable. After the first abdication of Napoleon he declared himself a royalist, received the order of St. Louis, and acted as minister for war from 3d December, 1814, to 11th March, 1815. When Napoleon returned from Elba Soult at once declared himself a Bonapartist, and acted as major-general to the emperor in the campaign of Waterloo. For this conduct he was exiled, but not for long, for in 1819 he was recalled and in 1820 again made a marshal of France. He once more tried to show himself a fervent royalist and was made a peer in 1827. After the revolution of 1830 he made out that he was a partisan of Louis Philippe and constitutional royalty, and served as minister for war from 1830 to 1834, as ambassador extraordinary to London for the coronation of Queen Victoria in 1838, and again as minister for war from 1840 to 1844. In 1848, when Louis Philippe was overthrown, Soult again declared himself a republican. He died at his castle of Soultberg near his birthplace in 1851.

SOUND. See ACOUSTICS.

SOUNDING to ascertain the depth of the sea has been practiced from very early times for purposes of navigation, but it is only since the introduction of submarine telegraphy that extensive efforts have been made to obtain a complete knowledge of the contour of the ocean-bed. As early as the middle of last century a few deep soundings were recorded in various parts of the world: Ellis made one in 1749 of 891 fathoms off the northwest coast of Africa. But these early results must be accepted only with great caution, for the methods then in use were not such as to insure accuracy at any depth greater than a few hundred fathoms. Sir John Ross, the arctic explorer, was much in advance of his times as regarded such investigations; he invented a "deep-sea clamm" for bringing up a portion of the bottom, and on September 1, 1819, in Possession Bay, made a successful sounding at a depth of 1000 fathoms, which is especially memorable because it was clear, from the organisms which came up entangled in the line, that animal life existed at that depth.

The operation of sounding is readily performed in shallow water by letting down a weight attached to a cord, which is marked off into fathoms by worsted tucked under the strands, the tens and hundreds being indicated by different colors. The bottom of the weight usually presents a hollow, which is filled with tallow, so that a portion of the material from the bottom may be brought up and give an indication of its nature. Sometimes a valved cavity is used instead of the tallow. It is easy to see that the longer the line let out the greater will be its friction in passing through the water, the more slowly the weight will descend, and the slighter will be the shock transmitted to the upper extremity when it reaches the bottom; indeed, at what are now considered very moderate depths this becomes quite imperceptible; hence in deep-sea sounding the line is carefully watched as it runs out, and the time each 100-fathom mark enters the water is noted down. Owing to the increasing friction these intervals gradually lengthen, but any sudden increment indicates that the bottom has been reached, for it shows that the weight has ceased to act, and that further descent of the line is due merely to its own gravitation. For instance, in one of the "Challenger" soundings, with a line 1 inch in circumference, and with a weight of 4 cwts. attached, the time occupied in descending from 2900 to 3000 fathoms was 2 m. 10 s.; from 3000 to 3100 fathoms 2 m. 13 s., and from 3100 to 3200 fathoms 3 m. 14 s., this sudden increase showing that the bottom had been reached in the interval.

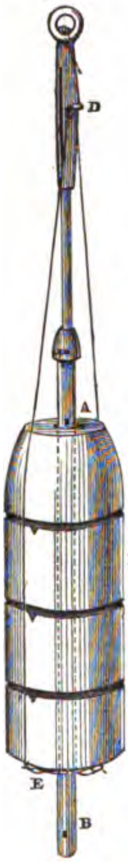

FIG. 1.

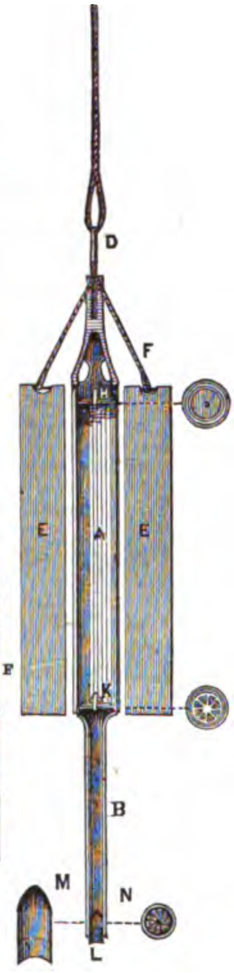

FIG. 2.

Furthermore, the weight required to sink a line in deep water with sufficient rapidity for purposes of accurate observation is so great that it is found impracticable to bring it up again without putting an undue strain upon the rope or seriously prolonging the operation. Hence in 1854 Brooke, an American, devised an apparatus by which the weight was detached when it reached the bottom and only a small tube containing a sample of the bottom was brought up. This was in fact a modification of an apparatus which had been devised by Hooke in the 17th century; he made an arrangement in which a light sphere was sunk by a heavy weight, but was liberated on reaching the bottom,—the depth being then deduced from the time which elapsed between the sinking of the globe and its reappearance at the surface. Of the various modifications of Brooke's sounding machine, perhaps the most famous is that constructed by the blacksmith of H.M.S. "Hydra," and commonly known as the "Hydra sounding rod." It was used on the cruises of the "Lightning" and "Porcupine" and during the earlier part of the "Challenger" expedition. This apparatus is shown in Fig. 1, where AB is the rod, terminating in a tube below so that it may bring up a sample of the bottom; the weights F fit loosely round it and are supported by the wire E which passes over the stud D, where a spring presses against it, the strength of which is so adjusted that it is unable to displace the wire as long as the strain of the weights is upon it, but so soon as this is relieved by their resting on the bottom the wire is thrust off the stud, and when the line is hauled in the weights and wire are left behind.

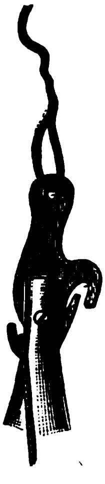

FIG. 3.

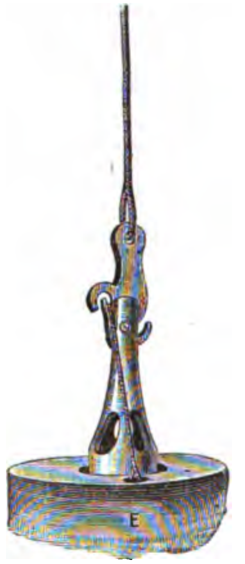

FIG. 4.

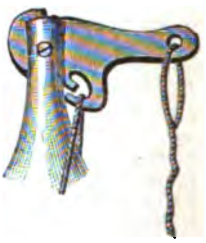

FIG. 5.

An improved apparatus has recently been invented by Mr. J. Y. Buchanan, and used by him on board the telegraph ships "Dacia" and "Buccaneer," which can be used either in shallow or deep water, and has the advantage of bringing up samples both of the water and of the mud from the bottom. It consists of a hollow cylinder A, Fig. 2, at the top and bottom of which are india-rubber valves H, K, opening upwards, so that water passes freely through them during the descent but is retained as soon as a plug of mud occupies the tube B. The weight EE which surrounds the cylinder is supported by a wire F passing over a peculiar hook D, shown separately in Figs. 3, 4, 5; when sounding in shallow water it is not necessary to detach the weight, and the wire is therefore placed as in Fig. 3; when working at greater depths the wire rests on the other side of the hook, as in Fig. 4,—the result being that on the bottom being reached it falls into the upper part of the notch, Fig. 5, and continues to press the tube into the mud, but when hauling up commences the wire slips out altogether and the weight is left at the bottom. A valve L, M, N is sometimes used to retain the sample of the bottom.

At the present time deep-sea sounding is extensively practiced for telegraphic purposes, and is almost entirely conducted by means of wire instead of rope, a method introduced by Sir William Thomson.[1] The friction of the wire in passing through the water is of course very much less than that of rope, and hence it runs out and can be hauled in much more rapidly; a smaller sinker may be used, and in very many instances it can be recovered. It is customary in sounding for cables to make very frequent observations (once in from 1 to 50 miles), for it is found that the laying can be accomplished with much less risk of accident if the contour of the ocean-bed be accurately known. The saving of time by the use of wire is very considerable; but the advantage is not so obvious in running out as in hauling in, because a heavier weight is used to increase the rate, this of course involving a loss of iron sinkers. For instance, an apparatus similar to that mentioned above as being used by the "Challenger" took on an average 24 m. 22 s. to sink 2000 fathoms, whilst in a recent sounding by the "Albatross" the weight ran out 2000 fathoms in 20 m. 30 s. and was hauled in in 21 m. 9 s.,—a rate which would have been quite unattainable by the aid of rope. The saving in the matter of sinkers is by no means inconsiderable; instead of 3 or 4 cwts., only 50 to 60 ℔ are used, and Sigsbee has calculated that this difference is sufficient to pay for any extra loss there may be by the breaking of the wire. Captain Magnaghi of the Italian navy and Captains Sigsbee and Belknap of the American Survey have successfully developed the method of sounding with wire, and owing to its use the last-mentioned officer was able to survey the route from San Francisco to Japan, doing all his sounding by hand, which would have been quite impossible had hempen rope been used. When soundings are made for scientific purposes it is customary to ascertain the temperature, both at the bottom and at intermediate depths, by a thermometer of special construction.

For further information, see Sir Wyville Thomson, *The Depths of the Sea* (London, 1874); *Narrative of the Cruise of H.M.S. "Challenger"* (London, 1885); Sigsbee, *Deep-Sea Sounding and Dredging* (Washington, 1880); Wille, *Norwegian North Atlantic Expedition*, pt. iv., "Apparatus and how used," 1876-78; Mill, *The Scottish Marine Station* (Edinburgh, 1885); and, for an improved apparatus used on board the "Talisman," *La Nature*, xii. p. 120, 1884; also the annual *Reports* of the U. S. Fish Commission. (W. E. HO.)

SOUTH, ROBERT (1633—1716), one of the wittiest of English divines, was the son of a London merchant, and was born at Hackney, Middlesex, in 1633. He was educated at Westminster school, whence in 1651 he was elected to Christ Church, Oxford. He became B.A. in 1654, and the same year wrote several Latin verses to congratulate Cromwell on concluding peace with the Dutch, which were published in a collection of university poems. The following year he published a Latin poem, entitled *Musica Incantans*. After commencing M.A. in 1657 he was in the habit before obtaining orders in 1658 of preaching as the champion of Calvinism against Socinianism and Arminianism. He was also at this time a strong supporter of Presbyterianism, but on the approach of the Restoration his views on church government underwent a change. In fact he adhered successively to the triumphant party as represented by Cromwell, Charles, James, and William, and there are substantial grounds for the assertion of Anthony Wood that he was much indebted for his preferments to his zeal for "the powers that be." On 10th August, 1660, he was chosen public orator of the university, and in 1661 domestic chaplain to Lord Clarendon. In March, 1663, he was made prebend of Westminster, and shortly afterwards he received from his university the degree of D.D. In 1667 he became chaplain to the duke of York. He was a zealous advocate of the doctrine of passive obedience, and also strongly opposed the Toleration Act, declaiming in unmeasured terms against the various noncomformist sects. In 1676 he was appointed chaplain to Lawrence Hyde (afterwards earl of Rochester), ambassador-extraordinary to the king of Poland, and of his visit he sent an interesting account to Dr. Edward Pocock in a letter, dated Dantzic, 16th December, 1677, which was printed along with South's *Posthumous Works* in 1717. In 1678 he was promoted by the chapter of Westminster to the rectory of Islip, Oxfordshire. Owing, it is said, to a personal grudge, South, in 1693, published *Animadversions on Dr. Sherlock's Book, entitled a Vindication of the Holy and Ever Blessed Trinity*, in which the views of Sherlock were attacked with much sarcastic bitterness. Sherlock, in answer, published a *Defence* in 1694, to which South replied in *Tritheism Charged upon Dr. Sherlock's New Notion of the Trinity, and the Charge Made Good*. The controversy was carried by the rival parties into the pulpit, and occasioned such keen feeling that the king interposed to stop it. During the greater part of the reign of Anne, South remained comparatively quiet, but in 1710 he showed himself a keen opponent of Sacheverell. He died 8th July, 1716, and was buried in Westminster Abbey.

The style of South is vigorous, pungent, and brilliant, though tending to exuberance. His sermons are strongly practical, but his theory of life is not ascetic. His wit generally inclines towards sarcasm, and it was probably the knowledge of his quarrelsome temperament that prevented his promotion to a bishopric. If he sacrificed principle to his desire for preferment, his ambition was not of a sordid kind, for he was noted for the extent of his charities. He published a large number of single sermons, and they appeared in a collected form in 1692 in six volumes, reaching a second edition in his lifetime in 1715. His *Opera Posthuma Latina*, including his will, his Latin poems, and his orations while public orator, with memoirs of his life, appeared in 1717. His *Works* were published with a memoir by the Clarendon press in 1823, and have been several times reprinted. The contemporary notice of South by Wood in his *Athenæ* is characterized by a strongly hostile tone, partly to be explained by a criticism of South at Wood's expense.

SOUTH AFRICAN REPUBLIC. See TRANSVAAL.

SOUTHAMPTON, a municipal and parliamentary borough, which gives name to Hampshire, or the county of Southampton, and one of the principal seaports on the south coast of England, is beautifully situated at the head of Southampton Water, forming the mouth of the Test, on a sloping peninsula, bounded on the east by the Itchen, at the terminus of the South-Western Railway, 79 miles southwest of London, 13 south-southwest of Winchester, and 24 west-northwest of Portsmouth. Southampton is also a county of itself,—the county of the town of Southampton. It preserves much of its antique appearance, but, although in the older parts the streets if picturesque are narrow and irregular, it may still claim the distinction it enjoyed in Leland's time of ranking "as one of the fairest that is in England," handsome and spacious shops lining the principal streets, while the suburbs are studded with numerous villas and mansions embosomed in woods. There are still considerable remains of the old town walls built in the time of Richard II., the most remarkable being a portion of the west walls, with an arcade on its exterior face. Four of the seven gates are comparatively well preserved—North or Bar Gate, South Castle Gate, Westgate, and Blue Anchor Gate. The finest of these is Bargate, in a room above which is the ancient Guildhall, where the quarter sessions are held. The representations of Sir Bevis of Hampton and the giant Ascupart which formerly stood on each side have recently been obliterated. The Castle, originally a

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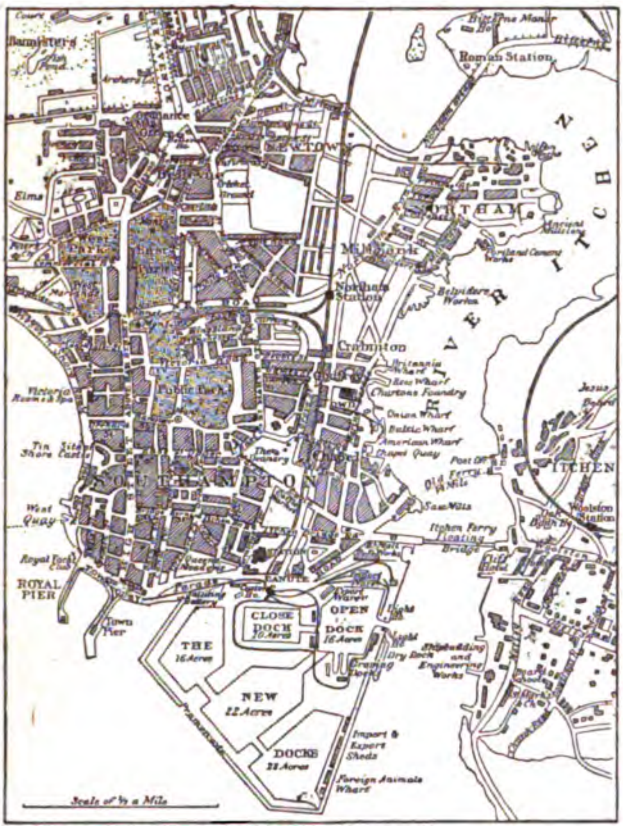
[1] [Wire was used in soundings by the U.S. steamer "Taney" in 1859, but without satisfactory results.—AM. ED.]

Saxon fortress, and rebuilt when the walls were erected, was partly demolished in 1650. After its rebuilding had been begun by the marquis of Lansdowne in 1805, it was sold, and in 1818 the site was parcelled out for building plots. In the vicinity of the castle there are some houses of very ancient date, including King's House (Early Norman). The two old churches, St. Michael's (originally Norman about the date of 1080) and Holyrood, have been in a great degree modernized; the former contains a beautiful Byzantine font and a monument to Sir R. Lyster, chief-justice in the 16th century. The French chapel of St. Julien, originally attached to the hospital of God's House, founded by Henry VIII. for eight poor persons, is of Norman architecture; it contains the burial-place of the earl of Cambridge, Lord Scrope, and Sir Thomas Grey, who in 1415 were executed outside the Bargate for conspiring against Henry V. Among the modern public buildings are the Watts memorial hall, erected in 1876 at a cost of £8000 [$38,880], the municipal office, occupying the old audit-house, the custom-house, the philharmonic hall, the assembly rooms, the county court-house, the corn exchange and chamber of commerce, and two theatres. The educational institutions include the Hartley Institution, founded by bequest for the advancement of natural history, astronomy, antiquities, and classical and Oriental literature, and now embracing a library, reading-room, museum, art gallery, laboratories, and schools of science and art associated with South Kensington; the Edward VI. grammar school, founded in 1550, and reorganized in 1875; and Alderman Taunton's school, founded in 1752, and lately remodelled. The school board was established in 1871. The benevolent and charitable institutions are numerous, embracing the dispensary (1809), the royal South Hants infirmary (1838), the female orphan asylum, the homœopathic dispensary (1873), St. Mary's cottage hospital (1873), and the Palk memorial home (1876). To the north of the town is Southampton Common, formerly part of the manor of Shirley; and adjoining the town to the north of Above Bar Street is the Public Park, prettily laid out and containing statues of Lord Palmerston, Dr. Watts, and Mayor Andrews. The town is supplied with water partly from artesian wells and partly from reservoirs. The population of the municipal borough (area 2004 acres) in 1871 was 53,741, and in 1881 it was 60,051. In 1885 the area of the parliamentary borough, formerly coextensive with that of the municipal borough, was extended to include the parish of Millbrook, the ecclesiastical district of the Holy Saviour, Bitterne, the parish of St. Mary Extra, and the detached portion of Hound included within St. Mary Extra. The population of this area in 1881 was 84,384. It is represented by two members.



Plan of Southampton.

The importance of the port dates from the Norman Conquest, and was originally due to its relation to Winchester. It had a considerable trade in wine as early as 1152, and from Queen Mary it obtained a monopoly in the importation of sweet wines from the Grecian islands. With Venice and Italy it had a large trade as early as the 14th century, and in the subsequent century it had a connection with Newfoundland, while its Channel trade and its shipbuilding were also of importance. About the end of the 16th century its trade had, however, begun to decline, and the visitation of the plague in 1665 tended still further to aid its retrogression. Some improvement took place in its prospects by the creation of a Pier and Harbor Commission in 1803, and the erection of the Royal Victoria pier in 1831 was a further step towards prosperity, but its modern trade really dates from the opening up of railway communication with London in 1840. It possesses one of the finest natural harbors and has the advantage of a double tide, a second high tide occurring two hours after the first. While largely dependent for its import trade on its connection with London and its easy communication with France, it has become an outlet for the manufactures of the midland and northern towns. Its great tidal dock, completed in 1842 at a cost of £140,000 [$680,400], has an area of 16 acres with a depth of 18 feet at low water, and the inner dock, completed in 1851, an area of 10 acres and a depth of 28 feet. Two other docks embracing an area of 50 acres are being constructed. There are also four dry docks, capable of receiving vessels of the largest tonnage at all tides. Within recent years the port has lost the overland trade between London and India by the removal to London of the headquarters of the Peninsular and Oriental Steam Navigation Company. At present it is the headquarters of the Royal Mail Steam Packet Company for the West Indies and the Pacific (*via* Panama) and for Brazil and the River Plate, the Union Line for the Cape of Good Hope, Natal, and East Africa, and the London and South Western Railway Company's steamers to the French coast. Steamers also sail regularly for Ireland and various ports on the west coast of England; and the steamers of the North German Lloyd Company touch at the port on the way to and from New York, and also to and from Asiatic and Australian ports. The total number of vessels that entered the port in 1876 was 7840 of 1,201,301 tons, of which 3780 with a tonnage of 201,434 were sailing vessels, and 4060 with a tonnage of 999,867 were steamers. The number that cleared in the same year was 8047 of 1,174,365 tons, of which 3994 (196,064 tons) were sailing vessels, and 4053 (978,301 tons) were steamers. In 1885 the number of vessels that entered the port was 9768 of 1,539,357 tons, of which 3456 (175,900 tons) were sailing vessels, and 6312 (1,363,457 tons) were steamers. The number that cleared in the same year was 9641 of 1,523,759 tons, of which 3350 (182,688 tons) were sailing vessels, and 6291 (1,341,071 tons) were steamers. Since 1845 the trade has increased more than tenfold, although within recent years the port has suffered from the prevailing dulness. The total value of imports and exports in 1845 was £1,475,000 [$7,168,500]; in 1880 the value of the imports was £9,205,183 [$44,739,189.38], and in 1884 it was £7,544,354 [$36,665,560.44]; for these last years the value of the exports of United Kingdom produce was £9,306,326 [$45,228,744.36] and £6,909,072 [$33,578,089.92]; while the value

of the exports of foreign and colonial produce and manufactures in 1882 was £1,589,652 [$7,725,708.72], and in 1884 £1,150,954 [$5,593,636.44]. Among the principal imports are cocoa, coffee, corn (including maize), apples, provisions (especially butter, eggs, and potatoes from France and the Channel Isles), rum and brandy, sugar, wine, wool, and rags. Among the principal exports of the produce of the United Kingdom are apparel, cotton goods, leather, linen goods, machinery, copper and iron goods, woollen and worsted goods. The number of ships built at the port in 1885 was 19, of 17,875 tons burden.

The Roman station of Clausentum was situated at Bitterne on the opposite side of the Itchen, where extensive Roman remains have been found. The present town was founded by the West Saxons, probably soon after their landing under Cerdic and Cynric on the shores of Southamptom Water in 495. The name Hantun-scire (Hamptonshire) occurs in the *Saxon Chronicle* under date 755, and Hamtun is first mentioned separately in 837. The prefix "South" was probably added after the annexation of Wessex to Mercia in 920, to distinguish it from the Hampton in Mercia afterwards called Northampton. The town was frequently ravaged by the Danes in the 9th and 10th centuries. Canute, after his establishment on the throne, made it his occasional residence, and Southampton beach is reputed to have been the scene of his rebuke to the flattery of his courtiers, by the demonstration of his powerlessness to control the waves. Southampton is mentioned in Domesday as Hantune. It possessed a mint as early as 925. It was frequently visited by successive monarchs from the time of Henry I. In 1338 it repulsed an attack of the French and Genoese. In 1415 it was the rendezvous of the army of Henry V. for France, and during his stay in the town he detected the conspiracy against him of the earl of Cambridge, Lord Scrope, and Sir Thomas Grey, who were executed outside the Bargate. In 1512 the marquis of Dorset embarked from the port with 10,000 men to the aid of Ferdinand of Spain against France, and in 1522 the earl of Surrey set out from it with a large fleet to escort Charles V. Queen Elizabeth held a court at Southampton in 1569. On account of the outbreak of the plague in London in 1625 the council was transferred by the king to Southampton, where on the 7th September a treaty was signed with the United Provinces. The town received its first charter from Henry II., and a charter of incorporation from Henry VI. in 1445 under the style of "mayor, bailiff, and burgesses." This charter was somewhat modified by that granted by Charles I. which remained the governing charter till the passing of the Municipal Act. The corporation act as the urban sanitary authority. The town first returned members to parliament in 1295. Among eminent persons connected with Southampton are Dibdin the song writer, Bishop Peacocke, Thomas Fuller, and Dr. Watts.

See *History of Southampton*, by J. Sylvester Davies, 1883.

SOUTH AUSTRALIA, which lies between 129° and 141° E. long., has New South Wales and Victoria on the E., Western Australia on the W., and the Southern Ocean on the S. Originally its northern line was 26° S. lat., but by the addition of the Northern Territory, or Alexandra Land, the area has been extended from 380,070 square miles to 903,690, and the northern border carried to the Indian Ocean. The length is therefore from lat. 38° S. to 11° S., nearly 2000 miles. Being much more northern and less southern than the neighboring colony, its present designation is incorrect in point of fact.

Plate IV.

The southern coast-line shows two large gulfs, Spencer and St. Vincent,—the first 180 miles long, the other 100. Spencer Gulf is open to the ocean, while St. Vincent Gulf is partly shielded by Kangaroo Island, with Investigator Straits as its westerly entrance and Backstairs Passage for an easterly one. Yorke Peninsula separates the two gulfs. Port Lincoln and Sleaford Bay are at the southwest of Spencer Gulf. On the western side of Eyria Peninsula—the land westward of Spencer Gulf—are the following bays: Coffin, Anxious, Venus, Streaky, Denial, and Fowler. The junction of South and Western Australia is on the Australian Bight. Encounter Bay is on the Victorian side, with Lacepede, Guichen, Rivoli, and Macdonnell Bays to the southeast. Flinders, Investigator, and Nuyt Islands are southwest. Cape Jervis is at the eastern entrance of St. Vincent Gulf, Spencer at the western. In Northern Territory are Melville, Adam, Arnhem, and Raffles Bays, Van Diemen's Gulf, Port Essington, and Port Darwin (lat. 12° S.). The Gulf of Carpentaria divides the territory from Cape York Peninsula of Queensland. Melville, Bathurst, and Groote-Eyelandt are northern islands. The ranges of hills are few, rarely reaching 3000 feet. One chain runs north from Cape Jervis. Flinders range has Brown and Arden, 3000 feet. Lofty, near Adelaide, is 2330 feet. Volcanic cones, as Gambier and Schanck, are southeast, near Victoria. In general the country is level, where not slightly undulating. It is far from being well watered, especially to the westward and in the interior. The Murray, passing through Lake Victoria, had previously received most of the drainage of the three eastern colonies. The Torrens flows by Adelaide. Few streams reach the ocean. Cooper's Creek drains part of Western Queensland. The Indian seas receive the Alligator, Liverpool, Roper, Macarthur, Daly and Victoria rivers. Albert and the Coorong are lakes at the Murray mouth. The depressed area northward contains Lakes Torrens, Eyre, Gairdner, Blanche, Hope, and Amadeus. The overland telegraph to Port Darwin passes mostly through an ill-watered country, with oases around springs. The population, 330,000, is principally within 100 miles of Adelaide, the capital, in lat. 35° S. The leading places north of Adelaide are Gawler, 25 miles, Barossa 38, Kapunda 49, Angaston 51, Port Wakefield 60, Clare 90, Kooringa of Burra Burra 100, Moonta 100 northwest, Kadina 96 northwest, Blyth 100, Morgan or North-West Bend 105, Broughton 150, St. Petersburg 154, Port Pirie 155 northwest, Port Augusta 240 northwest, Colton 320, Blinman 350. To the east are Barker 21, Echunga 23, Nairne 25, Kingston or Port Caroline 170 southeast, Narracoorte 220, Penola 250, Gambier 290, Macdonnell 304. Lincoln is 210 west. Adelaide Port is 7, Glenelg 7, Brighton 10, Willunga 30 south; Goolwa, the Murray port, is 60 south. Palmerston of Port Darwin is the chief town of Northern Territory; Southport is 25 miles south of it. Other settlements are inland mining townships. There are 36 counties, 4 pastoral districts, 23 municipalities, and 112 district councils in South Australia proper.

Climate.—Excepting Western Australia, this is the driest portion of the island continent. The rain clouds from the Pacific or the Indian Ocean have little store left on reaching the South Australian districts. The northwest summer monsoons favor the northern coastlands, though the rains penetrate but few miles inland. The trade-winds bring only dry blasts from the Queensland side. A large proportion of the southwestern shore has a very partial deposition, and even the southern Yorke Peninsula, laved by two great gulfs, seldom shows any surface water. The conflict between the polar and equatorial currents occasionally throws down rain in the interior, though many a thunderstorm fails to let fall more than a few drops. But the southeastern coast catches a fair amount of rain from the western breezes off the Southern Ocean. The settled districts have winter rains, when Adelaide plains are transformed from parched sterility to luxuriant vegetation. The average annual rainfall there is but 20 inches, with an evaporation of three times that amount. In 1885 (a dry year) Adelaide had only 16 inches. In some years only 5 inches have fallen, even on parts of the seashore. The interior, however, has been known to have extensive floods after sudden storms. The northern coast, as at Port Darwin, has from 50 to 70 inches, though for several months without a shower. The heat is considerable during the dry summer time, though cold is felt severely on winter mornings and nights, even in the tropics, when a dozen degrees of frost may be followed in a few hours by a temperature of 80° or 90°.

The health conditions of the colony are but little inferior, except in Adelaide and Port Darwin, to those ruling in Tasmania and New Zealand, which are so much cooler and wetter. Dry heat is never so prejudicial as a moist heat. A raging hot wind from the north and northwest, to which Adelaide is so unpleasantly exposed, is trying to young children, though it never brings noxious gases. On the contrary, when passing over eucalyptus forests it brings down health-giving airs, in spite of 160° in the sun, or even 120° in the shade. Diarrhœa may trouble in summer, and catarrh in winter; but, with a birth-rate of 39 in the thousand and a death-rate of from 12 to 17, South Australia stands more favorably than England in relation to health. Recently, several townships had for the year but seven deaths in the thousand, exhibiting a freedom from mortality three times greater than London. The death-rate of the colony during 1885 was only 12.48 to the thousand, while the birth-rate was 37.70. One-third of the deaths were in Adelaide. Reports from the tropical Northern Territory speak of fever and ague, especially among imprudent gold-miners.

Geology.—The few mountain ranges scattered throughout the colony were once, in all probability, but islands rising in a mediterranean sea that connected the Indian Ocean and Java Sea with the Southern Ocean. Over at least the southern half of South Australian territory the water flowed in Tertiary times. The climatic effect of such an archipelago of islands must have been very different from what now is realized in that region. The rise of the country displayed that vast extent of arenaceous limestone forming the southern coast floor, and extending westward hundreds of miles in Western Australia, and far eastward in Victoria. The south coast is still rising. The Murray cuts its channel through this vast coralline formation. According to the Rev. J. Tenison Woods, the newer Pliocene is near Adelaide, while the older is at Mount Gambier. The Murray cliffs are Upper Miocene, and the Murray flats are Lower Miocene. He finds little or none of Eocene. Flint bands occur in this limestone, particularly at Gambier. The Biscuit country, southeast, has flat limestone concretionary cakes on the surface, more or less rounded. Beds of sand cover large areas of the recent rock. Caves abound in the Gambier district, provided with stalactites and stalagmites. Subterranean rivers flow through some of the caverns, and are occasionally reached by natural sloping wells. Gambier exhibits much Bryozoan limestone. Its 40 species and 16 genera of *Polyzoa* are in Lower Crag. The coral limestone there has extensive flint bands. *Foraminifera* are of many kinds; some of the Rhizopods are still existing in Australian waters. Sharks' teeth and large nautili are frequently met with. Most fossils are in casts except *Pecten*, *Bryozoa*, *Echini*, etc. The Murray cliffs mark the remains of an extensive formation, since largely denuded. The Gambier deposits prove the presence of an ancient deep sea, when little of Australia, as we now perceive it, had any existence. The South Australian ranges are generally of Primary order, the Silurian formation being often pierced or flooded by igneous rocks, which have transmuted the strata. While granites and granitoids are in great masses, the basalts and greenstones of a later age are not wanting in the ranges. The Primary rocks are observed, also, in Eyria Peninsula, Port Lincoln, the central continental districts, and very prominently in the Northern Territory. Flat-topped sandstone hills prevail northward. Westward and southeastward the Tertiary rests on a granite floor. Eastward there is the same Primary presence, with crystalline mountains developing silver mines just over the border. Metamorphic rocks, rising amidst Tertiary beds, are strong in Yorke Peninsula, producing much copper. The tablelands are of horizontal sandstone, often on spiriferous limestone. Desert sandstone may be Miocene. Near the Victorian boundary, in the southeast corner of South Australia, recent volcanic action is apparent. Several of the lakes there were once craters. The deep Blue Lake, or Devil's Inkstand, occupies the centre of Mount Gambier. The banks are nearly 300 feet high, and are formed of lavas and volcanic ashes. Cinder walls are detected, and other varieties of volcanic products. Several smaller cones surround the great mount. The country itself is of the usual Tertiary limestone, more or less covered with ashes. Mount Schanck, between Gambier and the sea, is known as the Devil's Punchbowl. This cone of lava has an empty crater 200 feet deep. Gambier and Schanck are landmarks to passing mariners. Among the fossil forms in Tertiary Pliocene strata are those of the huge *Diprotodon*, a marsupial vegetable feeder 16 feet in height, with gigantic kangaroos, emus, wombats, etc.

Minerals.—South Australia, though without coal, was the first Australian colony to have a metallic mine, and the first to possess a gold mine. In 1841 the wheel of a dray, going over a hill near Adelaide, disclosed to view silver-lead ore. In the midst of the bad times in 1843 the Kapunda copper mine was found. In 1845 the wonderful Burra Burra copper was first wrought. The land, 10,000 acres, cost £10,000 [$48,600]; and for several years the dividends to shareholders were 800 per cent. per annum. The first colonial mineral export was 30 tons of lead ore, value £128 [$622.08], in 1843. The copper declined as prices fell. It was £322,983 [$1,569,697.39] in 1885, when rates were £50 [$243] a ton, but £762,386 [$3,705,195.96] ten years before with over £90 [$437.40]. In 1886 most of the mines were closed. Between 250 and 400 miles north of Adelaide a very rich copper district exists. Lead is very abundant. Manganese, nickel, bismuth, antimony, and silver have been mined. Tin is seen in granitic places. Iron occurs in almost all formations and in all conditions. There is abundance of hæmatite, micaceous, bog, and other ores rich in the metal. Talisker and other mines paid in silver. The wonderful Silverton, of Barrier Ranges, in a desert, is just outside the boundary, though 300 miles only from Adelaide while 600 from Sydney. Gold was got from a quartz vein at the Victoria mine, near Adelaide, as early as 1846, but did not pay the company. Partial gold working has been conducted at Echunga, etc., in southern hills. There are rich alluvial and quartz gold mines in Northern Territory, at from 100 to 150 miles south of Port Darwin. For the year 1884 the yield was £77,935 [$378,764.10]. Of 1349 miners 1205 were Chinese. Gold is now worked at Waukaringa, 225 miles north of Adelaide. Copper, tin, and silver are found in Northern Territory. Among other minerals asbestos, roofing slates, and fine marbles may be named. Some forty years ago precious stones, especially garnets and sapphires, were gathered in the Barossa Hills. Carbonaceous material is found at the Coorong, etc., yielding 50 per cent. of oil. Lake Eyre has a rude coal. Kapunda marble quarry is a success. In 1885 there were 16,493 acres leased for minerals. The value of minerals exported in 1885 was £338,132 [$1,643,321.52].

Agriculture.—This is essentially an agricultural colony. In its first establishment, farming was intended as the main occupation. The land was cut up for sale into eighty-acre lots with the view of settling the people on arrival, and concentrating them, instead of having them scattered as in the neighboring colonies, in which pastoral pursuits completely dwarfed the farming industry. This wise provision made the colony for years the supplier of breadstuffs to Sydney, Melbourne, Brisbane, Perth, and Auckland. As neighbors became wheat-producers, Adelaide merchants had to seek markets in Natal, Mauritius, the Cape, or even Europe. At all times the state has lent every assistance to agriculture. As the colony suffers more from drought than anything else, public reservoirs are constructed and artesian wells are sunk. Forest culture has especially attracted Government attention. Reforesting and the establishment of nurseries for the trees, fruits, and vegetables of other lands go hand in hand. Forest reserves already amount to 150,000 acres. Hundreds of thousands of trees are annually planted.

The land system sound at the beginning, has been repeatedly amended, especially with a view to the advancement of pastoral interests. Instead of cash sales, as formerly, conditional purchases may be made, extending over a long period, subject to conditions of residence and cultivation. At the end of 1884 only ten million acres had been purchased. There were, however, 53,000,000 acres inclosed, chiefly for pasturage, and 2,785,490 under cultivation. The crop for March, 1885, was as follows: wheat, 1,942,653 acres; fallow, 450,536; hay, 308,429; artificial grasses, 23,217; barley, 15,697; lucerne, 8649; oats, 7264; orchard, 5825; potatoes, 5666; pease, 4601; vineyard, 4590. The culture indicates a warm and dry climate, different from New Zealand or the tropical coast of Queensland. The product of South Australian fields is so much smaller per acre than in any of the neighboring colonies that only an open level country of cheap land, with effective machinery at moderate cost, could be managed at a profit. Going northward from Adelaide the country becomes too dry for roots, and then too precarious even for wheat. The county of Adelaide is very favorably placed for vineyards, oliveyards, and orchards. About half the olive trees and a third of the almond trees are there. Of 3,704,107 grape vines in the colony, Adelaide county had 2,158,468, and Light, in the neighboring hills, had 860,356. There were in 1884 473,535 gallons of wine made. The commissioners lately reported that the light white wines kept sound and good, while full-bodied red wines continue to improve with age. The Water Conservation Department is of great service to agriculture. Tropical cultivation receives some attention already in Northern Territory. The Chinese raise rice crops, there being heavy rains near the coast. Daly river has excellent soil and climate for sugar and coffee.

The pastoral progress has been considerable, notwithstanding want of moisture. In 1885 there were 1528 leases over 214,916 square miles, besides 257 annual leases with 11,214 square miles. There were then 168,420 horses, 389,726 cattle, 163,807 pigs, 6,696,406 sheep (twenty sheep per head of population). Of these the settled counties had 151,058 horses, 179,206 cattle, and 4,995,394 sheep. In Northern Territory, with 136,000 cattle, there were in December, 1885, 6000 horses and 40,000 sheep, that country, excepting in the dry interior, being unfitted for wool-bearers. The total export of wool grown in South Australia had only the value of £1,671,775 [$8,124,826.50] in 1885. The prices obtained were a fourth less than ten years before. The rabbit pest is felt as seriously in pastoral as in agricultural operations. Kangaroos are far less troublesome to stockholders than in Queensland. Where water can be procured by dams, reservoirs, or wells stock can be kept, since, where the grass fails, cotton bush and various saline plants supply sufficient food. An artesian well lately was sunk 1220 feet. Wool is remarkably fine there. While a South Australian merino has 2720 serrations to an inch of wool, a Leicester sheep has but 1850.

Fauna.—South Australia is not separated from the neighboring colonies by any natural boundaries; hence the fauna includes many animals which are also to be found in the land lying to the east and west. The northern half of the colony lies within the tropics, and possesses a tropical fauna, which is, however, practically identical with that of northern Queensland. In spite of its immense extent north and south, and a corresponding diversity in climate, the colony is poorer in animal life than its neighbors. It possesses thirty-five genera of mammals. These include both genera of the order *Monotremata*,—the *Echidna*, or spiny ant-eater, and the *Ornithorhynchus*, or duck-billed platypus, both of which are found also in eastern Australia and Tasmania. The other order of *Mammalia* associated with Australia, the *Marsupialia*, is well represented in South Australia. It contains seven genera of *Macropodidæ* or kangaroos, including the wallaby and kangaroo rat, four genera of *Phalangistidæ*, or opossums, and five species of *Dasyuridæ*, or "native cats." Two genera of this family are peculiar to the region—the *Chætocercus* and the *Antichinomys;* the latter is found in the interior. It is a mouse-like animal with large ears, and is remarkable for the elongation of its fore-arm and hind-foot and for the complete absence of the hallux. The *Phascolomys*, or wombat, one of the largest of the marsupials, is also found in South Australia, and the curious *Myrmecobius*, or ant-eater of Western Australia. This remarkable animal is about the size of a squirrel; it possesses fifty-two teeth (a greater number than any known quadruped), and unlike most other members of its order, the female has no pouch, the young hanging from nipples concealed amongst the hair of her abdomen. The *Chæropus*, with peculiarly slender limbs and a pouch opening backwards, is found in the interior. The remaining *Mammalia* consist of the dingo, or native dog, and a few species of *Muridæ*, the mouse family, and *Cheiroptera*, or bats. There are about 700 species of birds, including 60 species of parrots. Of the 9 families peculiar to the Australian region, 5 are well represented, including the *Meliphagidæ* (honey-suckers), *Cacatuidæ* (cockatoos), *Platycercidæ* (broad-tailed and grass parroquets), *Megapodidæ* (mound-makers[1]) and *Casuaridæ* (cassowaries). The last-named family is represented by the *Dromæus*, or emu, which is hunted in some parts of the colony. Reptiles are fairly represented: there are fifteen species of poisonous snakes. The lizards are very peculiar; South and Western Australia contain twelve peculiar genera. No tailed *Amphibia* exist in the continent, but frogs and toads are plentiful.

Flora.—The plant species resemble those of the eastern colonies and Western Australia, but are more limited in variety. The colony, from its dryness, lacks a number known elsewhere. Enormous areas are almost destitute of forests or of timber trees. The *Eucalyptus* family, so valuable for timber and gum as well as for sanitary reasons, are fairly represented. Acacias are abundant, the bark of some being an article of commerce. Flinders range has much of the valuable sugar-gum, *Eucalyptus Corynocalyx*, which is being now preserved in forest reserves. Its timber is very hard and strong, not warping, resisting damp and ants. The bead-flowered stringybark, *Euc. capitellata*, has a persistent bark. A sort of stringybark, *Euc. tetrodonta*, is found in Northern Territory. The gouty-stem tree (*Adansonia*) or monkey-bread of the north is a sort of baobab. About 500 northern plants are Indian. The *Tamarindus indica* occurs in Arnhem land, with native rice, rattans, and wild nutmeg. The cedar is of the Indian variety. Pines are numerous in the south, palms in the north; among the most beautiful is the *Kentia acuminata*. Banksias are very common in sandy districts. Flowering shrubs are common in the south. There are 130 known grasses in Northern Territory.

Fisheries.—Whaling was formerly an important industry about Encounter Bay, as sealing was in Kangaroo Island. The whales have migrated, and the seals are exterminated. On the northern side trepang or bêche-de-mer fishery has commenced, and pearl fisheries have been established. Of fish within colonial waters there are forty-two peculiar genera. The tropical north has similar fish to those of North Queensland, while those of southern bays resemble many of the species of Victoria, Tasmania, and New South Wales. There are the barracouta, bonito, bream, carp, catfish, rock cod and Murray cod, conger, crayfish, cuttle, dogfish, eel, flatfish, flathead, flounder, flying-fish, gadfish, grayling, gurnard, hake, John Dory, ray, salmon (so-called), schnapper, seahorse, shark, sole, squid, swordfish, whiting, etc. Though called by English names, the fish do not always correspond to those in Europe. The Murray cod is a noble freshwater fish.

Commerce.—There is little speculative trade, the shipping being employed in the conveyance of the exports of the colony and the introduction of needful supplies. The imports during 1884 amounted to £5,749,353 [$27,941,855.58], of which £2,983,296 [$14,498,818.56] came from the United Kingdom, £997,785 [$4,849,235.10] from New South Wales, £714,272 [$3,471,361.92] from Victoria, £38,460 [$186,915.50] from Tasmania, £34,675 [$168,520.50] from New Zealand, £97,230 [$472,537.80] from India, £28,011 [$136,133.46] from Natal, £55,598 [$270,206.28] from Hongkong, £19,201 [$93,316.86] from Canada, £239,093 [$1,161,991.98] from Mauritius, £54,945 [$267,032.70] from China, £49,028 [$238,276.08] from France, £61,727 [$299,993.22] from Germany, £72,214 [$350,960.04] from Norway and Sweden, £186,236 [$905,106.96] from the United States. Of the exports, £6,623,704 [$32,191,201.44], there went to the United Kingdom £4,081,864 [$19,837,859.04]; New South Wales, £773,240 [$3,757,946.40]; Victoria, £651,019 [$3,163,952.34]; Queensland, £255,746 [$1,242,925.56]; Cape Colony, £249,844 [$1,214,241.84]; India, £144,287 [$701,234.82]; Western Australia, £132,554 [$644,212.44]; Natal, £78,118 [$379,653.48]; France, £57,500 [$279,450]; Mauritius, £52,010 [$252,768.60]; Belgium, £33,092 [$160,827.12]. Among the exports during 1884 were wool, £2,616,626 [$12,716,802.36]; wheat, £1,694,005 [$8,232,864.30]; flour, £794,812 [$3,862,786.32]; copper, £469,231 [$2,280,462.66]; sheepskins, £87,455 [$425,031.30]; silver-lead, £66,592 [$323,637.12]; bark, £45,049 [$218,938.14]; jams, £35,338 [$171,742.68]; horses, £30,845 [$149,906.70]; tallow, £28,403 [$138,038.58]; wine, £17,061 [$82,916.46]; gold, £15,469 [$75,179.34]. There were imported overland 411,307 sheep and exported 168,770. Of shipping, there entered 1120 vessels of 909,335 tons, and cleared 1111 of 925,197. The British amounts were 768,301 and 783,121 tons respectively. In the Northern Territory the imports were £140,229 [$681,512.94], exports £90,411 [$439,397.46]; the gold export for the last six months of 1885 was £33,869 [$164,603.34]. The assets of the eleven banks at the close of 1885 were £13,380,716 [$65,030,279.76],—total deposits £5,880,950 [$28,581,417]. The Government savings banks, on June 30, 1885, had 53,164 depositors, with £1,571,283 [$7,636,435.38] as balances—five per cent. interest being allowed.

Manufactures.—Increased attention has been lately directed to local industries, and a more protective tariff has been enforced with a view to their development. The official returns for March 31, 1886, gave 640 works, employing 7952 men and 1350 women.

Communication.—The district councils have charge of many of the roads. The general dryness of the country is favorable to the condition of roads. Railways have been constructed for the conveyance of farming produce to market, the carriage of minerals to port, and the tapping of the Murray river traffic from the east. At the beginning of 1886 there were 1211 miles of railway open, and 570 in course of construction. The working expenses during 1885 came to £386,000 [$1,875,960], and the revenue to £556,000 [$2,702,160]. There are several tramways, supplementing railway traffic.

Water-Supply.—The Government is aiding the railway movement for opening out the interior by the construction of waterworks and public reservoirs. To supply Adelaide, independently of the Torrens river, there has been an expenditure of £866,942 [$4,213,338.12]. Kapunda has a reservoir of 41,200,000 gallons; Port Pirie of 25,700,000; Mount Barker of 6,000,000; Port Augusta of 666,000; Mount Gambier and Gawler each of 279,000. There are large storage tanks at many places, *e.g.*, for 810,000 gallons at Moonta.

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[1] One genus of this remarkable family—the *Lipoa*—is confined to the district.

Administration.—The governor is the representative of the crown. The legislative council, of twenty-four members, one-third retiring every three years, is chosen by 32,000 electors. The house of assembly, of fifty-two members, is appointed for three years by 60,000 electors. Responsible government dates from 1856. The public debt, contracted for useful public works, was £18,000,000 [$87,480,000] in 1886. For the year 1884–85 the revenue was £2,157,931 [$10,487,544.66], but expenditure was £2,430,513 [$11,812,293.18]. A revision of the tariff was necessary. Customs yielded £511,230 [$2,484,577.80]; railways, £662,455 [$3,219,531.30], against working expenses £411,850 [$2,001,591]; land sales, £333,369 [$1,620,173.34]; land rents, £132,013 [$641,583.18]; waterworks, £72,366 [$351,698.76]. The expenditure included £311,189 [$1,512,378.54] for public works, besides loans; police £102,784 [$499,530.24]; civil establishments, £73,828 [$358,804.08]; legal, £50,051 [$243,247.86]; charitable institutions, £86,968 [$422,664.48] (there being no poor law); military defences, £39,473 [$191,838.78]; immigration, £31,129 [$151,286.94], etc. The Northern Territory gave £71,518 [$347,577.48] as receipts to the state, but with £85,000 [$413,100] charges. The revenue for 1885–86 was £2,279,039 [$11,076,129.54], and the expenditure £2,383,290 [$11,582,789.40]. No Australasian colony has done so much for the good of the aborigines and the advance of good morals as South Australia. The administration is just and firm, being well sustained by public sentiment.

Education.—Not being so wealthy as its eastern neighbors, the colony has not been able to devote so large an amount to schools; still, a grant of £126,000 [$612,360] was made during 1884–85 towards the instruction of 50,000 pupils. Of 450 schools, half are called public, half provisional for thinly-peopled districts. Payment from scholars is not dispensed with as in Victoria. Lands are being set apart as educational grants for the future. All religious denominations are equal in the sight of the law, none receiving any state aid. Bible reading is sanctioned before school hours, and any religious lessons may be given at the close of school time. The Adelaide university, so richly endowed by the colonists, receives an annual grant of £2550 [$12,393] from the local parliament.

Population.—Including the Northern Territory, the population was returned in 1881 as 279,865 (149,530 males, 130,335 females), in addition to 6346 aborigines (3478 males, 2868 females). The births during 1885 were 12,046, and the deaths 3987 (2205 males and 1782 females). Classed at the last census according to religion, the population may be thus stated: Church of England, 76,000; Roman Catholic, 42,920; Wesleyans, 42,103; Lutherans, 19,617; Presbyterians, 17,917; Baptists, 14,000; Bible Christians, 10,500; Primitive Methodists, 10,350; Congregationalists, 9906. The population in the Northern Territory, 3500, contains only about a hundred females, but has 3000 Chinamen. More than half the people of South Australia, whether of English or German parentage, are native-born. In 1886 the population was 325,000.

History.—Though the coast of Northern Territory was well known to Portuguese and Spanish navigators as early as perhaps 1530, being called Great Java, it was not surveyed till 1644, when Tasman laid down the line of shore pretty accurately. The western part of the southern coast had been seen and named Nuyt's Land in 1627. But Flinders, by his discovery of the two great gulfs, Kangaroo Island, and Encounter Bay, in 1802, was the first to reveal South Australia proper. Captain Sturt descended the Murray in 1830, and looked over the hills near Adelaide. The first to direct attention to a settlement there was Major Baron, who communicated with the colonial office in February, 1831. His suggestion was to establish, at no charge to the British Government, a private company, that should settle a party on Yorke Peninsula. He believed a large river entered Spencer Gulf. In August Colonel Torrens and others proposed to purchase land between 132° and 141°—500,000 acres at 5s. [$1.21] an acre. Some were in favor of Spencer Gulf, others of Kangaroo Island, and a few for the mainland towards the Murray. Memorialists in 1832 sought a charter for the South Australian Association, giving extensive powers of self-government. Land sales were to pay the passages of free labor, chiefly young married people, and no convicts were ever to be sent thither. Lord Goderich did not favor the scheme, and thought a colony with free institutions might prejudice the interests of New South Wales, while free trade would interfere with the English navigation laws. After much negotiation, the English authorities regarded the scheme more favorably, but would not consent to give the company the powers they sought. The company receded in their demands, and offered security for the proper observance of law and order, while depositing cash for the purchase of land. Captain Sturt in 1834 informed the colonial secretary that Spencer Gulf and Kangaroo Island were objectionable, but that the eastern side of St. Vincent Gulf was the best locality. In 1835 the ministry got an Act passed for the erection of a colony, under commissioners appointed by the crown, who would be responsible for their acts to the British Government. It was arranged that a local government should be established when the settlement had 50,000 people. Mr. George Fife Angas advanced a large sum as security to the state. Though the first settlers were sent to Kangaroo Island, all were afterwards gathered on the Adelaide plains. The colony was proclaimed under a gum tree, December 28, 1836. Great delay took place in the survey of land. The South Australian Company purchased large tracts from the commissioners at 12s. [$2.91] per acre and sold at 20s. [$4.86]. A general speculative spirit arrested progress. Governor Gawler went into extravagant outlay on public buildings, etc., and drew against orders upon the English treasury. Such difficulties arose that the British rulers had to suspend the charter in 1841 and make South Australia a crown colony. A revival of prosperity took place when the farms were tilled and poverty had taught prudence. Copper and lead mines were subsequently discovered. Kapunda in 1843, and the Burra Burra copper mine in 1845, greatly aided in the restoration of commercial credit. The gold fever in Victoria drew off numbers in 1852; but the good prices then realized for breadstuffs gave a great impetus to farming. It deserves to be mentioned that rarely if ever has a colony been so favored as South Australia in the character of its early settlers. (J. BO.)

SOUTH BEND, a city of the United States, the county seat of St. Joseph county, Indiana, received its name from its position at a great bend of the St. Joseph river, which is navigable to this point from its mouth at St. Joseph on Lake Michigan. By railway the city is 85 miles east of Chicago. It is a great manufacturing centre, with ironworks, carriage, wagon, plough, and sewing machine factories, flour-mills, paper-mills, etc. The court-house is one of the best buildings in the State; and the Roman Catholic university of Notre Dame, St. Mary's academy, and St Joseph's academy are institutions of some importance. The population of the city numbered 1652 in 1850, 7206 in 1870, and 13,280 in 1880.

Plate V.

SOUTH CAROLINA, one of the original thirteen States of the American Union, commonly known as the Palmetto State, from the abundance of this kind of palm on the coast, once formed a part of that vast territory of the New World claimed by the Spaniards under the name of Florida and by the French under that of New France; or, to be more concise, it comprised the southern or lower portion of what was formerly styled Carolina, and subsequently divided into North and South Carolina. It lies between 32° 4′ 30″ and 35° 12′ N. lat. and between 78° 25′ and 83° 49′ W. long. In shape it is an irregular triangle, the vertex resting upon the Blue Ridge Mountains in the extreme northwest, while the Atlantic forms its base. It is bounded N. and N.E. by North Carolina, S.E. by the Atlantic, and S.W. by the Savannah river, which, with its tributaries the Tugaloo and Chatauga, separates it from Georgia. The State is 189 miles long and 160 broad, containing 30,961 square miles or 19,815,040 acres, and is divided into thirty-four counties (formerly districts). At the census of 1880 the population numbered 995,577, of whom 391,105 were white, the rest colored.

Surface.

Very few Indians are to be found. The surface may be about equally divided into high, middling, and low land, the last-named rising from the seacoast, where it is very flat and level, and gradually increasing in elevation towards the interior, where it attains a mean of 250 feet, continuing to the north line, where, after varying from 300 to 800 feet it reaches its highest elevation of 1000 feet. The land along and near the coast is low, marshy, and swampy, especially on the rivers' banks, rolling and diversified towards the centre and undulating near the mountain slope, but in places abrupt, King's Mountain rising

almost perpendicularly 500 feet. The chief elevations in this section are the Saluda Mountains, spurs of the Blue Ridge, King's Mountain (1692 feet), Paris Mountain (2054 feet), Table Rock (3000 feet), Cæsar's Head (3118 feet), and Mount Pinnacle (3436 feet). This region abounds in beautiful and picturesque scenery, rendering it attractive to tourists, and making it a great summer resort.

Rivers. The land is irrigated and well-drained by numerous rivers, the largest of which is the Santee, formed by the Saluda, Congaree, Catawba, and Wateree, uniting at the centre of the State. The other rivers of any size are the Waccamaw, Lynch's, Great and Little Peedee, forming the Peedee, Black, Wando, Ashley, Cooper, Edisto, Combahee, Ashepoo, Coosaw, Port Royal, and Broad (on the coast), this last being more of a bay. The sea-coast is fringed by numerous islands, and indented by bays and inlets,—Winyaw and Bull's Bays, Charleston Harbor, Stono Inlet, North and South Edisto Inlets, St. Helena Sound and Port Royal,—the last one of the finest harbors in the world, as its name, said to have been given on this account by the early discoverers and explorers, would imply. The entire coast south of Winyaw is composed of a network of creeks and sounds, so that, for small craft, navigation inland may be had from this point to the mouth of the Savannah on the extreme southwest. Most of the rivers rising in the mountains are navigable nearly to the foot-slope. Here numerous rapids and waterfalls afford excellent mill-power. Canals throughout the State are not numerous, the few formerly in use having been abandoned in favor of the railroads. The Santee Canal, connecting that river with the headwaters of the Cooper, 22 miles in length, has given place to the Northeastern Railway.

Climate. The climate of South Carolina is mild and genial, snow falling in the mountains but rarely in the middle sections, and seldom or never along the coast. The sea islands generally, as well as the pine barrens, are healthy, furnishing the planter with a summer home and safe retreat from the malaria of the rice lands. These regions were formerly innocuous to the whites, as they still are to the negroes, but subsequent clearance and cultivation have rendered them fatal in summer. The midlands are considered healthy in all parts except here and there along the creeks, while the mountain region is unexceptionable.

Earthquakes. The coast of South Carolina, like places in the same latitude, is subject to violent storms, tornadoes, and cyclones, which make their annual visits on or about the autumnal equinox, doing much damage. Till quite recently the district has never been seriously troubled with earthquakes. Slight tremors have indeed been felt and recorded since 1754, without, however, causing serious injury. But on the night of the 31st August, 1886, Charleston was visited by an earthquake which was followed by other shocks and tremors, which continued night and day at intervals with greater or less violence, as the following list shows:

Aug. 27...1 shock, slight.
Aug. 28...1 shock, slight.
Aug. 31...5 shocks, destructive.
Sept. 1...3 shocks, severe.
Sept. 2...3 shocks, severe.
Sept. 3...2 shocks, severe.
Sept. 4...2 shocks, slight.
Sept. 5...1 shock, moderate.
Sept. 7...2 shocks, slight.
Sept. 8...1 shock, slight.
Sept. 10...1 shock, slight.
Sept. 12...1 shock, slight.
Sept. 15...2 shocks, moderate.
Sept. 21...1 shock, severe.
Sept. 22...1 shock, moderate, local.
Sept. 27...1 shock, severe.
Sept. 28...1 shock, moderate.
Sept. 30...1 shock, slight.

The main shock was very destructive to property, while about forty lives were lost, and many more were injured. Crevices several yards in length and varying from one to four inches in width appeared, and in some places in the suburbs of the city fissures of much larger proportions threw up water to the height of several feet. There was no warning given except that in the small town of Summerville, about 22 miles to the north, considerable disturbance was caused by thuds and tremors with detonations on the 27th and 28th, felt on the latter date to some extent in Charleston. The violence of these shocks was confined almost exclusively to this State, though they were felt in a slighter degree in Georgia and North Carolina.

Vegetation. The soil in the low country is remarkably fertile, the river swamps and reclaimed marshes being admirably adapted to the cultivation of rice, while the sandy loam of the sea islands and surrounding main produces the finest long staple, black seed, or sea island cotton of silky fibre. As we recede from the salt the staple becomes shorter and the plant has a less luxuriant growth. The rice produced here, noted abroad as Carolina rice, is considered first in the markets of the world. The State was the first to introduce rice culture in America, the seed having been brought in 1693 by a vessel from Madagascar. Abundant crops are raised of wheat, rye, maize, oats, barley, buckwheat, peas, beans, sugar, tobacco, indigo, sorghum, broom-corn, sunflower, guinea-corn, sweet and Irish potatoes, hemp, flax, and hops. Numerous orchards, all over the State, furnish quantities of apples, pears, quinces, plums, peaches, nectarines, apricots, cherries, and along the coast figs, oranges, lemons, olives, and pomegranates. The raspberry, blackberry, mulberry, and whortleberry are produced. The strawberry is extensively cultivated along the coast, and shipped in immense quantities to the northern markets. Of nuts, the walnut, pecan, chestnut, hickory, shell-bark, hazel nut, and chinquapin may be mentioned. The grape grows wild in many portions of the State, and in great varieties, which, when cultivated, yield a delicious wine. In certain sections hundreds of acres are devoted to the culture. The gardens and farms produce in abundance turnips, beets, parsnips, carrots, artichokes, mustard, benne, rhubarb, arrowroot, water and musk melons, cucumbers, cabbages, kale, lettuce, cayenne pepper, squashes, okra, pumpkins, onions, leeks, beans, radishes, celery, green peas, and tomatoes,—the last two from early spring to mid-winter. The jasmine, Cherokee rose or nondescript, wild honeysuckle, and sweet-brier perfume the woods; the dog-wood and fringe tree abound in the forest; and garden flowers in the cities, especially Charleston, Columbia, and Beaufort, are the admiration of strangers. Conspicuous among these are the *Camellia japonica* of all varieties and shades, azalea in every hue, roses of numberless descriptions, hyacinth, snowdrop, violet, dahlia, tulip, verbena, sweet olive, and heliotrope. Valuable and almost inexhaustible forests extend over the greater part of the State, the long leaf or yellow pine, confined chiefly to the low country, covering 10,000,000 acres, and furnishing immense quantities of timber, tar, pitch, turpentine, and rosin. Here and elsewhere are found the magnolia, sweet and black gum, white, water, red, and live oak, black walnut, elm, hickory, maple, sycamore, ash, cypress, chestnut, beech, locust, persimmon, dogwood, poplar. The palmetto is peculiar to the coast.

Animals. The forests abound in deer, wild turkeys, foxes, wildcats, raccoons, opossums, rabbits, and squirrels; and along the water-courses are found the musk otter, etc. Among the birds are pigeons, doves, partridges, woodcock, snipe, immense flocks of wild ducks, including the English or canvas-back, teal, blackhead, etc. Freshwater fish of every variety are taken in all the streams in the interior, and the bays and inlets furnish whiting, mackerel, bass, flounder, sheephead, shad, mullet, blackfish, sturgeon, terrapin, turtle, shrimps, crabs, and oysters. Quantities of salmon and carp have been furnished by the fish commissioners for stocking the waters.

Minerals. Minerals are liberally diffused over the State. Gold is found in Lancaster, York, Union, Spartanburg, Greenville, Pickens, and Abbeville counties; copper in York, Spartanburg, and Pickens; lead in the last; iron of a superior quality in Union, Spartanburg, Greenville, and Pickens; manganese in Lancaster, York, Chester, Union, Spartanburg, Greenville, Pickens, Anderson, Abbeville, and Edgefield; bismuth in Chesterfield and Lancaster; plumbago in Spartanburg; soapstone in Fairfield, Chester, York, Spartanburg, Laurens, Greenville, Pickens, Abbeville, and Edgefield; coal in Chesterfield and Marlboro. Limestone abounds in nearly all the upper counties, but chiefly in Laurens and Spartanburg. The finest blue and gray granite is found in the middle and upper sections; sandstone, burrstone, and flagstone in Edgefield, Pickens, York, and Fairfield. Pottery and porcelain clay, quartz, and sand for glass exist in many places. Tuomey states that "the aluminous formations that occur in immense beds of the finest porcelain clay are often exposed by the denuding effects of water and lie in rich strata upon the very surface, ready to the hand of the manufacturer. Between Aiken and Graniteville the beds are in many cases 60 feet thick, while those in the Savannah river near Hamburg are from 10 to 15 feet and of unsurpassed purity." The Aiken council committee report in this vicinity immense beds of different kinds of clay, from the purest and whitest kaolin to the dark-colored mud of which bricks are made, sands of all hues, some as fine as flour, others with large coarse crystals, siliceous earths of many kinds, ferruginous sandstones, conglomerate shell, burrstone, mica, feldspar, and ochres of different colors. But a short distance off a deposit of magnesia is found, and potash can readily be made in the surrounding forests. Experts have pronounced the sands to be admirably adapted for making glass and crystal, and the quality of the kaolin is admitted to be equal, if not superior, to that of which Staffordshire ware is made. It is doubtful if the combination of the ingredients of glass and earthenware can be found in such immediate proximity anywhere else. Mineral springs exist in several of the upper counties.

Railways.

Railroads are on the increase. The South Carolina Railway, between Charleston and Augusta, Ga., was, at the time of its completion, the longest continuous railroad in the world.

Industries.

Manufactures are growing in importance; chief among them are cotton yarn and cloth, flour, lumber, turpentine, and fertilizers. The capacity of twenty-nine mills now in operation is estimated at 14,821,166 ℔ of yarn, 79,442,327 yards of cloth, and the value of product $9,097,464. In 1880 there were 82,324 spindles and 1676 looms; in 1884 195,112 spindles and 3652 looms. The number of lumber mills at work is 729, employing 5894 hands and a capital of $2,920,870. The value of their annual production is $5,592,565. Of turpentine stills there are 291, with 6991 hands and a capital of $1,454,800, with an annual production to the value of $2,912,271. These figures show an increase of 100 per cent. in less than four years. The fertilizers are valued at $3,346,400, and the miscellaneous manufactures at $2,114,680. The whole value of manufactured products was in 1860 $8,615,195; in 1870, $9,858,981; in 1880, $16,738,008; in 1884, $32,324,404. South Carolina phosphates are of recent date, but their importance may be shown by stating that they pay yearly, by direct taxation, an amount for royalty which is 20 per cent. of the whole income of the State. The value of this rock was first pointed out by Mr. Jonathan Lucas, a planter, who afterwards materially assisted in developing its usefulness. The first company, the Charleston South Carolina Mining and Manufacturing Company, was formed in 1867. There are now fourteen land and eleven river mining companies with capital ranging from $10,000 to $200,000. In addition to these there are a number of individuals who are licensed by the State to mine in the navigable streams, employing an estimated capital of about $50,000. The total amount of phosphate rock mined and shipped in 1868–70 was 20,000 tons; in 1871, 50,000 tons; in 1875, 115,000 tons; in 1880, 190,000 tons; and in 1883, 355,000 tons,—the total since 1868 being 2,290,000 tons. Of this amount 1,078,070 tons were river and 1,211,830 land rock. The capital invested in the former is $525,000, and 649 hands are employed (wages $259,300), with an annual production of $907,170; in the latter the corresponding figures are—capital $1,980,000, hands 1286, wages $363,560, production $1,283,830.

The six gold-mining counties report eleven mines in operation, employing 600 hands, with a capital of $440,000 and an annual production of $90,000. The same counties report eighteen gold mines or gold-bearing areas not now worked; one of the mines has a capital of $40,000. Ten counties report quarries or kaolin beds. Worked and unworked, there are twenty-five granite quarries, five kaolin beds, and one soapstone quarry. There are also in the State large unworked deposits of mica, pyrites, corundum, and marl, with some silver. The quarries and kaolin works, with a capital of $96,350, have an annual production of $220,000.

The upland cotton crop of 1883 was 468,227 bales of 400 ℔. The corn area was 1,359,593 acres, and the production 10,876,744 bushels. 321,958 acres in oats yielded a crop of 4,187,062 bushels. Of wheat (182,215 acres) the yield was 1,388,731 bushels. The rice crop of 1883–84 was 33,600 tierces. The sea-island cotton crop was 9500 bags. This last, as well as the small grain and subsidiary crops, has suffered a decline in the last few years of 25 to 35 per cent.

The proportions of white and colored labor in the State are about 30 per cent. and 70 per cent. respectively. The rate of wages paid is from $8 to $9 a month for men and $6 for women, with board. About 23 per cent. of white women and children work on the farms, and about 61 per cent. of the colored. The systems used are — the contract, in which services rendered are paid by giving the laborer the use of the land and house, or where the wages are paid monthly, or a portion monthly and the remainder at the end of the year; and the tenant system, in which the laborer rents the land, and from the crop pays the landlord the rent and for the use of the animals. Land varies in price from 50 cents for pine barren to $100 for choice farming land.

Live stock.

Horses and mules are raised at very little cost. Ordinary scrub cattle are seldom housed, roaming the forest at will except when herded for branding or for driving to market. Sheep thrive away from the salt, and are profitable in the mountains. Hogs, not improved breeds, like cattle, have the liberty of the woods, and are taken with dogs when needed. According to estimates of improved stock, there are 792 Jerseys, 177 Ayrshires, 50 Devons, 33 Holsteins, 1 Guernsey, besides a number of Shorthorns and Brahmins. Merino, South Down, Oxford Down, and Broad-Tail sheep are raised in many parts of the State, with Essex and Berkshire hogs.

Education.

Free schools trace their origin as far back as 1710. A system of free schools was inaugurated in 1811. The present public-school system was established in 1868. It provides free instruction to pupils of both races, in primary and intermediate grades. Their management is under the direction of the State board of examiners, consisting of the State superintendent of education, and four other persons appointed by the governor. In each county the school commissioner is elected by the people for two years. The schools are supported entirely by taxation. There are 3562 public schools in the State. The number of persons in the State between the ages of six and sixteen is 281,664, of whom 51,440 are white males, 49,749 white females, 90,897 colored males, 89,578 colored females. The number of pupils enrolled is 178,023 (41,819 white males, 36,639 females, 48,418 colored males, 51,147 females). The number of male white teachers employed is 1137, females, 1205; colored males 982, females 449,—making a total of 3773. There are 3562 public schoolhouses, valued at $405,097.31. Institutions for higher education, supported by the State, are the South Carolina College and South Carolina Military Academy for white males, and the Claflin College for colored persons of both sexes. There is an institution for the education of the deaf, dumb, and blind. There are, besides, numerous private schools and colleges.

Religion.

Churches of all denominations multiplied in the State during the colonial period, and subsequently Episcopalians, Presbyterians, Independents, Baptists, and French Protestants established congregations in Charleston just after 1680. Methodists and Romanists came a century later, Jews in 1756, German Lutherans in 1759. The colored people are for the most part Methodists, some being Baptists and Presbyterians, a few Episcopalians.

Cities.

CHARLESTON (*q.v.*) is the largest city of the State. COLUMBIA (*q.v.*), the capital, has (1886) a population of 20,000, while that of Charleston is 60,000. Greenville, in the northwest portion of the State, is a growing railway centre and manufacturing city, with a population of 10,000. Georgetown and Beaufort on the coast do a good shipping business in lumber and other exports. Spartanburg and Aiken are important places, the former as a railway centre, the latter as a health resort for invalid strangers in winter, when the population is more than doubled. Other towns are Newberry, Orangeburg, Florence, Camden, Sumter, Graniteville, Chester, Anderson, Abbeville, Winnsboro, Yorkville, Union, Cheraw, Walhalla, Piedmont, Port Royal, Marion, Darlington, Lancaster.

Government.

The executive department consists of a governor, lieutenant-governor, who is *ex-officio* president of the senate, comptroller-general, treasurer, secretary of state, attorney-general, and a superintendent of education; these are elected by the people to serve two years. The legislative department embraces a senate and a house of representatives, which together are called the general assembly. The former is composed of thirty-seven members, elected for four years, one from each county, except Charleston, which sends two. The house of representatives consists of 124 members, elected for two years. The judicial department consists of a supreme court and of circuit, probate, and justices' courts. The supreme and circuit court judges are elected by the general assembly, —the former for six years, the latter for four. The probate judges for each county are elected by the people, and the justices of the peace are appointed by the governor.

History.

The first attempt to settle Carolina was in 1562, when Admiral Coligny obtained from Charles IX. of France permission to plant a colony of Protestants on the coast of Florida. An expedition was fitted out at the expense of the crown, and placed under the command of Jean Ribault. Fear of the Spaniards perhaps induced them to change their plans, and entering Port Royal, they landed on Lemon Island, where they erected a pillar, and afterwards a fort, which they named in honor of the king, Arx Carolina. Leaving a sufficient number to garrison the fort, Ribault returned to France. Two years later a second expedition under Laudonnière, one of Ribault's men, was fitted out, but on landing at Port Royal it found no traces of the former. This colony likewise met with disaster, being massacred by the Spaniards from Florida. It was not until a century later that a permanent settlement was made by the English, who, after the Restoration, began to recognize their claim to a large territory in the southern district of North America. In 1662 a grant was obtained from Charles II., and in 1667 an expedition sailed under command of Captain William Sayle. They reached Port Royal, where they made a settlement, but a few years after removed to the west bank of the Ashley, and built a town which they called, after the English monarch, Charlestown. Subsequently they again removed to Oyster Point, the present site of Charleston. (W. SI.)

SOUTHCOTT, JOANNA (1750–1814), was born in Devonshire about 1750, and was for a considerable time a domestic servant. She was originally an adherent of the Methodists, but, becoming persuaded she possessed supernatural gifts, she wrote and dictated prophecies in rhyme, and announced herself as the woman spoken of in the Apocalypse (ch. xii.), affirming, when beyond the age of sixty, that she would be delivered of Shiloh on the 19th October, 1814. For some days previous to this she was attended by her followers night and day, but Shiloh failed to appear, and it was given out that she was in a trance. She died of dropsy on the 29th of the same month. Her followers are said to have numbered over 100,000, and so late as 1860 they were not extinct.[1]

Among her publications, which number over sixty, and are all equally incoherent in thought and grammar, may be mentioned *Strange Effects of Faith*, 1801–2; *Free Exposition of the Bible*, 1804; *The Book of Wonders*, 1813–14; and *Prophecies announcing the Birth of the Prince of Peace*, 1814. A lady named Essam left large sums of money for printing and publishing the *Sacred Writings of Joanna Southcott*. The will was disputed by a niece on the ground that the writings were blasphemous, but the Court of Chancery sustained it.

See Roberts, *Observations on the Divine Mission of Joanna Southcott*, 1807; Reece, *Correct Statement of the Circumstances attending the Death of Joanna Southcott*, 1815.

SOUTHEND, a watering-place of Essex, is situated on the north bank of the Thames, 5 miles west of Shoeburyness, and by the London, Tilbury, and Southend Railway, 42 miles east of London, with which it is also connected by steamer. It first sprang into notice from a visit of Queen Caroline in 1804, and, as it is the nearest watering-place to London, it is much frequented by excursionists, especially by the poorer classes. It is clean and well built, and at Cliff Town there are a number of large villas. Opposite Cliff Town there is a public garden called the Shrubbery. The bathing is good, but the tide recedes with great rapidity and for nearly a mile. The pier, which is 1¼ miles in length, and on which there is a tramway, permits the approach of steamers at all tides. The public hall was erected in 1872 at a cost of £3000 [$14,580], and a mechanics' institution dates from 1881. The Rochford county court is held every alternate month in the public hall. A local board of health was established in 1866. The population of the urban sanitary district (area 3441 acres) in 1871 was 4561, and in 1881 it was 7979.

SOUTHERNE, THOMAS (1660–1746)—"Honest Tom Southerne," to give the author of *The Fatal Marriage* the name by which his contemporaries usually called him—was a clever craftsman for the stage, according to the degenerate tradition of the Restoration dramatists,—with the eye of a born opportunist for the popular interests of the hour in so far as they could be turned to histrionic account, but without deeper seeing of the functions of the drama. Born in Dublin in 1660, he came to London and entered the Middle Temple in 1678, but only to desert law very speedily for dramatic authorship. His first play, *The Persian Prince, or the Loyal Brother*, is a good example, in its diplomatic reference to passing events and its veiled compliment to James, duke of York, of his ready tact as a playwright. The most important practical result of the play, which was remarkably successful on the stage, was an ensign's commission, noteworthy in that it supplied Southerne with materials for later dramatization. After an interval of active service more plays followed, and were produced with equal success; of these *The Fatal Marriage* (1694), known also by the name of its heroine, Isabella, has the best claim to remembrance. Its strain of pathetic quality echoes the later Elizabethans in a way that contrasts suggestively with the shallow, if spirited, indecencies of Southerne's comedies, which, although their author was commended by Dryden for his purity as a playwright, are certainly not overweighted with delicacy. *Sir Anthony Love, or the Rambling Lady*, in which the hero assumes female disguise without accession of modesty, is a good example of the rest; one utterance of its hero, "Every day a new mistress and a new quarrel," might indeed serve as a good motto of Restoration comedy in general. Except to the student, Southerne's work, however, is hardly of permanent interest. The Southerne of whom Pope, who ranked him as friend and praised him for his sterling qualities, remarked in some lines that

> "Heaven sent down to raise
> The price of prologues and of plays."

exemplifies what business tact and dramatic ingenuity can accomplish, for of real artistic faculty he had little. His plays resulted, through ingenious management, in a pecuniary return which dazzled Dryden and made their author a wealthy citizen, but they have not the quality of work which endures. He died in 1746.

SOUTHEY, CAROLINE (1786–1854), the second wife of Robert Southey, was born at Lymington, Hants, on December 6th, 1786. As a girl Caroline Ann Bowles showed a certain literary and artistic aptitude, the more remarkable perhaps from the loneliness of her early life and the morbidly delicate condition of her health,—an aptitude, however, of no real distinction. When money difficulties came upon her in middle age she determined to turn her talents to account in literature. Her first venture was the sending anonymously of a narrative poem called *Ellen Fitzarthur* to Southey, and this led to the acquaintanceship and lifelong friendship which in 1839 culminated in their marriage. *Ellen Fitzarthur* (1820) may be taken as typical, in its prosy simplicity, of the rest of its author's work, which reproduced the studied unadornment of certain portions of Southey's and Wordsworth's poetry without that glamour which, especially with the second of these writers, so often redeemed simplicity from mere baldness. Mrs. Southey's poems were published in a collected edition in 1867. Her prose is on the whole more interesting than her verse, though—with rare exceptions—infected with like dulness. Among her prose writings may be mentioned *Chapters on Churchyards* (1829), her best work; *Tales of the Moors* (1828); and *Selwyn in Search of a Daughter* (1835). Her most interesting memorial is her correspondence with Southey, which, somewhat unfairly overlooked in the edition of the poet's *Life and Letters* edited by his son, has been published by Prof. Dowden in the Dublin University Press Series. It was soon after her marriage that her husband's mental state became hopeless, and from this time till his death in 1843, and indeed till her own, her life was one of much suffering. Mrs. Southey died at Buckland Cottage, Lymington, on July 20th, 1854, two years after the queen had granted her an annual pension of £200 [$972].

Besides the works already mentioned, she wrote *The Widow's Tale, and Other Poems*, 1822; *Solitary Hours* (prose and verse), 1826; *Tales of the Factories*, 1833; *The Birthday*, 1836; *Robin Hood*, written in conjunction with Southey, at whose death this metrical production was incomplete.

SOUTH DAKOTA. See Vol. VI. p. 681.

SOUTHEY, ROBERT (1774–1843), was born in Bristol, on the 12th of August, 1774. His father, a native of Somerset, was an unsuccessful draper. To his mother, Margaret Hill, Southey owed his buoyant spirits, his practical sense, and his earliest friends. The first of these, Miss Tyler, his mother's half-sister, took possession of him when he was three; under her care he saw and heard a great deal of theatres and of acting. His solitary life in an old maid's household threw him upon his own resources, and developed a taste for reading. He was sent to several private schools, and had good fortune at none of them; in 1788 he went to Westminster, where he was scarcely more fortunate. After a brief sojourn, he was expelled in 1792, because an essay of his on flogging, in a school magazine called *The Flagellant*, was resented by Dr. Vincent, the head master. At Westminster he gained the friendship of two boys who were faithful to him and helpful throughout his life; these were Charles Winn and Grosvenor Bedford. About this time his father died; his aunt, however, determined that he should go to Oxford. He was refused at Christ Church on account of the essay in *The Flagellant;* but Balliol gave him a home. At Oxford he led his own life, lived in his own thoughts, and got little or nothing from the university. In 1794, Coleridge dashed at Southey, took him by storm, and filled his head with plans for an ideal colony in the wilds. The new society, whose members were to have all things in common, was to be called "The Pantisocracy." Their life was to combine manual labor and domestic bliss; to attain the latter, Southey set his affections on a Miss Edith Fricker, whose sister married Coleridge. All this was intolerable to Miss Tyler, and Southey was banished. He and Coleridge then tried, by lecturing and journalism, to raise money for their American schemes; but luckily Southey's uncle, who had educated him,—Mr. Hill, the English chaplain at Lisbon,—advised him to travel. On the 14th of November, 1795, before he started, he was secretly married to Edith Fricker. On his return from Lisbon the marriage was acknowledged, and Southey wandered from one house to another in the South of England. He tried, or was urged to try, the three professions which are by courtesy styled "learned"; it might be more true to call them the technical, the stereotyped professions. Southey was scared from all three,—from clericalism by dogma, from medicine by the dissecting-room, from law by its crabbed dulness. In literature alone he found his proper sphere; and in 1803 he settled down in his lifelong home, Greta Hall, near Keswick. Henceforth his years were even and uneventful. He wrote and read with mechanical, with appalling regularity; his library grew to fourteen thousand volumes. He had children, and lost several; and his house was a refuge for the wife and family of Coleridge. With Wordsworth and Landor he formed close friendships. In 1813 he was made poet-laureate; and some years before his death he was offered a baronetcy—which, however, he with good reason declined. Two great sorrows embittered his life; in 1809 he lost his eldest boy, Herbert, and in 1834 his wife was taken to a madhouse, whence she came back to die. In 1839 he married Caroline Bowles. That same year his memory failed, his speech became uncertain, and his power of writing soon went; softening of the brain had taken irremediable hold of the once tireless intellect. To the last he would hover round his books, and handle them lovingly. He died on the 21st of March, 1843: he is buried, near his first wife and her children, in Crosthwaite churchyard.

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[1] [They were certified to the Registrar-General as meeting in England and Wales so late as 1885.—AM. ED.]

The amount of Southey's work in literature is enormous. His collected verse, with its explanatory notes, fills ten volumes; his prose occupies about forty. But his greatest works were left uncompleted, and this, in some sense, is typical of Southey's whole achievement in the world of letters; there is always something unsatisfying, disappointing, about him. He seldom realized or seldom found scope for his true bent in literature. This is most true of his efforts in verse. In his childhood Southey fell in with Tasso, Tasso led him to Ariosto, and Ariosto to Spenser. These beautiful, these luxuriantly imaginative poets, captivated the boy; and Southey mistook his youthful enthusiasm for an abiding, a lifelong inspiration. His inspiration was not genuinely imaginative; he had too large an infusion of prosaic commonplace in his nature to be a true follower of Ariosto and Spenser. Southey, quite early in life, resolved to write a series of epics on the chief religions of the world. The subject was dangerous, and one epic is a life's work; it is not surprising that the too ambitious poet failed. His failure is two-fold; he was wanting in artistic power and in poetic sympathy. With regard to the first, he says of himself, "It was long before I acquired this power," —the power of plan and construction,—"not fairly, indeed, till I was about five or six and thirty." The fact is, he never acquired it; he never could construct a dramatic plot or mould it into artistic details. When his epics are not wildly impossible, they are incurably dull; at the best their interest is extrinsic rather than intrinsic, pervaded by the glamour of historic romance rather than the light of pure poetry. And a man is not fit to write epics on the religions of the world when he can say of the prophet who has satisfied the gravest races of mankind,—Mohammed was "far more remarkable for audacious profligacy than for any intellectual endowments." Southey's age was bounded, and had little sympathy for anything beyond itself and its own narrow interests; it was violently Tory, narrowly Protestant, defiantly English. And in his verse Southey truthfully reflects the feeling of his age. This led him to say dreadful things about the Eastern religions in his prefaces to *Kehama* and *Thalaba;* it made *Joan of Arc* an incongruous blending of Rousseau, of Horace Walpole's romanticism, of the Surrey theatre, and of Lady Huntingdon; it gave Madoc, a Celt of the 12th century, the mind of a cold middle-class Saxon evangelical of the regency. In the shorter pieces, Southey's commonplace asserts itself, and if that does not meet us we find his bondage to his generation. This bondage is quiet abject in *The Vision of Judgment;* Southey's heavenly personages are British Philistines from Old Sarum, magnified but not transformed, engaged in endless placid adoration of an infinite George III. When Southey sets himself to fondle the regent, he loses all sense of measure and propriety. In the *Funeral Ode* to the Princess he can assert of her father—

> "Such the proud, the virtuous story,
> Such the great, the endless glory
> Of her father's splendid reign!"

This famous ode, "with the grace and beauty of which," Sir Henry Taylor thinks, "no facts could compete," is, it must be said, in many of its couplets, too like the average hymn. The twang of the hymn spoils two of Southey's best pieces. *The Holly Tree* ends—

> "That in my age as cheerful I might be
> As the green winter of the holly tree."

The last lines of *Stanzas Written in his Library*, a poem dear to the book lover, are painfully like a rhyme on a tombstone—

> "Yet leaving here a name, I trust,
> That will not perish in the dust."

Some of his subjects, *The Poet's Pilgrimage*, for instance, he would have treated delightfully in prose; others, like the *Botany Bay Eclogues*, *Songs to American Indians*, *The Pig*, *The Dancing Bear*, should never have been written. *The Retrospect*, of which this is a fair specimen,—

> "There where my little hands were wont to rear
> With pride the earliest salad of the year,"—

a living critic and biographer of Southey has compared to *The Deserted Village*. Southey was not in the highest sense of the word a poet; but if we turn from his verse to his prose we are in a different world; there Southey is a master in his art, who works at ease with grace and skill. "Southey's prose is perfect," said Byron; and, if we do not stretch the "perfect," or take it to mean the supreme perfection of the very greatest masters of style, Byron was right. For good prose, plain, unassuming, natural, he is not surpassed in English. In his charming story of *The Three Bears*, a phrase is often used which exactly describes his style; when the old lady finds what is neither too hot nor too cold, too large nor too small, she says it is "just right." Southey's prose is "just right,"—it expresses his meaning with simple and admirable precision. In his prose and in his criticism we of a later generation could do worse than learn from Southey; his sober writing is an excellent corrective for our prevailing faults. In prose the real Southey emerges from his conventionality. His interest and his curiosity are unbounded, as his *Common-Place Book* will prove: his stores of learning are at his reader's service, as in *The Doctor;* his patriotism is vigorous and healthy, as in the *Life of Nelson;* his criticism is sound, as in the *Lives* of Cowper and of Wesley. But the truest Southey is in his *Letters;* the loyal, gallant, tenderhearted, faithful man that he was is revealed in them. Southey's fame will not rest, as he supposed, on his verse; all his faults are in that,—all his own weakness, and all the false taste of his age. But his prose assures him a high place in English literature, though not a place in the first rank even of prose writers.

SOUTHPORT, a municipal borough of Lancashire, England, and a favorite seaside resort, is situated between the estuaries of the Mersey and the Ribble, 18 miles north of Liverpool, and is a terminal station of three railway systems. Its foreshore consists of a great expanse of firm, bright sands, to the radiation of heat from which is attributed the mildness of its winter climate. Its proximity to Liverpool, Manchester, and other large manufacturing towns, has drawn to it a large resident population, and its visitors, in quest of health and pleasure, number many thousands annually. Its spacious streets, laid out at right angles to each other, are bordered with trees and ornamental gardens. The promenade along the shore is two miles in length; in its centre is the pier, a mile long, down which tramcars are drawn by a stationary steam-engine. Other facilities for outdoor enjoyment are provided in Hesketh Park (presented to the town by the late Rev. Charles Hesketh, rector of North Meols, and one of the lords of the manor), the Botanic Gardens, Kew Gardens, and the Winter Gardens. The last, laid out at a cost of £130,000 [$631,800], include a large conservatory, a fine enclosed promenade, a theatre, and an aquarium. There is also a glaciarium, or skating and curling hall, in which those amusements may be practiced on real ice all the year round. The Victoria baths were erected in 1870 at an expenditure of £50,000 [$243,000]. The principal public buildings are the town-hall, the Cambridge hall (used for concerts, etc.), and an extensive range of markets, erected in 1881 at a cost of £40,000 [$194,400]. Among the benevolent institutions are a general infirmary, a convalescent hospital, a sanatorium for children, and a neuro-hydropathic hospital. Southport has also a free library and art gallery (the gift of the late William Atkinson), a literary and philosophical institute, and a college (Trinity Hall) for the education of the daughters of Wesleyan ministers; and the town council are now (1886) engaged in building a museum and schools of science and art. The first house in Southport (an inn for the reception of sea-bathers) was built in 1791, and soon after other houses were erected on the site now known as Lord Street. The population, which in 1809 was 100, had increased in 1851 to 4766, and in 1861 to 10,097. In 1867 the town received a charter of incorporation, and since then its progress has been remarkable. In 1871 the population of the borough (area 7526 acres) was 18,086; in 1881 this had grown to 32,206, and in 1886 it was estimated at 36,596. Its sanitary arrangements are very perfect, and the water supply is abundant and excellent. Southport gives its name to one of the parliamentary divisions of South-west Lancashire.

SOUTH SHIELDS. See SHIELDS, SOUTH.

SOUTHWARK. See LONDON.

SOUVESTRE, ÉMILE (1806–1854), a French novelist of merit, was born on April 15, 1806, and died on July 5, 1854. He was a native of Morlaix, and his affection for Brittany colored most of his best work in after life. He had rather a chequered career of employment besides his literary pursuits. He was by turns a bookseller's assistant, a private schoolmaster, a journalist, and *professeur* at the grammar schools of Brest and Mulhouse. In 1848 he received what may sound to English ears the odd appointment of "professor of administrative style" in a school founded for the instruction of civil servants. His literary work, however, was his labor of love. He began like most Frenchmen with the drama, but was never very successful with it. In novel-writing he did much better, and with Jules Sandeau (though on a somewhat lower level of writing, construction, and grasp of character) may be said to rank as the chief recent French novelist who deliberately aimed at making the novel an engine of moral instruction. With less genius and less sense of art than Sandeau, he did not always escape the reproach of dulness. His best work is undoubtedly to be found in the charming *Derniers Bretons* (1835–1837) and *Foyer Breton* (1844) (where the folklore and natural features of his native province are worked up into story form, with a success hardly excelled by any other writer), and in *Un Philosophe sous les Toits*, which received the honor of an academic prize in the year 1851. This Souvestre deserved, not merely for his sentiments, but for his easy and agreeable style. He also wrote a not inconsiderable number of other works—novels, dramas, essays, and miscellanies.

SOWERBY, JAMES (1757–1822), was at first a painter, but soon applied his art to the illustration of botanical and conchological works, which are still highly valued, especially his *English Botany* (12 vols. 8vo, 1846). His son George (1788–1854) followed in his father's steps, and produced a monumental work on conchology.

SOWERBY BRIDGE, a manufacturing town in the West Riding of Yorkshire, is situated on both sides of the river Calder, at the termination of the Rochdale Canal, and on the Lancashire and Yorkshire Railway, 2 miles southwest of Halifax, and 8 northwest of Huddersfield. Christ church, dating from 1526, was rebuilt in 1819. The other public buildings include the town-hall (1857) and the local board offices, opened in 1878, attached to which are the public baths and the slaughter-houses. The town is almost entirely the growth of the last fifty years. It possesses worsted and cotton mills, iron-works, dye-works, and chemical works. The population of the urban sanitary district (area 536 acres) in 1871 was 7041, and in 1881 it was 8724.

SOZOMEN, church historian. Hermias Salamanes (Salaminius) Sozomenus came of a wealthy family of Palestine, and it is exceedingly probable that he himself was born (not later than 400 A.D.) and brought up there—in Gaza or the neighborhood. What he has to tell us of the history of South Palestine was derived from oral tradition. His grandfather, as he himself tells us, lived at Bethel near Gaza, and became a Christian, probably under Constantius, through the influence of Hilarion, who among his other miracles had miraculously healed an acquaintance of the grandfather, one Alaphion. Both men with their families became zealous Christians and conspicuous for their virtues. The historian's grandfather became within his own circle a highly esteemed interpreter of Scripture, and held fast his profession even in the time of Julian. The descendants of the wealthy Alaphion founded churches and convents in the district, and were particularly active in promoting monasticism. Sozomen himself had conversed with one of these, a very old man. He was brought up under monkish influences; so he expressly states, and his history bears him out. As a man he retained the impressions of his youth, and his great work was to be also a monument of his reverence for the monks in general and for the disciples of Hilarion in particular. He became a lawyer and advocate in Constantinople, where as such he wrote his 'Εκκλησιαστικὴ 'Ιστωρία about the year 440. The nine books of which it is composed begin with Constantine and come down to the death of Honorius (423); but according to his own statement the author intended to continue it as far as the year 439. From Sozomen himself (iv. 17), and statements of his excerptors Nicephorus and Theophanes, it can be made out that the work did actually come down to that year, and that consequently it has reached us only in a somewhat mutilated condition, at least half a book being wanting. A flattering and bombastic dedication to Theodosius II. is prefixed. When compared with the history of SOCRATES (*q.v.*), it is plainly seen to be a plagiarism from that work, and that on a large scale. Some three-fourths of the materials, essentially in the same arrangement, have simply been appropriated from his predecessor without his being so much as named even once, the other sources to which Sozomen was indebted being, however, expressly cited. All that can be said to the credit of Sozomen is that he has been himself at the trouble to refer to the principal sources used by Socrates (Rufinus, Eusebius, Athanasius, Sabinus, the collections of epistles, Palladius), and has not unfrequently supplemented Socrates from them, and also that he has adduced some new authorities, in particular sources relating to Christianity in Persia, Arian history, monkish histories, the *Vita Martini* of Sulpicius, books of Hilarius; the whole of the ninth book is entirely drawn from Olympiodorus.

It is difficult to discern the motive for a work which was merely an enlarged edition of Socrates. But it is probable that Sozomen did not approve of Socrates's freer attitude towards Greek science, and that he wished to present a picture in which the clergy should be still further glorified, and, above all, monasticism brought into still stronger prominence. In Sozomen everything is a shade more ecclesiastical—but only a shade—than in Socrates. Perhaps also he wrote for a different circle,—say, the monks in Palestine,—and could be sure that in it the work of his predecessor would not be known.

Sozomen is everywhere an inferior Socrates. What in Socrates still betrays some vestiges of historical sense, his moderation, his reserve in questions of dogma, his impartiality,—all this is wanting in Sozomen. In many cases he has repeated the exact words of Socrates, but with him they have passed almost into mere phrases. The inferiority of Sozomen to Socrates as an historian appears as much in the manner in which he transcribed him as in those passages where he introduces something new. The chronological scrupulosity of the earlier writer has made no impression on his follower; he has either wholly omitted or inaccurately repeated the chronological data. He writes more wordily and diffusely. In his characterizations of persons, borrowed from Socrates, he is more dull and colorless. After Socrates he has indeed repeated the caution not to be too rash in discerning the finger of God; but his way of looking at things is throughout mean and rustic. Two souls inhabit his book; one, the better, is borrowed from Socrates; another, the worse, is his own. Wherever he abandons his leader he frequently falls into mere retailing of stories, and prostrates himself in reverence before the poorest products of the religious fantasy of a degenerating age. Evidence of a boundless credulity with regard to all sorts of monkish fables is to be met with everywhere. Raisings of the dead are quite common occurrences with him, and he repeatedly gives accounts of enormous dragons. In the finding of the bones of saints, he takes the highest interest and even believes in the rediscovery of the tombs of the Old Testament prophets.

Where we still possess Socrates's account that of Sozomen very seldom has any consequence, but some of the additions he has made are instructive and important. The number of new acts of councils introduced by him is small. His monkish histories are as sources almost utterly valueless; his account of the Christians in Persia absolutely swarms with mistakes. It must, however, be noted that for the period from Theodosius I. onward he has emancipated himself more fully from Socrates and has followed Olympiodorus in part, partly also oral tradition; here accordingly his statement possess greater value.

Editions and Literature.—Socrates and Sozomen have been edited by Stephanus (Paris, 1544; Geneva, 1612), Valesius (Paris, 1659–73), Reading (Cambridge, 1720), Hussey (Oxford, 1853, 1860). They are also to be found in vol. lxvii. of Migne's *Patrologia*, and there is an Oxford school edition (1844) after Reading. Bright edited Socrates according to the text of Hussey in 1878. There are "Testimonia Veterum" in Valesius, and Nolte's papers in *Tübing. Quartalschr.* (1859); p. 518 *sq.* (1861), p. 417 *sq.*, contain emendations in Hussey's text, and notes towards the history of the text and editions; see also Overbeck in *Theol. Lit. Ztung.* (1879), No. 20.

Special studies have been made by Baronius, Miræus, Labbé Valesius, Halloix, Scaliger, Ceillier, Cave, Dupin, Pagi, Ittig, Tillemont, Walch, Gibbon, Schroeckh, Lardner. See also Voss, *De Histor. Græcis;* Fabricius-Harless, *Biblioth. Gr.*, vol. vii.; Rössler, *Bibliothek d. Kirchenväter;* Holzhausen, *De Fontibus quibus Socr., Soz., ac Theod. in scribenda Historia Sacra usi sunt* (Göttingen, 1825); Stäudlin, *Gesch. u. Lit. d. K.-G.*, Hanover, 1827; Baur, *Epochen* (1825); Harnac, "Socr. u Soz," in Herzog-Plitt's *Theol. Encykl.* Detached details are given also in works upon Constantine (Manso), Julian (Mücke, Rode, Neumann, Rendall), Damasus (Rade), Arianism (Gwatkin's *Studies of Arianism*, 1882, gives a severe but trustworthy criticism of Rufinus and discusses the manner in which Socrates was related to him), the emperors after Julian (De Broglie, Richter, Clinton, the *Weltgeschichte* of Ranke, the *Gesch. d. Kaiser Arcadius u. Theod. II.*, 1885, of Güldenpenning, and the *Kaiser Theodosius d. Gr.*, Halle, 1878, of Iffland, the last-named work discussing the relation of Socrates to Sozomen), the barbarian migrations (Wietersheim, Dahn), the Goths (Waitz, Bessel, Kauffmann, and Scott's *Ulfilas*, 1885). Lastly, reference may be made to Rosenstein, *Forsch. z. deutsch Gesch.*, vol. i.,—*Krit. Untersuch üb. d. Verhältniss zu Olympiodor, Zosimus, u. Soz.;* Sarrazin, *De Theodoro Lectore Theophanis Fonte Præcipuo*, 1881 (treats of the relation betwen Socrates and Sozomen, and of the completeness of the former's work); Jeep, *Quellenuntersuch. z. d. griech. Kirchenhistori-kern*, Leipsic, 1884. (A. HA.)

SPA, a watering-place of Belgium, in the province of Liége, 20 miles by rail from Liége *via* Pepinster, is beautifully situated, at a height of 814 feet above the sea, in the valley of the Wayai (a small sub-tributary of the Meuse). On the north and northeast it is protected by the wooded range of hills known as the Spaloumont, or in its several parts as Bois de la Reid, Bois du Chieneul, etc.; and on the south are a number of beautiful ravines cut in the Primary rocks of the district by small affluents of the Wayai. Much of the charm of the place is due to the promenades and drives along the sides and crests of the hills. The principal mineral spring called the Pouhon (a local word for "well") is inclosed in a pump room in the centre of the Place Pierre le Grand. Public baths, fed by chalybeate streams collected in a remarkable reservoir at the hamlet of Nivesé, occupy a large building in Place Royale, erected in 1868; and in the same neighborhood is the casino, with ball and concert rooms. An English church was built in 1872–76. A local industry is the production of fancy articles in lacquered wood (bois de Spa). A liqueur resembling Chartreuse is also manufactured under the name of "elixir de Spa." The population of the commune was 6930 in 1884. Several springs in the neighboring district are nearly as celebrated as those of Spa proper; the Sauvenière waters, supposed to be effective against sterility are half a mile distant.

Spa, said to derive its name from a Walloon word, *Espa*, for "fountain," was practically founded by a certain Wolf, or Collin le Loup, iron-master of Breda, who had obtained benefit from the waters, and purchased the piece of ground containing the Pouhon spring from Erard de la Marck, bishop of Liége, in 1326. At the beginning of the 15th century the little town numbered 250 houses. The European celebrity of the waters dates from the 16th century, when they were drunk by the duke of Nevers, Margaret of Valois, Henry III. of France, and Alexander Farnese, and the fashion of visiting Spa became thoroughly established in the 18th century. The French Revolution, and, as far as English visitors were concerned, the attractions of the German watering-places made known by Sir Francis Head, for a time turned the tide elsewhere; but since the middle of the century Spa has taken a new lease of prosperity.

SPAGNA, Lo (? –*c.* 1529), the usual designation (due to his Spanish origin) of Giovanni di Pietro, one of the chief followers of Perugino. Nothing whatever is known of his early life, or of the circumstances under which he became a member of the Perugian school. A large number of panel pictures by him exist, of which some are painted with much grace and refinement of touch. There is, however, a very marked absence of individuality about his style, which seems like an imitation of the earliest manner of Raphael and that of Pinturicchio in a weaker and less virile form. The chief of his numerous panel paintings are the Nativity, in the Vatican, and the Adoration of the Magi, at Berlin. In 1510 Lo Spagna executed many frescos at Todi, and in 1512 several other mural paintings in and near Trevi. His most important works were frescos at Assisi and Spoleto, of which some exist in good preservation. He received the freedom of the city of Spoleto in 1516, as a reward for his work there. As is so often the case, Lo Spagna's frescos reach a much higher standard of merit than his panel pictures. The museum of the capital in Rome now possesses a very beautiful series of life-sized fresco figures by him, representing Apollo and the Nine Muses. These are drawn with a strong feeling for grace of pose and beauty of expression, and are very remarkable for the delicate refinement of their coloring; in style they strongly recall Raphael's earliest manner. Lo Spagna was alive in 1528, but he appears to have died before 1530 as in that year a pupil of his named Doni completed a fresco in S. Jacopo, near Spoleto, which Lo Spagna had begun.

SPAGNOLETTO. See **Ribera.**

SPAIN.

PART I.—GEOGRAPHY AND STATISTICS.

Plate VI. Coast-line.

SPAIN, a country rather more than twice the size of Great Britain including the adjacent small islands, constitutes in its mainland portion about eleven-thirteenths of the Iberian Peninsula, and has in addition an insular area (in the Balearic and Canary Islands) of nearly 5000 square miles. On all sides except that of Portugal the boundaries are natural, the Peninsula being separated from France by the Pyrenees and on every other side being surrounded by the sea. On the side of Portugal a tract of inhospitable country led originally to the separation between the two kingdoms, inasmuch as it caused the reconquest of the comparatively populous maritime tracts from the Moors to be carried out independently of that of the eastern kingdoms, which were also well peopled. The absence of any such means of intercommunication as navigable rivers afford has favored the continuance of this isolation. The precise line of this western frontier is formed for a considerable length by portions of the chief rivers or by small tributaries, and on the north (between Portugal and Galicia) it is determined to a large extent by small mountain ranges. The British rock of Gibraltar, in the extreme south of the peninsula, is separated from Spain by a low isthmus known as the Neutral Ground. The coast-line on the north and northwest is everywhere steep and cliffy. On the north there are numerous small indentations, many of which form more or less convenient harbors, but the current flowing along the coast from the west often leaves in the stiller water at their mouths obstructive bars. The best harbors are to be found on the *rias* or fiord-like indentations in the west of Galicia, where high tides keep the inlets well scoured; here occur the fine natural harbors of Pontevedra and Vigo, Coruña and Ferrol, the last one of the chief stations of the Spanish fleet. Less varied in outline but more varied in character are the Spanish coasts on the south and east. Flat coasts prevail from the frontier of Portugal to the Straits of Gibraltar. Between the mouth of the Rio Tinto and that of the Guadalquivir they are sandy and lined by a series of sand-dunes (the tract known as the Arenas Gordas). Next follows a marshy tract at the mouth of the Guadalquivir, after which the coast-line becomes more varied, and includes the fine Bay of Cadiz. From the Straits of Gibraltar a bold and rocky coast is continued almost right round to Cape Palos, a little beyond the fine natural harbor of Cartagena. North of Cape Palos a line of flat coast, beginning with the narrow strip which cuts off the lagoon called the Mar Menor from the Mediterranean, bounds half of the province of Alicante, but in its northern half this province, becoming mountainous, runs out to the lofty headland of Cape Nao. The whole coast of the Bay of Valencia is low and ill-provided with harbors; and along the east of Catalonia stretches of steep and rocky coast alternate with others of an opposite character.

Surface.

The surface of Spain is remarkable at once for its striking contrasts and its vast expanses of dreary uniformity. There are mountains rising with Alpine grandeur above the snow-line, but often sheltering rich and magnificent valleys at their base. Naked walls of white limestone tower above dark woods of cork, oak, and olive. In other parts, as in the Basque country, in Galicia, in the Serrania de Cuenca (between the head waters of the Tagus and those of the Jucar), in the Albarracin (between the head waters of the Tagus and those of the Guadalaviar), there are extensive tracts of undulating forest-clad hill country, and almost contiguous to these there are apparently boundless plains, or tracts of level tableland, some almost uninhabitable, and some streaked with canals and richly cultivated—like the Requena of Valencia. While, again, continuous mountain ranges and broad plains and tablelands give the prevailing character to the scenery, there are here and there, on the one hand, lofty isolated peaks, landmarks for a wide distance round, such as Monseny, Monserrat, and Mont Sant in Catalonia, the Peña Golosa in Valencia, Moncayo on the borders of Aragon and Old Castile, and, on the other hand, small secluded valleys, such as those of Vich and Olot among the Catalonian Pyrenees.

Central tableland.

The greater part of the interior of Spain is composed of a tableland bounded by the Cantabrian Mountains in the north and the Sierra Morena in the south, and divided into two by a series of mountain ranges stretching on the whole from east to west. The northern half of the tableland, made up of the provinces of Leon and Old Castile, has an average elevation estimated at about 2700 feet, while the southern half, made up of Estremadura and New Castile, is slightly lower—about 2600 feet. On all sides the tableland as a whole is remarkably isolated, and hence the passes on its boundary and the river valleys that lead up to it from the surrounding plains are geographical features of peculiar importance. The isolation on the side of Portugal, where the tableland gradually sinks to the sea in a succession of terraces, has already been referred to. On the northwest the valley of the Sil and a series of valleys further south, along both of which military roads have been carried from an early period, open up communication between Leon and the hill country of Galicia, which explains why this province was united to Leon even before the conquest of Portugal from the Moors. The passes across the Cantabrian Mountains in the north are tolerably numerous, and four of them are already crossed by railways. The two most remarkable are the Pass of Pájares, across which winds the railway from Leon to Oviedo and the seaport of Gijon, and that of Reinosa leading down to the deep valley of the Besaya, and now crossed by the railway from Valladolid to Santander. In its eastern section the chain is crossed by the railways from Burgos to Bilbao and San Sebastian, the latter of which winds through the wild and romantic gorge of Pancorbo (in the northeast of the province of Burgos) before it traverses the Cantabrian chain at Idiazabal.

On the northeast and east, where the edge of the tableland sweeps round in a wide curve, the surface sinks on the whole in broad terraces to the valley of the Ebro and the Bay of Valencia, and is crowned here and there by more or less isolated mountains, some of which have been already mentioned. On the northeast by far the most important communication with the Ebro valley is formed by the valley of the

Jalon, which has thus always formed a military route of the highest consequence, and which is now traversed by the railway from Madrid to Saragossa. Further south the mountains clustered on the east of the tableland (Albarracin, Serrania de Cuenca) render direct communication between Valencia and Madrid extremely difficult, and the principal communications with the east and southeast are effected where the southern tableland of La Mancha merges in the hill country which connects the interior of Spain with the Sierra Nevada.

In the south the descent from the tableland to the valley of the Guadalquivir is again comparatively gradual, but even here in the eastern half of the Sierra Morena the passes are few, the most important being the Puerto de Despeñaperros, where the Rio Magaña has cut for itself a deep gorge through which the railway now ascends from Andalusia to Madrid. Between Andalusia and Estremadura farther west the communication is freer, the Sierra Morena being there broken up into series of small chains.

Cantabrian Mountains.

Of the mountains belonging to the tableland the most continuous are those of the Cantabrian chain, which stretches for the most part from east to west, parallel to the Bay of Biscay, but ultimately bends round towards the south between Leon and Galicia. Almost everywhere it consists of two parallel ranges, the higher of which, the more southerly, is the immediate continuation of the Pyrenees. The highest summits of the chain belong to the Jura limestones of the Peñas de Europa, on the borders of the provinces of Santander, Oviedo, Leon, and Palencia. The highest of all is the Torre de Ceredo, which attains the height of at least 8750 feet, and next is the Peña Prieta (8300 feet). At the sources of the Sil the main chain divides into two branches, inclosing the fertile and thickly-populated district known as El Vierzo, once the bed of a lake, now watered by the stream just mentioned and its tributaries. The whole chain is remarkable for its intricate ramifications and its wild grandeur, but, as already indicated, is not so much of a barrier to communication as might be expected from its general aspect. Besides the railways above mentioned it is crossed at many points by bridle-paths and roads.

Central mountain chains.

A peculiar feature of the chain and the neighboring parts of the tableland is formed by the *parameras* or isolated plateaus, surrounded by steep rocky mountains, sometimes even by walls of naked rock. Among the larger of these are the bleak districts of Siguenza and Soria, round the headwaters of the Duero,—districts which separate the mountains of the so-called Iberian system on the northeast of the tableland from the eastern portion of the central mountain chains of the peninsula. Of these chains, to which Spanish geographers give the name Carpetano-Vetonica, the most easterly is the Sierra de Guadarrama, the general trend of which is from southwest to northeast. It is the Montes Carpetani of the ancients, and a portion of it (due north of Madrid) still bears the name of Carpetanos. Composed almost entirely of granite, it has an aspect when seen from a distance highly characteristic of the mountains of the Iberian Peninsula in general, presenting the appearance of a saw-like ridge (*sierra*) broken up into numerous sections. Its mean height is about 5250 feet, and near its centre it has three summits (the highest named the Pico de Peñalara) rising to the height of nearly 8000 feet.

A region with a highly irregular surface, filled with hills and parameras, separates this sierra from the Sierra de Gredos farther west. This is the loftiest and grandest sierra in the whole series. Its culminating point, the Plaza de Almanzor, attains the height of 8725 feet, not far short of that of the highest Cantabrian summits. Its general trend is east and west; towards the south it sinks precipitously, and on the north it descends with a somewhat more gentle slope towards the longitudinal valleys of the Tormes and Alberche which separate it from another rugged mountain range, forming the southern boundary of the paramera of Avila. On the west another rough and hilly tract, similar to that which divides it from the Sierra de Guadarrama in the east, separates it from the Sierra de Gata, the westernmost and the lowest of the Spanish sierras belonging to the series. These hilly intervals between the more continuous sierras greatly facilitate the communication between the northern and southern halves of the Spanish tableland. The Guadarrama is indeed crossed by three good pass-roads, and even the Sierra de Gredos has a road across it connecting Avila with Talavera de la Reina by the Puerto del Pico; but for the most part there are only bridle-paths across the sierras, and up to the present date not a single railway crosses any one of the sierras directly. The only railway crossing the central system of mountains is that from Madrid to Avila, which traverses the interval between the Sierras de Gredos and Guadarrama, passing through numerous tunnels on the way. A railway from Madrid to Segovia to cross the latter sierra at the Puerto de Navacerrada (5830 feet),[1] the pass at present crossed by the principal high road across these mountains, is now (1886) in course of construction.

Sierra Morena.

On the southern half of the tableland a shorter series of sierras, consisting of the Montes de Toledo in the east (highest elevation 4600 feet) and the Sierra de Guadalupe in the west (highest elevation 5100 feet), separates the basins of the Tagus and Guadiana. The southern system of mountains bounding the Iberian tableland—the Sierra Morena—is even less of a continuous chain than the two systems last described. As already intimated, its least continuous portion is in the west. In the east and middle portion it is composed of a countless number of irregularly-disposed undulating mountains all nearly equal in height.

Sierra Nevada.

Sierras of south coast.

Even more important than the mountains bounding or crossing the tableland are those in the northeast and in the south, which are connected with the tableland only at their extremities. The former are the PYRENEES (*q.v.*), the latter are the Sierra Nevada, and the coast ranges still farther south. The Sierra Nevada, or "snowy sierra," is a well-defined chain, between 50 and 60 miles in length, and about 25 miles in breadth, situated to the south of the valley of the Guadalquivir, and stretching from the upper part of the valley of the Jenil in the west to the deep valley of the Almeria in the east. It is composed chiefly of soft micaceous schists, sinking precipitously down on the north, but sloping more gently to the south and southeast. Its culminating summit, the Cerro de Mulahacen (11,660 feet), is the highest in Spain, and the range contains several other peaks upwards of 10,000 feet in height, and above the limit of perpetual snow. On both sides deep transverse valleys (*barrancas*) follow one another in close succession, in many cases with round basin-shaped heads, like the *cirques* of the Pyrenees. In many of these cirques repose alpine lakes, and in one of them, the Corral de Veleta, there is even a small glacier, the most southerly in Europe. On the south the transverse valleys of the Sierra Nevada open into the mountainous longitudinal valley of the Alpujarras, into which open also on the other side the transverse valleys from the most easterly of the coast sierras, the Sierra Contraviesa and the Sierra de Almijara. The latter are continued farther west by the Sierra de Alhama and Sierra de Abdalajiz. Immediately to the west of the latter sierra lies the gorge of the Guadalhorce, which now affords a passage for the railway from Malaga to Cordova; and beyond that gorge, to the west and southwest, the Serrania de Ronda, a mountain group difficult of access, stretches out its sierras in all directions. To Spanish geographers the coast ranges just mentioned are known collectively as the Sierra Penibetica. Northeast of the Sierra Nevada two small ranges, Alcaraz and La Sagra, rise with remarkable abruptness from the plateau of Murcia, where it merges in that of the interior.

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[1] About 3700 feet above the level of Madrid, 2700 feet above that of Segovia.

Lowland valleys.

The only two important lowland valleys of Spain are those of the Ebro and the Guadalquivir. The former occupies the angle in the northeast between the Pyrenees and the central tableland, and is divided by ranges of heights proceeding on the one side from the Pyrenees, on the other from the base of the Moncayo, into two portions. The uppermost of these, a plateau of between 1000 and 1300 feet above sea-level, is only about one-fourth of the size of the remaining portion, which is chiefly lowland, but is cut off from the coast by a highland tract connecting the interior tableland with spurs from the Pyrenees. The Guadalquivir basin is likewise divided by the configuration of the ground into a small upper portion of considerable elevation and a much larger lower portion mainly lowland, the latter composed from Seville downwards of a perfectly level and to a large extent unhealthy alluvium (*las marismas*). The division between these two sections is indicated by the change in the course of the main stream from a due westerly to a more southwesterly direction.

Rivers.

The main water-parting of the peninsula is everywhere near the edge of the tableland on the north, east, and south, and hence describes a semicircle with the convexity to the east. The Ebro alone of the great rivers flows into the Mediterranean. The following table gives the length of the principal Iberian rivers, with the area of their basins,—the length according to different authorities, the area of the basins according to Strelbitsky, whose measurements of area appear to be more trustworthy than those made by him of the length of rivers:

	Length in English Miles.			Area in Square Miles.
	Wagner.	Ritter.	Strelbitsky.	
Ebro...............	442	416	470	38,580
Duero (Douro)...	452	507	485	36,710
Tagus................	565	553	566	31,865
Guadiana...... ...	510	490	316	25,300
Guadalquivir.....	337	350	374	21,580

With the exception of the Guadalquivir, none of the Iberian rivers is of great service for inland navigation, so far as they lie within the Spanish frontier. On the other hand, those of the east and south are of great value for irrigation, and the Jucar and Segura in the southeast are employed in floating timber from the Serrania de Cuenca.

The EBRO and TAGUS are described in separate articles (*q.v.*).

The Miño (Portug. *Minho*, the *Minius* of the Romans) is formed by the union of two small streams in the north of the province of Lugo, and flows first southwards, then on the whole southwestwards to the Atlantic, forming in the lower part of its course the boundary between Spain and Portugal. It becomes navigable for small vessels at Salvaterra, 25 miles above its mouth. Large vessels cannot cross the bar at its mouth. Its only important tributary is the Sil (left), which at the confluence is the larger river of the two.

The Duero (Portug. *Douro*, the *Durius* of the Romans) emerges from the rock as a small stream among the mountains of Urbion on the borders of the provinces of Logroño and Soria, and, after describing a wide sweep to the east, flows westwards across the northern half of the Spanish tableland and across Portugal. For a distance of nearly 60 miles it forms the boundary between the two countries. It begins to be navigable 80 miles above its mouth, but seagoing vessels ascend only to Oporto, and even so far, on account of a bar at the mouth, only at high tide. The principal tributaries on the right are the Pisuerga and Esla, on the left the Adaja, Tormes, and Coa (the last in Portugal).

The Guadiana (*i.e.*, *Wâdi Ana*, the *Anas* of the ancients) was long believed to take its rise in the district known as the Campo de Montiel, where a string of small lakes known as the Lagunas de Ruidera (partly in Ciudad Real, partly in Albacete) are connected by a stream which, on leaving the last of them, flows northwestwards towards the Zancara and then disappears within two or three miles of that river. About 22 miles to the southwest of the point of disappearance the stream was believed to re-emerge in the form of several large springs which form a number of lakes at no great distance from the Zancara, and these lakes are hence known as the "eyes of the Guadiana" (*los ojos de Guadiana*). The small stream issuing from them is known as the Guadiana and soon joins the Zancara. It has now been ascertained, however, that the stream which disappears higher up can have no such course, but that in fact its waters flow or trickle underground to the Zancara itself, which is therefore entitled to be regarded as the upper Guadiana. It has its source not far from that of the Jucar in the east of the plateau of La Mancha, and flows westwards till, under the name of the Guadiana, it turns south-southwest on the Portuguese frontier. In piercing the Sierra Morena it forms a series of foaming rapids, and it begins to be navigable only at Mertola, about 42 miles above its mouth.

The Guadalquivir (*i.e.*, *Wâdi-el-Kebir*, "the great river," the *Bætis* of the ancients), though the shortest of the great rivers of the Peninsula, is the only one that at all seasons of the year is a full-bodied stream, being fed in winter by the rains, in summer by the melting of the snows on the Sierra Nevada. What is regarded as the main stream rises in the Sierra de Cazorla in the east of the province of Jaen, but it does not become a considerable river till after it is joined by the Guadiana Menor (from the Sierra Nevada), on the left bank and the Guadalimar on the right. Lower down the principal tributary which it receives is the Jenil (left). In the days of the Moors the Guadalquivir was navigable for large vessels to Cordova, but, having been allowed to become silted up in the lower part of its course, it has only recently again been made navigable for vessels of 1200 tons burden to Seville.

Lakes.

The only considerable lakes in Spain are three coast lagoons,—that of Albufera in the province of Valencia, the Mar Menor in Murcia, and the Laguna de la Janda in Cadiz behind Cape Trafalgar. Small alpine and other lakes are numerous, and small salt lakes are to be found in every steppe region.

Geology.

The geological structure of the Spanish Peninsula is comparatively simple. Upon a fundamental platform of ancient crystalline rocks, which had previously been upraised into detached ridges, a series of sedimentary formations was laid down, among which occur representatives of most of the geological systems from the older Palæozoic rocks up to those of Quaternary date. Arranged in order of age, with their respective areas, these various groups of rock are shown in the subjoined table:

Quaternary......	covering	49,477	sq. kil. or	10.00 %	of whole surface.
Pliocene...........	“	9,064	“	1.80	“
Miocene and Oligocene......	“	137,867	“	27.85	“
Eocene.............	“	23,564	“	4.80	“
Cretaceous.......	“	47,002	“	9.50	“
Jurassic............	“	22,697	“	4.45	“
Triassic............	“	22,448	“	4.45	“
Carboniferous...	“	11,301	“	2.22	“
Devonian.........	“	5,780	“	1.40	“
Silurian (and Cambrian).....	“	114,382	“	23.18	“
Archæan..........	“	1,694	“	0.85	“
Eruptive rocks of various ages	“	49,665	“	10.00	“

Archæan rocks are exposed in the northern half of the Peninsula, particularly along the great Pyrenean axis, in Galicia, Estremadura, the Sierra Morena, the Sierra Nevada, and Serrania de Ronda. They consist of granites, gneisses, and mica-schists, with talc-schists, amphibolites, and crystalline limestones. The oldest Palæozoic strata are referred, from their included fossils, to the Cambrian and Silurian divisions. They range through a vast region of Andalusia, Estremadura, Castile, Salamanca, Leon, and Asturias, and along the flanks of the Pyrenean and Cantabrian chain. They consist of slates, graywackes, quartzites, and diabases. Grits, quartzites, and shales referable to the Devonian system occur in a few scattered areas, the largest and most fossiliferous of these occurring in the Asturias. The Carboniferous rocks of Spain are divisible into three groups, the lowest consisting of limestones with sandstones and shales, the middle of conglomerates and sandstones, and the upper of sandstones, conglomerates, shales, and coals. They lie in detached basins, and have not yet been well explored. One of these areas covers a considerable space in the Asturias, whence it stretches more or less continuously through the provinces of Leon, Palencia, and Santander, covering altogether an area of 6500 square kilometres. Another tract occurs at San Juan de las Abadesas in Catalonia, where it occupies about 200 square kilometres; while a third, about 500 square kilometres in extent, runs from the province of Cordova into that of Badajoz. There are other smaller areas containing little or no coal, but showing by the included plant-remains that the strata undoubtedly belong to the Carboniferous system.

The Triassic system is well developed in the north of the Peninsula along the Cantabrian chain and eastwards to the Mediterranean. It is composed of red and variegated sandstones, dolomites, and marls, traversed in some places by ophitic rocks, and containing deposits of gypsum, aragonite, and rock-salt. These strata are overlain by members of the Jurassic series, which are especially conspicuous in the eastern part of the Peninsula between Castile and Aragon, along the Mediterranean border, in Andalusia, and likewise along the flanks of the Pyrenees. The Lias is best represented. The Cretaceous system is distributed in four great districts: the largest of these extends through the kingdoms of Murcia and Valencia; a second stretches between the two Castiles; a third is found in the Basque Provinces and the Asturias; and a fourth spreads out along the southern slopes of the Pyrenees from Navarre to the Mediterranean. The lower members of the Cretaceous series include an important freshwater formation (sandstones and clays), which extends from the Cantabrian coast through the provinces of Santander, Burgos, Soria, and Logroño, and is supposed to represent the English Wealden series. The higher members comprise massive hippurite limestones, and in the Pyrenean district representatives of the upper subdivisions of the system, including the Danian.

Deposits of Tertiary age cover rather more than a third of Spain. They are divisible into two great series, according to their mode of origin in the sea or in fresh water. The marine Tertiary accumulations commence with those that are referable to the Eocene series, consisting of nummulitic limestones, marls, and siliceous sandstones. These strata are developed in the basin of the Ebro, and in a belt which extends from Valencia through Murcia and Andalusia to Cadiz. Marine Miocene deposits occupy some small tracts, especially on the coast of Valencia. But most of the sandy Tertiary rocks of that district are Pliocene. The Tertiary masses of Andalusia have coarse conglomerates (Middle Miocene) at their base, followed by thick beds of Bryozoan molasse and younger (Pliocene) beds. These strata are specially noteworthy for containing an important metalliferous deposit, that of the native silver of Herrerias, which is found in a Pliocene bed in the form of flakes, needles, and crystals. But the most extensive and interesting Tertiary accumulations are those of the great lakes which in Oligocene and Miocene time spread over so large an expanse of the tableland. These sheets of fresh water covered the centre of the country, including the basins of the Ebro, Jucar, Guadalaviar, Guadalquivir, and Tagus. They have left behind them thick deposits of clays, marls, gypsum, and limestone, in which numerous remains of the land-animals of the time have been preserved.

Quaternary deposits spread over about a tenth of the area of the country. The largest tract of them is to be seen to the south of the Cantabrian chain; but another, of hardly inferior extent, flanks the Sierra de Guadarrama, and spreads out over the great plain from Madrid to Caceres. Some of these alluvial accumulations indicate a former greater extension of the snowfields that are now so restricted in the Spanish sierras. Remains of the reindeer are found in caves in the Pyrenees.

Eruptive rocks of many different ages occur in different parts of Spain. The most important tract covered by them is that which stretches from Cape Ortegal to Coria in Estremadura and spreads over a large area of Portugal. They likewise appear in Castile, forming the sierras of Gredos and Guadarrama; farther south they rise in the mountains of Toledo, in the Sierra Morena, and across the provinces of Cordova, Seville, Huelva, and Badajoz as far as Evora in Portugal. Among the minor areas occupied by them may be especially mentioned those which occur in the Triassic districts. Of rocks included in the eruptive series the most abundant is granite. There occur also quartz-porphyry, (Sierra Morena, Pyrenees, etc.), diorite, porphyrite, diabase (well developed in the north of Andalusia, where it plays a great part in the structure of the Sierra Morena), ophite (Pyrenees, Cadiz), serpentine (forming an enormous mass in the Serrania de Ronda), trachyte, liparite, andesite, basalt. The last four rocks occur as a volcanic series distributed in three chief districts—that of Cape Gata, including the southeast of Andalusia and the south of Murcia, that of Catalonia, and that of La Mancha.

Climate.

Climate.—In accordance with its southerly position, its differences of elevation, and the variety in its superficial configuration in other respects, Spain presents within its borders examples of every kind of climate to be found on the northern hemisphere, with the sole exception of that of the torrid zone. As regards temperature, the heart of the tableland is characterized by extremes as great as are to be met with in almost any part of central Europe. The northern and northwestern maritime provinces, on the other hand, have a climate as equable, and, it may be added, as moist, as that of the west of England or Scotland.

Four zones of climate are distinguished. The first zone may be called that of the tableland, although to it also the greater part of the Ebro basin may be referred. This is the zone of the greatest extremes of temperature. Even in summer the nights are often decidedly cold, and on the high parameras it is not a rare thing to see hoar-frost in the morning. In spring cold wetting mists occasionally envelop the land for entire days, while in summer the sky is often perfectly clear for weeks together. At all seasons of the year sudden changes of temperature, to the extent of from 30° to 50° F., are not infrequent. The air is extremely dry, which is all the more keenly felt from the fact that it is almost constantly in motion. At Madrid (2150 feet above sea-level) it regularly freezes so hard in December and January that skating is carried on on the sheet of water in the Buen Retiro; and, as winter throughout Spain, except in the maritime provinces of the north and northwest, is the season of greatest atmospheric precipitation, snowfalls are frequent, though the snow seldom lies long except at high elevations. The summers, on the other hand, are not only extremely warm but almost rainless, the sea-winds being deprived of their moisture on the edge of the plateau. In July and August the plains of New Castile and Estremadura are sunburnt wastes; the roads are several inches deep with dust; the leaves of the few trees are withered and discolored; the atmosphere is filled with a fine dust, producing a haze known as *calina*, which converts the blue of the sky into a dull gray. In the greater part of the Ebro basin the heat of summer is even more intense. The treeless mostly steppe-like valley with a bright-colored soil acts like a concave mirror in reflecting the sun's rays, and, moreover, the mountains and highlands by which the valley is enclosed prevent to a large extent the access of winds, and thus hinder the renewal of the air, which in the lowest parts is little disturbed.

The second zone is that of the Mediterranean provinces, exclusive of those of the extreme south. In this zone the extremes of temperature are less, though the summers here also are warm, and the winters decidedly cool, especially in the northeast.

The southern zone, to which the name of African has been given, embraces the whole of Andalusia as far as the Sierra Morena, the southern half of Murcia, and the province of Alicante. In this zone there prevails a genuine subtropical climate, with extremely warm and almost rainless summers and mild winters, the temperature hardly ever sinking below freezing-point. The hottest part of the region is not the most southerly district but the bright-colored steppes of the coast of Granada, and the plains and hill terraces of the southeast coast from Almeria to Alicante. Snow and frost are here hardly known. It is said that at Malaga snow falls only about once in twenty-five years. The winter, in fact, is the season of the brightest vegetation; after the long drought of summer the surface gets covered once more in late autumn with a fresh green varied with bright-colored flowers, and so it remains the whole winter through. On the other hand, the eastern part of this zone is the part of Spain which is liable to be visited from time to time by the scorching and blasting *levecho*, the name given in Spain to the sirocco, as well as by the *solano*, a moist and less noxious east wind.

The fourth zone, that of the north and northwest maritime provinces, presents a marked contrast to all the others. The temperature is mild and equable; the rains are abundant all the year round, but fall chiefly in autumn, as in the west of Europe generally. Monthly roses bloom in the gardens at Christmas as beautifully and as plentifully as in summer. The chief drawback of the climate is an excess of rain in some parts, especially in the west. Santiago de Compostella, for example, has one of the highest rainfalls on the mainland of Europe (see table below).

The figures given in the following table (I.),[1] although based only on data of short periods (from 3½ to 20 years), will help to illustrate the preceding general remarks. Greenwich is added for the sake of comparison.

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[1] By conversion from Th. Fischer's *Klima der Mittelmeerländer*.

Station.		Height in feet.	Mean Temp. F.			R'nfall in ins.
			Jan.	July	Year	
Tableland zone	Leon	2600	37°	73°	53°	19
	Madrid	2150	41	76	56	15
Southern zone	San Fernando	90	52	75	63	30
	Malaga	75	54	79	70	...
Mediterranean zone	Murcia	140	49	79	63	14
	Mahon	...	52	77	64	27
Northern maritime zone	Bilbao	50	46	70	58	46
	Oviedo	750	43	66	54	36
	Santiago	750	45.5	66	55	66
	Greenwich	...	39	63	50	25

Flora.

Vegetation.—The vegetation of Spain exhibits a variety in keeping with the differences of climate just described. The number of endemic species is exceptionally large, the number of monotypic genera in the Peninsula greater than in any other part of the Mediterranean domain. The endemic species are naturally most numerous in the mountains, and above all in the loftiest ranges, the Pyrenees and the Sierra Nevada; but it is a peculiarity of the Spanish tableland, as compared with the plains and tablelands of central Europe, that it also possesses a considerable number of endemic plants and plants of extremely restricted range. This fact, however, is also in harmony with the physical conditions above described, being explained by the local varieties, not only of climate, but also of soil. Altogether no other country in Europe of equal extent has so great a wealth of species as Spain. According to the *Prodromus Floræ Hispanicæ* of Willkomm and Lange (completed in 1880), the number of species of vascular plants then ascertained to exist in the country was 5096.

Spain may be divided botanically into four provinces, corresponding to the four climatic zones.

In the tableland province (including the greater part of the Ebro valley) the flora is composed chiefly of species characteristic of the Mediterranean region, generally of species confined to the Peninsula. A peculiar character is imparted to the vegetation of this province by the growth over large tracts of evergreen shrubs and large herbaceous plants belonging to the *Cistineæ* and *Labiatæ*. Areas covered by plants of the former group are known to the Spaniards as *jarales*, and are particularly extensive in the Mancha Alta and on the slopes of the Sierra Morena, where the ladanum bush (*Cistus ladaniferus*) is specially abundant; those covered by plants of the latter group are known as *tomillares* (from *tomillo*, thyme), and occur chiefly in the south, southwest, and east of the tableland of New Castile. In the central parts of the same tableland huge thistles (such as the *Onopordum nervosum*), centaureas, artemisias, and other *Compositæ* are scattered in great profusion. From the level parts of these tablelands trees are almost entirely absent. On the lofty parameras of Soria and other parts of old Castile the vegetation has an almost alpine character.

The southern or African province is distinguished chiefly by the abundance of plants which have their true home in North Africa (a fact easily understood when we consider the geologically recent land connection of Spain with that continent), but is also remarkable for the occurrence within it of numerous Eastern plants (natives of Syria and Asia Minor), and plants belonging to South Africa and the Canaries, as well as natives of tropical America which have become naturalized here (see below under *Agriculture*). In this province the maritime parts of Malaga and Granada present scenes of almost tropical richness and beauty, while, on the other hand, in Murcia, Alicante, and Almeria the aspect is truly African, fertile oases appearing in the midst of rocky deserts or barren steppes. A peculiar vegetation, consisting mainly of low shrubs with fleshy glaucous leaves *Inula crithmoides*, etc.), covers the marismas of the Guadalquivir and various parts of the southwest coast where salt-marshes prevail. Everywhere on moist sandy ground are to be seen tall thickets of *Arundo Donax*.

The Mediterranean province is that in which the general aspect of the vegetation agrees most closely with that of southern France and the lowlands of the Mediterranean region generally. On the lower slopes of the mountains and on all the parts left uncultivated the prevailing form of vegetation consists of a dense growth of shrubs with thick leathery leaves, such as are known to the French as *maquis*, to the Italians as *macchie*, and are called in Spanish *monte bajo*,[1] shrubs which, however much they resemble each other in external appearance, belong botanically to a great variety of families.

The northern maritime province, in accordance with its climate, has a vegetation resembling that of central Europe. Here only are to be found rich grassy meadows adorned with flowers such as are seen in English fields, and here only do forests of oak, beech, and chestnut cover a large proportion of the area. The extraordinary abundance of ferns (as in western France) is likewise characteristic.

Forests.

The forest area of Spain generally is relatively small. The whole extent of forests is estimated at little more than 3 millions of hectares (7½ million acres), or less than 6 per cent. of the area of the kingdom. Evergreen oaks, chestnuts, and conifers are the prevailing trees. The cork oaks of the southern provinces and of Catalonia are of immense value, but the groves containing this tree have suffered greatly from the reckless way in which the product is collected. Among other characteristic trees are the Spanish pine (*Pinus hispanica*), the Corsican pine (*P. Laricio*), the Pinsapo fir (*Abies Pinsapo*), and the *Quercus Tozza*, the last belonging to the slopes of the Sierra Nevada. Besides the date-palm the dwarf-palm grows spontaneously in some parts of the south, but it nowhere makes up a large element of the vegetation.

Steppes.

The Spanish steppes deserve a special notice, since they are not confined to one of the four botanical provinces, but are found in all of them except the last. Six considerable steppe regions are counted: (1) that of Old Castile, situated to the south of Valladolid, and composed chiefly of hills of gypsum; (2) that of New Castile, in the southeast (the district of La Mancha); (3) the Aragonese, occupying the upper part of the basin of the Ebro; (4) the littoral, stretching along the southeast coast from Alicante to the neighborhood of Almeria; (5) the Granadine, in the east of Upper Andalusia (the former kingdom of Granada); and (6) the Bætic, in Lower Andalusia, on both sides of the valley of the Jenil. All of these are originally salt-steppes, and, where the soil is still highly impregnated with salt, have only a sparse covering of shrubs, mostly members of the *Salsolaceæ*, with thick, grayish green, often downy leaves. A different aspect is presented by the grass steppes of Murcia, La Mancha, the plateaus of Guadix and Huescar in the province of Granada, etc., all of which are covered chiefly with the valuable esparto grass (*Macrochloa tenacissima*).

Fauna.

Fauna.—The Iberian Peninsula belongs to the Mediterranean sub-region of the Palæarctic region of the animal kingdom, a division which includes also the north of Africa. The forms that betray African affinities are naturally to be found chiefly in the south. Among the mammals that fall under this head are the common genet (*Genetta vulgaris*), which extends, however, pretty far north, and is found also in the south of France, the fallow-deer, the porcupine (very rare) and a species of ichneumon (*Herpestes widdringtonii*), which is confined to the Peninsula, and is the only European species of this characteristically African genus. The magot or Barbary ape (*Inuus ecaudatus*), the only species of monkey still found wild in Europe, is also a native of Spain, but the only flock still surviving, on the rock of Gibraltar, has often been on the point of extinction, and has to be renewed from time to time by importations from the north of Africa. Of the mammals in which Spain shows more affinity to the fauna of central and northern Europe, some of the most characteristic are the Spanish lynx (*Lynx pardinus*), a species confined to the Peninsula, the Spanish hare (*Lepus madritensis*), and the species mentioned in the article PYRENEES. The birds of Spain are very numerous, partly no doubt in consequence of the fact that the Peninsula lies in the route of those birds of passage which cross from Africa to Europe or Europe to Africa by way of the Straits of Gibraltar. Many species belonging to central Europe pass the winter in Spain, especially on the southeastern coasts and in the valley of the Guadalquivir. Innumerable, for example, are the snipes which in that season are killed in the latter district and brought to the market of Seville. Among the birds of prey may be mentioned, besides the cinereous and bearded vultures, the Spanish vulture (*Gyps occidentalis*), the African or Egyptian vulture (*Neophron percnopterus*), which is found among all the mountains of the Peninsula, the Spanish imperial eagle (*Aquila adalberti*), the short-toed eagle (*Circaetus gallicus*,), the southern eagle-owl (*Bubo atheniensis*), besides various kites and falcons. Among gallinaceous birds, besides the red-legged partridge, which is met with everywhere on the steppes, there are found also the *Pterocles alchita* and *P. arenarius;* and from among the birds of other orders the southern shrike (*Lanius meridionalis*), the Spanish sparrow (*Passer cyaneus*), and the blue magpie (*Cyanopica cooki*) may be singled out as worthy of mention. The last is highly remarkable on account of its distribution, it being confined to Spain while the species most closely allied to it (*Cyanopica cyanea*) belongs to the east of Asia. The flamingo is found native in the Balearic Islands and on the southern coasts, and occasionally a stray specimen is to be seen on the tableland of New Castile. Other birds peculiar to the south are two species of quails, the Andalusian hemipode (*Turnix sylvatica*), confined to the plains of Andalusia, the southern shearwater (*Puffinus cinereus*), and other water-birds. Amphibians and reptiles are particularly numerous in the southern provinces, and among these the most remarkable are the large southern or eyed lizard (*Lacerta ocellata*), which sometimes attains 3 feet in length and is very abundant, the *Platydactylus saccicularis*, the gray amphisbæna (*Blanus cinereus*), the European pond tortoise (*Emys europaæ*), and another species, *Emys siegrizii*. Insect life is remarkably abundant and varied. More than 350 species of butterflies, many of them endemic have been counted in the province of Madrid alone. Besides the ordinary European scorpion, which is generally distributed in southern Europe, there is another species, the sting of which is said to be still more severe, found chiefly in the basin of the Ebro. Trout abound in the mountain streams and lakes, barbel and many other species of *Cyprinidæ* in the rivers of the plains. For the sea fauna, see under *Fisheries* below.

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[1] As distinguished from *monte alto*, the collective name for forest trees.

Extent.

Extent.—The total area of the mainland of Spain, according to the calculations of Strelbitsky, is 495,612 square kilometres or 191,365 square miles, that of the Balearic Islands 4982 square kilometres or 1923 square miles, and that of the Canary Islands, which, though belonging geographically to Africa, are administratively associated with the kingdom of Spain, 7611 square kilometres or 2939 square miles; so that the total area of the kingdom is 508,205 square kilometres or 196,225 square miles. This total agrees pretty closely with that in Justus Perthes's table given below (Table II.), although considerable differences will be observed in the areas assigned to the mainland provinces and the two island groups respectively. The length of the coast-line of the mainland, according to Strelbitsky, is 2662 miles, which is equivalent to 1 mile of coast for every 72 square miles of area, about the same proportion as in France. The greatest length from northeast to southwest is 420 miles.

Administrative divisions.

Territorial Divisions and Population.—For administrative purposes the kingdom of Spain has since 1833 been divided into forty-nine provinces, forty-seven of which belong to the mainland. Before 1833 the mainland was divided into thirteen provinces,[1] also enumerated below, which took their names from the ancient kingdoms and principalities out of which the modern kingdom was gradually built up. The present provinces are subdivided into judicial districts (*partidos judiciales*) and communes (*ayuntamientos*).

Population.

It is probable that the population of Spain attained its highest development during the period of the early Roman empire, when it has been estimated, though of course on imperfect data, to have numbered forty or fifty millions. The best evidence of a dense population in those days is that afforded by the specific estimates of ancient writers for some of the larger cities. The population of Tarraco (Tarragona) was estimated at 2½ millions, and that of Nova Carthago (Cartagena), Italica (Sevilla la Vieja), and others at several hundreds of thousands. Emerita Augusta (Merida) had a Roman garrison of 90,000 men, which also implies a large population.[2]

The first Spanish census was made in 1594, but some of the provinces now included in the kingdom were for one reason or another not embraced in the enumeration, so that the total population assigned to Spain within its present limits for that date is obtained by adding the results of enumerations at different dates in the provinces then excluded. The total thus arrived at is 8,206,791. No other census took place till 1787, when the total was found to be 10,268,150; and this census was followed by another in 1797, when the population was returned as 10,541,221. Various estimates were made within the next sixty years, but the census of 1857 proved that some of these estimates must have been greatly below the truth. The total population then ascertained to exist in Spain was 15,464,340, an increase of not much less than 50 per cent. since the census of 1797. The last census took place on December 31, 1877, and the total population then ascertained, 16,631,869, shows an increase of only 7½ per cent., equal to an annual increase at the rate of 0.35 per cent.—lower than in any other country in Europe except France.

As Table II. shows, the density of population in Spain as a whole is little more than that of the most thinly peopled county of England in 1881 (Westmoreland, 82 to the square mile). Looking at the old provinces, we find that the most thickly peopled are all maritime, and that all the maritime provinces except Andalusia and Murcia have a density exceeding 100 to the square mile. The most densely peopled province of all is not Catalonia, in which manufacturing industries are so highly developed, nor the Basque Provinces with their great iron industry, but Galicia, where

Table II.—Area and Population of the Former and Present Provinces.

Provinces.	Area in Square Miles.	Population 1857.	Population Dec. 31, 1877.	Increase or Decrease.	Pop. per sq. mile, 1877.
NEW CASTILE....	**28,018**	**1,477,915**	**1,627,131**	**+10.1**	**58**
Madrid...........	2,997	475,785	594,194	+24.8	198
Guadalajara....	4,869	199,088	201,288	+ 1.1	41
Toledo	5,586	328,755	335,038	+ 1.8	60
Cuenca...........	6,726	229,959	236,253	+ 3.3	34
Ciudad Real...	7,840	244,328	260,358	+ 6.6	33
OLD CASTILE......	**25,409**	**1,609,948**	**1,654,718**	**+2.8**	**65**
Burgos............	5,651	333,356	332,625	— 0.2	59
Logroño	1,945	173,812	174,425	+ 0.4	89
Santander	2,112	214,441	235,299	+ 9.7	111
Avila	2,982	164,039	180,436	+10.0	60
Segovia	2,714	146,839	150,052	+ 2.1	55
Soria...............	3,836	147,468	153,652	+ 4.2	40
Palencia..........	3,126	185,970	180,771	— 2.8	58
Valladolid......	3,043	244,023	247,458	+ 1.4	80
ASTURIAS...........	**4,091**	**524,529**	**576,352**	**+9.9**	**140**
Oviedo	4,091	524,529	576,352	+ 9.9	140
LEON	**15,242**	**861,434**	**885,625**	**+3.0**	**57**
Salamanca......	4,940	263,516	285,695	+ 8.3	58
Zamora...........	4,135	249,162	249,720	+ 0.2	60
Leon...............	6,167	348,756	350,210	+ 0.4	57
ESTREMADURA ..	**16,702**	**707,115**	**739,403**	**+4.6**	**44**
Badajoz..........	8,688	404,981	432,809	+ 6.9	50
Caceres...........	8,014	302,134	306,594	+ 1.5	38
GALICIA	**11,343**	**1,776,879**	**1,848,027**	**+4.0**	**163**
Coruña	3,078	551,989	596,436	+ 8.0	193
Lugo...............	3,787	424,186	410,810	— 3.3	110
Orense	2,739	371,818	388,835	+ 4.6	142
Pontevedra.....	1,739	428,886	551,946	+ 5.4	260
ANDALUSIA	**33,926**	**2,937,183**	**3,283,436**	**+11.7**	**94**
Almeria	3,302	315,664	349,076	+10.8	106
Granada..........	4,937	444,629	479,066	+ 7.5	96
Malaga............	2,824	451,406	500,322	+10.8	177
Cordova	5,300	351,536	385,482	+ 9.7	73
Jaen...............	5,184	345,879	423,025	+22.3	82
Cadiz (with Ceuta).........	2,828	390,192	429,206	+10.2	152
Seville............	5,429	463,486	506,812	+ 9.3	93
Huelva............	4,122	174,391	210,447	+20.8	51
VALENCIA	**8,897**	**1,246,485**	**1,374,592**	**+10.1**	**154**
Castellon de la Plana..........	2,446	260,919	283,981	+ 8.8	116
Valencia.........	4,353	606,608	679,046	+11.9	156
Alicante.........	2,098	378,958	411,565	+ 8.6	194
MURCIA.............	**10,449**	**582,087**	**670,669**	**+15.2**	**64**
Albacete	5,972	201,118	219,058	+ 8.9	35
Murcia...........	4,477	380,969	451,611	+18.5	101
CATALONIA........	**12,483**	**1,652,291**	**1,752,033**	**+5.9**	**140**
Lerida............	4,775	306,994	285,339	— 7.6	60
Gerona	2,272	310,970	299,702	— 3.9	131
Barcelona	2,985	713,734	836,887	+17.2	280
Tarragona	2,451	320,593	330,105	+ 3.0	138
ARAGON	**17,979**	**880,643**	**894,991**	**+1.6**	**50**
Huesca...........	5,878	257,839	252,239	— 2.2	44
Saragossa	6,607	384,176	400,587	+ 4.2	60
Teruel............	5,494	238,628	242,165	+ 1.5	44
NAVARRA..........	**4,046**	**297,422**	**304,184**	**+2.3**	**75**
Navarra	4,046	297,422	304,184	+ 2.3	75
BASQUE PROV'S..	**2,782**	**413,470**	**450,699**	**+8.9**	**162**
Vizcaya (Bis'y)	849	160,579	189,954	+18.3	224
Guipuzcoa.....	728	156,493	167,207	+ 6.8	229
Alava	1,205	96,398	93,538	— 3.1	78
Balearic Islands	**1,860**	**262,893**	**289,035**	**+9.9**	**155**
Canary Islands	**2,944**	**234,046**	**280,974**	**+19.9**	**95**
Total........	**196,171**	**15,464,340**	**16,631,869**	**+7.5**	**85**
Presidios of N. Africa (exc. of Ceuta)...			**2,476**	...	—
			16,634,345	...	...

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[1] [Of which all but Asturias, Leon and Murcia are under Captains-general.—AM. ED.]

[2] Garrido, *La España Contemporanea*, i. 489.

there are neither manufactures nor minerals to speak of, but where tillage occupies a relatively larger area than anywhere else in Spain. Of the modern provinces the most thinly peopled are Cuenca and Ciudad Real, in the barren region of the east and south of New Castile, and Albacete in the Murcian steppe, in each case the density being less than half of that of the most thinly peopled English county. The column indicating the increase (or decrease) per cent. of the population between 1857 and 1877 shows that, outside of the province in which the capital is situated, the increase points chiefly to the recent development of manufactures and mining—to the development of copper mines in Huelva, lead mines in Jaen, iron mines in Vizcaya, cotton manufactures in Barcelona. In Murcia it points no doubt to the great development of the trade in esparto as well as in southern fruits. On the other hand the decrease in Lerida and Gerona indicates how the attraction of higher wages in the manufacturing districts of Catalonia tends to deplete the neighboring country districts.

As regards the distribution of population between town and country, Spain contrasts in a marked manner with Italy, Spain having but few large towns and a relatively large country population. In 1877 there were only five towns with more than 100,000 inhabitants: Madrid (397,816), Barcelona (248,943), Valencia (143,861), Seville (134,318), and Malaga (115,882). Only nine had a population between 50,000 and 100,000, and besides these only 171 had a population above 10,000.

The birth-rate in Spain is 33.9 per thousand as against 35.1 in England and Wales, the death-rate 29.1 (21.4 in England and Wales); the number of marriages per thousand inhabitants was 7.32[1] (8.08 in England and Wales). The percentage of illegitimacy is 5.6. The number of males born for every 100 females averages 107, a higher proportion than in any other country of Europe for which statistics are obtainable except Greece (112) and Roumania (111).

Foreign Possessions.—The population of the principal foreign possessions of Spain in 1877 numbered 7,822,123, made up as follows:

Foreign possessions.

Cuba	1,521,684	Philippine Islands	5,567,685
Porto Rico	731,648	Fernando Po	1,106

Besides the Philippine Islands in the Eastern Archipelago, Spain possesses the greater part of the Sulu Archipelago, and, in the Pacific, the Marianne, Pelew, and Caroline Islands. Off the Guinea coast she possesses the island of Annobon as well as that of Fernando Po, and on the coast itself the district round Corisco Bay. She has likewise declared a protectorate over the West African coast between Capes Bojador and Blanco (desert of Sahara). The presidios, whose population is given in Table II., are Peñon de Velez, Alhucemas, and Melila (besides Ceuta).

Agriculture.

Agriculture.—Agriculture is by far the most important Spanish industry, nearly 73 per cent. of those whose occupations were classified at the census of 1877 being entered under that head. In general it is in a backward condition, and is now much less productive than in the time of the Romans and again under the Moors. The expulsion of the latter people in many places inflicted upon agriculture a blow from which it has not recovered to this day. Aragon and Estremadura, the two most thinly peopled of all the old provinces, and the eastern half of Andalusia (above Seville), have all suffered particularly in this manner, later occupiers never having been able to rival the Moors in overcoming the sterility of nature, as in Aragon, or in taking advantage of its fertility, as in Andalusia and the Tierra de Barros. The implements in general use are of the rudest description. The plough is merely a pointed stick shod with iron, crossed by another stick which serves as a share, scratching the ground to the depth of a few inches. But the regular import now of agricultural implements (chiefly from England and France) betokens an improvement in this respect. In general there has been considerable improvement in the condition of agriculture since the introduction of railways, and in every province there is a royal commissioner intrusted with the duty of supervising and encouraging this branch of industry. Among other institutions for the promotion of agriculture, the royal central school at Aranjuez, to which is attached a model farm, is of special importance.

The provinces in which agriculture is most advanced are those of Valencia and Catalonia, in both of which the river valleys are thickly seamed with irrigation canals and the hill-slopes carefully terraced for cultivation. In neither province is the soil naturally fertile, and nothing but the untiring industry of the inhabitants, favored in the one case by the rivers which traverse the province from the tableland of New Castile and the numerous small streams (*nacimientos*) that issue from the base of the limestone mountains of which the province is largely composed, and in the other case by the numerous torrents from the Pyrenees, has converted them into two of the most productive regions in Spain. In the Basque Provinces and in Galicia the cultivable area is quite as fully utilized, but in these the difficulties that have to be contended with are not so great. The least productive tracts, apart from Aragon and Estremadura, are situated in the south and east of New Castile, in Murcia, and in Lower Andalusia—the marshes or *marismas* of the lower Guadalquivir and the *arenas gordas* between that river and the Rio Tinto. By far the greater part of the tableland, however, is anything but fertile, the principal exceptions being the Tierra de Campos, said to be the chief corn-growing district in Spain, occupying the greater part of Palencia in the northwest of Old Castile, and the Tierra de Barros, in the portion of Badajoz lying to the south of the Guadiana in Estremadura, another district noted for its corn.

Except in Leon and the provinces bordering on the Bay of Biscay and the Atlantic irrigation is almost everywhere necessary for cultivation, at least in the case of certain crops. Almost all kinds of vegetables and garden-fruits, oranges, rice, hemp, and other products are generally grown solely or mainly on irrigated land, whereas most kinds of grain, vines, and olives are cultivated chiefly on dry soil. The water used for irrigation is sometimes derived from springs and rivers in the mountain valleys, whence it is conveyed by long canals (*acequias*) along the mountain sides and sometimes by lofty aqueducts to the fields on which it is to be used. Sometimes the water of entire rivers or vast artificial reservoirs (*pántanos*) is used in feeding a dense network of canals distributed over plains many square miles in extent. Such plains in Valencia and Murcia are known by the Spanish name of *huertas* (gardens), in Andalusia by the Arabic name of *vegas*, which has the same meaning. Many of the old irrigation works,—such, for example, as those of the plain of Tarragona,—date from the time of the Romans, and many others from the Moorish period, while new ones are still being laid out at the present day. Where no running water is available for irrigation, water is often obtained from wells by means of waterwheels (*norias*) of simple construction. In most cases such wheels merely have earthenware pitchers attached to their circumference by means of wisps of esparto, and are turned by a horse harnessed to a long arm fitted to a revolving shaft. In recent years many artesian wells have been sunk for irrigation. According to Higgin (see Bibliography), the total area of irrigated land in Spain amounts to 4439 square miles. The effect of irrigation is shown by the fact that the irrigated portion of Murcia has a population of 1681 to the square mile as against 101 for the whole province, and Orihuela a population of 767 to the square mile as against 194 for the whole province of Alicante to which it belongs.

Cereals.

Cereals constitute the principal object of cultivation, and among these wheat ranks first, the next in importance being barley, the chief fodder of horses and mules. Both of these grains are cultivated in all parts—on the plains as well as among the mountains, but chiefly on the more level parts of the two Castiles and Leon, and on the plains of the basin of the Guadalquivir. Oats and rye are cultivated only in the higher parts of the mountains, the former as a substitute for barley in feeding horses and mules, the latter as a breadstuff. Maize also is cultivated in all the provinces; nevertheless the total extent of its cultivation is limited, since, being a summer crop, it requires irrigation except in the Atlantic provinces, and other products generally yield a more profitable return where irrigation is pursued. Rice is cultivated on a large scale only in Valencia. Among cereals of less importance are buckwheat (in the mountainous regions of the north), millets, including both the common millet (*Panicum miliaceum*) and the so-called Indian millet (*Sorghum vulgare*, the *joári* of India, the *durrah* of Africa), and even (in La Mancha) guinea-corn (*Penicillaria spicata*). As to the quantity of cereals produced in the country we are without official information, and the estimates of the average annual production of cereals of all kinds are very discrepant, varying from 250 to 430 million bushels. The average production of wheat alone has been estimated[2] at 177 million bushels, and the average produce of that crop per acre at 11.13 bushels (that of England being about 29 bushels). If these figures can be taken as approximately correct, it follows that the average acreage under wheat in Spain is nearly 16 million acres, or between five and six times the averag in Great Britain, which has less than half the area of Spain. The produce per acre just indicated places Spain among those countries of Europe in which the return is least, which is probably fully accounted for by the backward state of cultivation generally and in particular by the small expenditure on manure. As a rule, in fact, the straw left on the ground is the only manure which the land receives.

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[1] In all these cases the figures for Spain are the means of the years 1865-70 and 1880-83 inclusive.

[2] In an article by M. P. A. Delboy in the *Journal of the Statistica Society* for March, 1884, translated from the *Journal de la Société de Statistique de Paris*, September, 1883.

The cereal and especially the wheat production of the country regularly furnishes a considerable export. During the five years 1879–83 the value of the export of cereals and pod-fruits of all kinds was nearly 3 per cent. of the total value of the exports; but this export is balanced by a large import, especially of wheat flour. In bad years, indeed, the value of the import under this head greatly exceeds that of the export.

In the production of pod-fruits and kitchen vegetables Spain is ahead of all other countries in Europe. The chick pea forms part of the daily food of all classes of the inhabitants; and among other pod-fruits largely cultivated are various kinds of beans and pease, lentils (*Ervum lens*), Spanish lentils (*Lathyrus sativus*) and other species of *Lathyrus*, lupines, etc. The principal fodder-crops are lucerne (*Medicago sativa*) and esparcette (a variety of sainfoin). Clover, particularly crimson clover (*Trifolium incarnatum*), is grown in the northern provinces. Among vegetables garlic and onions take the chief place, and form an indispensable part of the diet of all Spaniards; besides these, tomatoes and Spanish pepper are the principal garden crops. It is upon such crops that the Spanish peasant in general bestows his chief care.

Wine.

As regards the quantity of the product wine comes next after cereals among the objects of cultivation in Spain. Here again we are dependent only upon vague estimates of the average amount produced, but usually the average annual Spanish production of wine is estimated at between 440 and 500 million gallons, an estimate which places Spain third (next after France and Italy) among the wine-producing countries of Europe. So far as quantity is concerned the principal wine-producing districts are in the northeast, but the only wines of Spain which have a world-wide reputation are those of the south, and more particularly those which take the name of "sherry," from the town of Jerez, in the neighborhood of which they are grown. The total area under the vine is estimated at about 3,480,000 acres (or about 2.8 per cent. of the entire surface), and of this total about 772,700 acres belong to the Catalonian provinces, chiefly Barcelona. The provinces which produce most wine are Barcelona, Saragossa, Cadiz, and Malaga, the annual amount of the production being in the order in which the provinces are mentioned.

The official tables distinguish the wines exported from Spain as common wines, sherry and similar wines, and other full-bodied wines (*vino generoso*). The returns of recent years, as will be seen from Table III. given below, show that of late an enormous increase has taken place in this export both as regards quantity and value, this increase being chiefly due to the extension of the export of the commoner wines to France by way of Barcelona:

	Av. of Five Yrs. 1874-78.		Av. of Five Yrs. 1879-88.		1884.	
	Thousands of Gallons exported.	Value in thousands of Pounds.	Thousands of Gallons exported.	Value in thousands of Pounds.	Thousands of Gallons exported.	Value in thousands of Pounds.
Common wine.........	40,524	2,547	133,562	7,748	135,432	8,865
Sherry and similar wines.................	6,446	2,466	5,874	2,137	5,368	1,465
Other full-bodied wines.................	2,244	470	3,388	879	2,420	493
Total......	49,214	5,488	142,824	10,764	143,220	10,823

There is also a large export of grapes and raisins, especially from the southern provinces (Malaga and Almeria). The average quantity of the two together exported in each of the five years 1879–83 was about 50 millions of kilogrammes (110 million lb), the average value about £1,560,000 [$7,581,600]. The vines whose fruit is intended for table use as grapes or raisins are trained on espaliers or on trees, especially the nettle-tree (*Celtis australis*).

Fruits.

Among fruit-trees the first place belongs to the olive, which is estimated to cover about 3 per cent. of the surface, and accordingly about an equal area to that occupied by the vine. Its range in Spain embraces the whole of the southern half of the tableland, the greater part of the Ebro valley, and a small strip on the west coast of Galicia. Along the base of the Sierra Morena from Andujar to the vicinity of Cordova there run regular forests of olives, embracing hundreds of square miles. The annual production of oil is estimated at 55 millions of gallons, and might be greatly increased in quantity and improved in quality if more attention were bestowed upon the cultivation of the trees and the preparation of the oil. Oranges, excluded from the plateau by the severity of the winter cold, are grown in great quantity on the plains of Andalusia and all round the Mediterranean coast; and figs, almonds, pomegranates, carobs, and other southern fruits are also grown abundantly in all the warmer parts, the first two even in central Spain and the more sheltered parts of the northern maritime provinces. In these last, however, the prevailing fruit-trees are those of central Europe, and above all the apple, which is very extensively cultivated in Asturias, the Basque Provinces, and Navarre. The date-palm is very general in the southeastern half of the kingdom, but is cultivated for its fruit only in the province of Alicante, in which lies the celebrated date-grove of Elche. In the southern provinces flourish also various subtropical exotics, such as the banana, the West Indian cherimoya, and the prickly pear or Indian fig (*Opuntia vulgaris*), the last frequently grown as a hedge-plant, as in other Mediterranean countries, and extending even to the southern part of the tableland. It is specially abundant on the Balearic Islands. The agave or American aloe is cultivated in a similar manner throughout Andalusia. Cotton is now cultivated only here and there in the south; but, on the other hand, sugar-cane, the cultivation of which was introduced by the Arabs in the 12th century or later, and was of great importance in the kingdom of Granada at the time of the expulsion of the Moors at the close of the 15th century, but has since undergone great vicissitudes, first in consequence of the introduction of the cane into America, and afterwards because of the great development of beet-sugar in central Europe, is now becoming every year more and more of a staple in the provinces of Granada, Malaga, and Almeria. The annual production on the Spanish mainland is estimated at about 75,000,000 lb. Such prosperity as this branch of agriculture at present enjoys is largely due to the protection which it receives at the hands of the Spanish Government. A duty imposed on all imported sugars in 1876, while inflicting a severe blow on the Spanish colony of Cuba, has had the desired effect of stimulating the native production, but according to the law at present in force (passed on June 30, 1882) the amount of this duty, as far as regards the produce of the Spanish colonies, is being gradually reduced, and the duty will be entirely abolished on July 1, 1892. Sugar.

Among the vegetable products not yet mentioned the most important are the mulberry, grown in almost all provinces, but principally in those bordering on the Mediterranean, and above all in Valencia, the chief seat of the Spanish silk production and manufacture; hemp and flax, grown chiefly in Galicia and other northern provinces; among dye-plants, madder, saffron, woad (*Isatis tinctoria*), and wild woad or dyer's weed (*Reseda luteola*); ground-nuts (*Arachis hypogæa*), grown for their oil, for the preparation of which the nuts are exported in considerable quantity to France; liquorice, cummin, colocynth, etc.

Live stock.

The rearing of animals has likewise been receiving in recent years increased attention at the hands of both Government and people, though here also we are without recent official statistics to show the consequent advance. The middle of the present century appears to have been the time when this industry was at its lowest point, and the following table (IV.) shows the increase in numbers that has taken place at certain subsequent dates for which official returns or estimates are obtainable:

	1858.	Enumeration Sept. 24, 1865.	Estimate 1878.
Horses	298,722	672,559	700,000
Mules............	499,172	1,001,878	1,200,000
Asses.	496,516	1,290,814	1,300,000
Cattle	1,557,033	2,904,598	3,000,000
Sheep...........	16,443,950	22,054,967	23,000,000
Goats...........	3,034,701	4,429,576	4,500,000
Swine	1,272,978	4,264,817	4,500,000
Camels	...	3,104	...

In 1865 horses were reared chiefly in the provinces of Seville, Coruña, and Cadiz, mules in Toledo, Cuenca, Teruel, Saragossa, and Badajoz, asses in Badajoz, Toledo, Murcia, Seville, and Granada, cattle in Oviedo, Coruña, Leon, and

Pontevedra, sheep in Badajoz, Leon, Teruel, Soria, and Saragossa, goats in Caceres and Badajoz, camels mainly on the Canary Islands, the total number on the Spanish mainland at the date of the enumeration being less than a hundred. Badajoz was the richest of the provinces in live-stock of all kinds, containing about one-fourteenth of the total number of domestic animals in the kingdom.

The only animals belonging to Spain still noted for their excellence are mules and asses, which are recognized as the best to be found anywhere. The quality of the horses has been greatly improved, however, since the establishment of Government studs more than forty years ago. Besides the cattle reared throughout the kingdom for field-labor and (in the northern provinces) for regular dairy farming, bulls for the great national pastime of bull-fighting are specially reared in many parts of the country, particularly in the forests of Navarre, the mountains separating the two Castiles, the Sierra Morena, and the Serrania de Ronda in Granada, and also in separate enclosures on the islands of the Guadalquivir. Spanish sheep, which in former times enjoyed so high a reputation and formed so important a part of the national wealth, are far from having the same relative importance at the present day, though sheep-rearing also is sharing in the general rise of agricultural and other industries. The most famous breeds of Spanish sheep are the merinos or migrating sheep, which once brought immense revenues to the state as well as to the large proprietors to whom they mostly belonged. These sheep, which are distinguished by their long slim legs and still more by their long wool, are pastured in different districts in summer and winter. Their winter quarters are in the lower parts of Leon and Estremadura, La Mancha, and the lowlands of Andalusia, their summer quarters the more mountainous districts to the east and north (Plasencia in the province of Caceres, Avila, Segovia, Cuenca, Valencia), which are not so much affected by the summer droughts of the Peninsula. The mode of the migration and the routes to be followed are prescribed by law. Each herd consists of about 10,000 individuals, under the command of a *mayoral*, and is divided into sections containing about 1000 each, each section under the charge of an overseer (*capatas*), who is assisted by a number of shepherds (*pastores*) attended by dogs. The shepherds, rudely clad in a sleeveless sheepskin jacket, the wool outside, and leather breeches, and loosely wrapped in a woollen mantle or blanket, are one of the most striking and characteristic objects in a Spanish landscape, especially on the tableland. The migration to the summer quarters takes place at the beginning of April, the return at the end of September. At one time the owners of merino herds enjoyed the right of pasturing their herds during their migrations on a strip of ground about 100 yards in breadth bordering the routes along which the migration took place, a strip which had accordingly to be left uncultivated; but this right (the *mesta*, as it was called) was abolished in 1836 as prejudicial to cultivation. Since that date the migrating sheep have been compelled to keep the roads. The average quantity of wool exported in the five years 1879–83 was about 9,000,000 ℔. Even in the best of the years (1883–84) the total export of Spanish wool to all countries was only about one-thirtieth of the total average import of that commodity into the United Kingdom during the corresponding period.

Bees are reared chiefly on the cistus heaths and the districts abounding in *tomillares* (see p. 311). The rearing of the silkworm on the mulberry trees of the Mediterranean provinces has already been referred to; the total annual production of raw silk in Valencia is estimated at 1,500,000 ℔, in Murcia at 500,000 ℔, and in Catalonia at 200,000 ℔. The rearing of the cochineal-insect, which was introduced into southern Spain in 1820, is being carried on with more and more success, especially round Malaga, Velez-Malaga, and Motril.

Fisheries.

Fisheries.—The catching of tunnies, sardines, anchovies, and salmon on the coasts employs large numbers of fishermen, and the salting, smoking, and packing of the first three give employment to many others. Spanish fishermen likewise dive for coral on the coasts of Andalusia and the north of Africa. The fishermen of Catalonia and Valencia have the greatest reputation for their skill. The centre of the principal tunny fisheries of Spain is a small rocky islet called Cristina about three leagues from the mouth of the Guadiana. The fishing lasts from May to August, that of sardines from August to the end of January. The average value of the export of fish in 1879–83 was nearly £120,000 [$583,200].

Minerals.

Minerals.—The mineral resources of Spain are vast and varied, but are as yet far from being adequately turned to account. No European country produces so great a variety of minerals in large amount, and in the production of copper ore, lead ore, and quicksilver Spain heads the list. In the production of salt and silver it is excelled only by Austria-Hungary, and, as regards silver, not always even by it. The following table (V.) gives particulars regarding the production of some of the principal minerals in the years named:

	1863.	1883.					
	Thousands of Metric Tons[1] produced.	Thousands of Metric Tons produced.	Value in thous. of Pounds at the Mine.	Persons empl'd. Men.	Women.	Children.	Number of productive Mines.
Iron ore	223	4,526	506.1	12,157	472	2,550	766
Lead ore	270	280	1,405.2	14,874	110	2,538	871
Argentiferous lead ore	40	25	157.5	3,578	72	192	92
Silver ore	...	23	88.3	539	2	14	16
Copper ore	246	2,455	1,094.5	9,716	684	1,265	38
Mercury	169	23	209.1	2,991	1	309	12
Zinc	481	54	56.4	1,572	111	297	97
Common salt	...	20[2]	17.4	371	94	108	53
Coal	...	1,044	463.6	7,235	680	1,365	465

Of the minerals mentioned in the preceding table it will be seen that iron and copper ores are those which show the greatest advance as compared with 1863. The production of these two ores advanced with rapid strides during the ten years 1874–1883. In the former year the production of both stood at about 500,000 tons. The iron ore is chiefly obtained in Vizcaya and Murcia, the former yielding by far the greatest quantity (in 1883 four-fifths of the total production of Spain), but the latter yielding the best quality (average value of Murcian iron in 1883, 5 pesetas = 4s. [97 cts.], per ton at the mine, as against 2.25 pesetas, or 1s. 9½d. [43 cts.], the average for the Vizcayan ore). All except a small fraction of the copper ore is obtained from the province of Huelva, in which lie the well-known mines of Rio Tinto. The lead ore is obtained chiefly in Murcia and Jaen. The famous mines of Linares belong to the latter province. Argentiferous lead is chiefly produced in Almeria, which also produces most of the silver ore of other kinds except argentiferous copper ore, which is entirely obtained from Ciudad Real. The still more celebrated cinnabar (mercury) mines of Almaden, the richest in the world till the discovery of the Californian mines of New Almaden, belong to Ciudad Real, and this province, together with that of Oviedo, furnishes the whole of the Spanish production of this mineral. Spanish salt is partly marine, partly derived from brine-springs, and partly from rock-salt, of which last there is an entire mountain at Cardona in Barcelona. Coal is chiefly obtained in Oviedo, Palencia, and Cordova. The production is quite insignificant compared with the extent of the coal-bearing beds, which are estimated to cover an area of about 3500 square miles, of which nearly a third belongs to Oviedo, between one-eighth and one-seventh to Burgos and Soria, and about one-tenth to Teruel and Cordova. Among the less important Spanish minerals are manganese (chiefly in Ciudad Real), antimony, gold, cobalt, sodic sulphate, sulphate of barium (barytes), phosphorite (a valuable manure, a variety of apatite found in Caceres), alum, sulphur, kaolin, lignite, asphalt, besides a variety of building and ornamental stones.

The total number of mines (including springs for the production of mineral waters) in operation in Spain in 1883 was 2620, and the total number of laborers employed in them in that year was 57,626. The working of the mines is carried on under state supervision. For this purpose the whole kingdom, including the Balearic and Canary Islands, is divided into three sections, and each of these into four districts. Each section is under the charge of an inspector-general of the first class, and each of the districts under an inspector of the second class. By the law of July 6, 1859, a large number of important mines, including all the salt-works and rock-salt mines, were reserved as state property, but financial necessities have compelled the Government to surrender one mine after another, so that at present the state possesses only the cinnabar mines and some salt-works. Many of the mines have been granted to foreign (principally English) companies.

Of the metallic ores produced in Spain, those of lead and mercury are the only ones which are chiefly reduced in the country. Though the working of iron is an industry of old standing in Spain, and a primitive kind of forge takes its name from Catalonia (see IRON), the total production of iron, refined and unrefined, in Spain in 1883 was only 200-000 tons, and by far the greater part of the Spanish ore is exported, as will be seen by comparing Tables V. and VI. The production of iron in Spain is, however, rapidly and steadily increasing, the total amount in the first year of the decade ending in 1883 having been less than 60,000 tons. During the same decade the amount of copper produced in the kingdom increased from about 5000 to 32,000 tons. The amount of steel produced in the kingdom is quite insignificant (little more than 400 tons in 1883). The following table (VI.) gives particulars regarding the export of the chief mineral products of Spain in 1883:

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[1] A metric ton = 1000 kilogrammes = 2205 lbs., or 35 lbs. less than a ton avoirdupois.

[2] Exclusive of 100,000 tons produced in the state salt works of Torrevieja (Alicante).

Minerals.	To United Kingdom	To France.	Total expt. to all Countries.
	Met. Tons	Met. Tons	Metric Tons.
Iron ore	2,895,000	511,000	4,226,000[1]
Argentiferous galena	2,400	2,000	13,000
Lead ore	...	1,400	2,500
Copper ore	555,000	...	565,000
Zinc ores—			
Calamine	...	20,000	30,000[2]
Blende	...	...	15,000[2]
Antimony ore	70	...	70
Manganese	8,300	...	4,500
Phosphorite	1,000	...	56,000[3]
Iron	...	13,000	30,000
Argentiferous lead	31,000	20,000	51,000
Non-argen. lead (unwrought)	51,000	25,000	77,000
	Oz.	Oz.	Oz.
Gold	243	522	765
Silver	190.595	549,090	739,686
	Lbs.	Lbs.	Lbs.
Mercury	910,037	23,924	1,139,932[4]
Wrought-iron and steel	7,440	68,708	186,510
Lead in tubes and other forms	...	...	546,425[5]
Copper, brass, and bronze in plates, tubes, and other forms	171,403	187,844	385,551

Manufactures.

Manufactures.—At the census of 1877 only about 3 per cent. of the classified population was returned as engaged in manufacturing industries. The principal manufacture is that of cotton, and the following table, which shows the position of Spain relatively to the other countries of Europe with reference to this branch of manufacturing industry, will also serve to some extent as an index of the rank belonging to Spain in mechanical industries generally:

TABLE VII.—*Average Import of Raw Cotton for Home Consumption in the Principal Countries of Europe during* 1879–1883.

	Millions of lb.		Millions of lb.
United Kingdom.	1460.8	Spain	100.3
Germany	336.9	Holland	94.8
France	309.6	Belgium	54.7
Russia	242.6	Switzerland	53.8
Austria-Hungary	176.6	Sweden	21.6
Italy	116.0		

The average import per head of population during the same period was as follows: United Kingdom, 41.7 lb; Holland, 23.6; Switzerland, 18.7; Belgium, 9.9; France, 8.2; Germany, 8.2; Spain, 6.0; Austria-Hungary, 4.6; Sweden, 4.6; Italy, 4.0; Russia, 2.9. It thus appears that Spain occupies the seventh place in the consumption of raw cotton, both in absolute amount and relatively to population. In the five years 1874–78 the average import of raw cotton into Spain was 79,690,000 lb, so that the increase of the average in the succeeding period of five years amounted to 25.8 per cent. Nevertheless the products of this branch of industry in the country do not yet suffice to meet the wants of the population. There is every year a considerable import of cotton manufactures, while the export of this commodity is too trifling to be included in the list of chief exports. The maritime provinces, being those most favorably situated for the import of coal, and, where necessary, of raw material, are the chief seats of Spanish manufactures, and the cotton industry is principally centred in Catalonia and, above all, in Barcelona and the surrounding district. This region is indeed the only distinctively manufacturing portion of Spain, and in it also the manufactures of linen and woollen goods and of lace are mainly carried on. Flax-spinning and the manufacture of linen goods are pursued to a considerable extent in Galicia and Asturias. The silk industry, which is likewise of high importance, but inadequate to meet the home demand for silk fabrics, is chiefly centred in Valencia, next to which come Murcia and Seville. Metal industries are chiefly carried on in the Basque Provinces, where various articles in iron and copper are made. A royal factory for the making of artillery and other weapons of war exists at La Trubia, in Asturias. Toledo is still noted, as it has been from the earliest times, for the excellence of its sword-blades. The manufacture of leather, another Spanish industry of old renown, is still extensively carried on in Catalonia and elsewhere, but the making of *cordwain* has long ceased to be a specialty of Cordova, from which it takes its name. Boots and shoes and other articles in leather form the only considerable export of manufactured goods. Gloves are made in great quantity in Madrid, shoes in the Balearic Islands. The paper industry is very flourishing, especially in Catalonia and Valencia. Esparto is twisted into cords and ropes, and plaited into a variety of other articles, in Murcia and Alicante and elsewhere. The refining of cane-sugar is largely carried on in Barcelona, Malaga, Almeria, and Granada, and the making of olive oil and brandy is general. So also is the making of charcoal, which in most parts of Spain takes the place of coal for all ordinary heating purposes, and even in some cases in mechanical industries. The large furnaces for the distillation of mercury at Almaden were at one time, if they are not still, heated solely with charcoal obtained from the *Cistus ladaniferus*. Among manufacturing industries of less importance are the making of porcelain (at the royal factory of Moncloa, near Madrid), glass and earthenware, soap, chocolate, and cork-stoppers. The manufacture of tobacco, which is a royal monopoly, is carried on at seven factories—at Seville, Madrid, Santander, Gijon, Coruña, Valencia, and Alicante,—that of Seville being the largest.

Foreign Commerce.—Possessing such varied resources as it does, and being peculiarly favorably situated for commerce, Spain might be expected to take a leading place among the trading communities of Europe. This it did at one time hold, when the treasure acquired by the discovery of America and the conquest of Mexico and Peru was squandered in the purchase of various commodities from England, the Netherlands, and other countries. This period of outward prosperity, however, was also that in which the seeds of decline were planted. The expulsion of the Moors from Granada was contemporaneous with the discovery of the New World. Hundreds of thousands of Moors were driven out from the country on subsequent occasions, and in the act Spain lost the best of her agriculturists and handicraftsmen. For the stay-at-home industry by which the resources of the land could be developed as they had been by the Moors the Spaniards of that day had no taste. Excited by the hope of rapidly-acquired wealth and the love of adventure, the more enterprising spirits embarked upon a career of discovery, and agriculture and manufacturing industry fell into contempt. The mercantile supremacy of the country was thus short-lived. Political causes supervened to hasten the country's decline, and it is only within recent times, since the introduction of railways, that the commerce of the country has begun to revive. The average value of the imports and exports combined during the period of ten years from 1875 to 1884 was equal to rather less than £2 [$9.72] per head,[6] as against about £18 [$87.48] per head during the same period in the United Kingdom; but even this state of matters shows a considerable advance compared with 1859, when the total value of the exports and imports was equal to only about £1, 12s. [$7.78] per head. The following table (VIII.) gives total value in round numbers of imports and exports, with percentages from and to Great Britain and France, at various dates from 1849 (the year after the opening of the first railway in Spain) to 1884:

Years.	Value of Imports.	P. c. from Britain	P. c. from France.	Value of Exports.	P. c. to Britain	P. c. to France.
1849	£6,360,000	...	...	£5,240,000	...	...
1860	14,833,000	25	25	10,982,000	29	22
1865	16,262,000	26	34	12,864,000	29	27
1870	20,877,000	24	39	15,982,000	39	16
1875	22,812,000	84	26	18,081,000	34	16
1880	28,482,000	18	88	25,999,000	32	35
1881	26,023,000	21	32	26,836,000	33	38
1882	82,667,000	21	27	30,615,000	31	41
1883	35,738,000	21	26	28,779,000	28	42
1884	31,186,000	21	25	24,768,000	27	43

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[1] Of this total 478,000 tons were exported to Holland, 142,000 to Belgium, and 199,000 to the United States.

[2] All the blende and one-third of the calamine were exported to Belgium.

[3] Chiefly to Portugal.

[4] Of this total 158,760 lbs. were exported to Belgium.

[5] Chiefly to Cuba.

[6] An increase of the population since 1877 at the rate of .35 per cent. per annum allowed for in making the calculation.

On the average of the five years 1879–83 the principal exports, in the order of their importance, were wine, metals and mineral ores, fruit, oil, and cork,—wine being by far the most valuable; the principal imports, in the order of their importance, raw cotton, brandy and spirits, sugar, machinery, tobacco, coal and coke, timber, cod-fish, iron (wrought and unwrought), hides and skins, chemical products, cocoa, cotton manufactures, and mineral oils. The large imports of cod-fish (from Norway and British North America) are due to the large consumption of fish, especially during Lent; the great demand for mineral oil as a source of light is a consequence of the dearness of coal. It is interesting to note the high place which cocoa takes among the imports. The average import of that commodity is nearly double that of coffee, and that of tea is quite insignificant (in 1884 only 155,777 lbs.).

The foreign commerce of Spain is chiefly carried on with the United Kingdom, France, Cuba, and the United States. In the ten years 1873–82 France, the United Kingdom, and the United States together (in the order named) furnished on an average rather more than 67 per cent. of the imports, and the United Kingdom, France, and Cuba (also in the order named) received on an average during the same period 75 per cent. of the exports. Next to the three countries mentioned, those which had the largest share in the import trade during the same period were Cuba, Portugal, and the Argentine Confederation, and in the export trade Portugal, the United States, and the Argentine Confederation. From the United Kingdom Spain received in 1884 chiefly coal and coke, iron and articles in iron (articles in wrought-iron and steel, however, in rather greater amount from Belgium), locomotives (also from Belgium), jute and jute yarn, hemp and flax yarn, sulphur (for use in the vineyards), and alkaline carbonates; from France, chiefly wool and woollen goods, silk and silk goods, and wheat flour; from the United States, petroleum, raw cotton, and tobacco (also from the Philippine Islands); from Cuba chiefly sugar and fine woods; from the Argentine Confederation chiefly untanned hides and skins and animal fats. Wheat was received chiefly from Russia, and spirits from Germany, which also supplied a large proportion of the sugar consumed in the country.

Of the principal export of Spain—wine—by far the greater proportion goes to France. In 1884 that country received four-fifths of the common wine, and the quantity is rapidly increasing. The wine classed as full-bodied also went chiefly to France, but that entered under the head of sherry and similar wines was imported chiefly by the United Kingdom. The destination of the minerals is shown above (Table VI.). Oranges were sent mainly to the United Kingdom, France, the United States, and Germany; raisins chiefly to the United States and the United Kingdom; olive oil chiefly to Cuba, Denmark, and France, but in considerable quantity also to other countries; esparto grass almost entirely to England; cork and wool chiefly to Portugal and France; cattle chiefly to Portugal and England; raw silk mainly to France; and wheat flour and chickpeas chiefly to the Spanish West Indies.

The foreign trade of the country is of course carried on mainly by sea. In 1884 more than 80 per cent. both of the imports and exports were transmarine, and of the land commerce by far the largest proportion is with or through France. The smallness of the trade with Portugal, which on an average furnished less than 1½ per cent. of the imports and received less than 5½ per cent. of the exports during 1873–82, is partly due no doubt to the similarity of the chief products of the two countries, but also to the defectiveness of the communications between the two countries, a circumstance largely accounted for by the physical conditions already alluded to. The introduction of railways has as yet only partially served to bring the countries into more intimate relations. On the first of January, 1885, not a single line connected with the general system of Spanish railways entered Portugal north of the Tagus, though Lisbon was connected by rail both with Madrid by way of Caceres and with Valencia by way of Ciudad Real and Albacete. At the date mentioned, however, a railway intended to connect Salamanca with the mouth of the Mondego was in course of construction, and a branch from the Portuguese coast-line in the north was in process of being connected with the Spanish railway to Coruña, and by way of Leon with other northern seaports.

The foreign commerce of Spain is greatly hampered by the number and amount of the custom duties, which are imposed on all the principal articles both of export and import. On imports the duties vary from 6 to 28.33 per cent. of the value of the commodities, the highest duties being upon cotton yarn, sugar, and cocoa (to protect home or colonial industries). For protective reasons high import duties are levied also on iron manufactures, woollen manufactures, live animals, coffee, and wine. Export duties are levied mostly in proportion to quantity. In the case of sherry it amounts to 200 pesetas (£8 [$38.88]) per hectolitre (22 gallons); full-bodied wines pay 112 pesetas [$21.77] per hectolitre, and ordinary wines 33 pesetas [$6.42] per hectolitre. In the case of "the most favored" nations slight reductions are made in the amount of the duties, and under a treaty which came into operation on the 15th of August, 1886, Great Britain enjoys the benefit of the most favored nation treatment in consideration of a reduction in the import duties levied at British ports on Spanish wines.

Shipping.

Shipping and Navigation.—Relatively to the extent of its coast-line and the number and excellence of its seaports (of which there are sixty on the Mediterranean coast, fifty-six on the Atlantic), the amount of shipping belonging to Spain is small. In 1884 the total register tonnage was 524,000 tons, not much more than that of Sweden at the same date, and only about half that of Italy. The number of vessels was 1803, including 301 steamers. Nearly half the transmarine imports (reckoned by value) and 58 per cent. of the transmarine exports were carried under a foreign flag. The following table (IX.) gives further particulars as to the shipping of 1884:

Flag.	Metric Tons (in Thousands) of Cargo.		Percentage of Total.	
	Discharged	Loaded.	Imports.	Exports.
National	623	766	22.6	13.0
British	1394	3866	50.5	65.7
Dutch	11	54	0.3	0.9
French	174	666	6.3	11.3
German	76	123	2.7	2.1
Greek	41	2	1.5	...
Italian	131	165	4.7	2.8
Norwegian	121	67	4.3	1.1
Russian	60	27	2.1	0.4
Swedish	57	39	2.1	0.7
Total (under all flags)	2760	5880		

The following table (X.), gives the number, etc., of ships entered and cleared with cargo at Spanish ports in 1884:

Entered from	Under Spanish Flag.			Under Foreign Flags.		
	No. of Vessels.	Capacity in Tons.	Met. Tons Discharged.	No. of Vessels.	Capacity in Tons.	Met. Tons Discharged.
Algeria	658	74,122	17,883	140	69,360	4,987
Belgium	...	...	...	288	191,122	54,587
Cuba	186	199,744	37,522	11	29,121	498
France	1,974	711,241	140,055	1,058	452,970	169,631
Norway	17	3,551	2,685	261	81,796	35,850
Philippine Islands	97	194,278	19,256	...	...	...
United Kingdom	1,120	712,363	240,365	1,721	960,135	1,256,285
Total from all countries	5,652	2,376,861	628,156	5,470	2,694,876	2,137,222

Cleared for	Under Spanish Flag.			Under Foreign Flags.		
	No. of Vessels.	Capacity in Tons.	Met. Tons Loaded.	No. of Vessels.	Capacity in Tons.	Met. Tons Loaded.
Algeria	536	76,585	13,476	36	49,128	621
Belgium	86	60,548	17,893	145	110,588	119,105
Cuba	439	612,258	97,553	7	14,854	171
France	2,347	1,126,607	226,713	1,858	936,247	695,408
Norway	...	...	...	73	28,524	24,167
Philippine Islands	94	243,245	8,849	...	...	...
United Kingdom	907	638,518	200,570	3,790	2,988,857	3,182,671
Total for all countries	5,266	3,500,207	766,308	7,844	5,638,259	5,114,082

The total number of vessels entered with cargo under the national and foreign flags in 1884 was thus 11,122, and the total quantity of cargo discharged by them at Spanish ports 2,760,378 metric tons, the total number of vessels cleared with cargo 13,110, and the total quantity of cargo taken on board by them at Spanish ports 5,880,385 metric tons. Of the total number of vessels entered with cargo 6768 were steamers, which discharged 2,052,937 tons of cargo, and 4354 were sailing vessels, which discharged 707,441 tons of cargo. Of the number of vessels cleared with cargo 9506 were steamers, which took on board at Spanish ports 5,300,366 metric tons of cargo, and 3604 were sailing vessels, which took on board 580,019 metric tons of cargo.

Roads.

Communication.—The communications in Spain have been greatly improved since the beginning of the present century. In 1808 there were little more than 500 miles of carriage roads, but now there are over 28,000. At the end of 1882 14,600 miles were state roads, all well built and well maintained, and 3027 miles of state roads were in course of construction. The aggregate length of the provincial roads then completed was 2714 miles, and that of the communal roads 10,760 miles. In the mountainous districts, where there are only narrow paths, frequently rather steep, it is still not uncommon to meet long trains of mules.

Railways.

Railways have made great advance since the middle of the century. The oldest line is that from Barcelona to Mataro, 17½ miles, which was opened on the 28th of October, 1848. Of late years railway construction has been going on pretty rapidly. In 1880 the number of miles open for traffic was 4645, and in the four succeeding years it was 4800, 4867, 5118, and 5386. All the Spanish railways belong to private companies, but most of them have obtained subventions from the Government, to which most of the Spanish railways will revert at the end of a term of ninety-nine years. In granting a concession for a new railway the regular practice is to give it to whatever company offers to construct it with the lowest subvention. The total amount of the subventions for railway construction up to the end of 1884 was £25,676,690 [$124,788,713.40]. For strategical reasons the Spanish gauge was made different from that of France.

Post-office. Telegraphs.

The postal and telegraphic systems have been placed on the same footing as in other civilized countries. The total number of letters, postal-cards, and samples (including official and international letters, etc.) that passed through the post-office in 1882–83 was 111 millions. The length of state telegraphic lines on January 1, 1883, was 10,664 miles, and of wires 25,989 miles. The number of messages in 1883 was 3,020,000, nearly 80,000 being transit messages and 654,000 from or to foreign countries.

Army.

Army and Navy.—Military (or naval) service is obligatory on all Spaniards, but in certain cases recruits are allowed to buy themselves off. According to the law of January 8, 1882, the period of service for all arms is twelve years, of which three years must be passed with the colors, three years in the active reserve, and six years in the second reserve. The minister of war is empowered, however, on financial grounds to transfer troops serving with the colors to the active reserve before the period of three years' service has been fulfilled. Liability to service begins with the first day of the calendar year in which the twentieth year is completed. Persons holding a civil appointment or pursuing any handicraft independently are allowed to buy themselves off for 1500 pesetas (£60) [$291.60], and brothers are allowed to take each others' place in service, or to exchange the numbers that have fallen to them by lot in the raising of the recruits for the year. For carrying out the law Spain is divided into fourteen military districts, the boundaries of which do not at all coincide with those of provinces.

The actual strength of the regular army is fixed at about 94,000 men for the kingdom (including the Balearic and Canary Islands), but this number may be brought up to 400,000 in time of war. The strength of the regular army in Cuba is about 22,500 men, in Porto Rico about 3200, and on the Philippine Islands about 8200. The active army is divided into 140 battalions, besides the same number of depôt and reserve battalions; 24 cavalry regiments, and the same number of depôt squadrons and reserve cavalry regiments; 9 regiments of field artillery, and 3 of mounted artillery, besides 6 reserve regiments of artillery, and 10 battalions of engineers. There are also 13 battalions of fortress artillery.

Navy.

The following statement shows the strength of the navy in 1885: *First Class*—4 ironclad frigates (55 guns), 4 screw frigates (97 guns), 6 cruisers (48 guns); *Second Class*—5 frigates (104 guns), 3 cruisers, 12 corvettes and troopships (39 guns); *Third Class*—1 ironclad monitor (3 guns), 1 floating battery, 79 gunboats, transports, etc. (124 guns).

There were at the same time building one ironclad of the first class, five cruisers of the second class, besides torpedo boats, tugs, and other vessels. For the defence of the colonies, and more particularly those of the West Indies, there are 35 screw gunboats, all of the same size (about 5 feet draught), and each carrying a 100-pounder pivot-gun at the bow.

The navy is manned by conscription in the maritime districts. In 1885 the number of seamen was about 14,000, that of marines about 7000.

Religion.

Religion.—Roman Catholicism is the established religion, and the church and clergy are maintained by the state. The immense majority of the people (in 1877 16,603,959 out of a total of 16,634,345) are professed adherents of this faith, so that, so far as numbers go, Spain is still the most "Catholic" country in the world, as it has long been styled. According to Willkomm, however, religious indifferentism is now very general, not only among the educated but also among the lower classes; and of the bigotry and fanaticism which in former times led to the destruction of hundreds of thousands of victims at the hands of the Inquisition the only traces at the present day are to be found, says the same authority, in the provinces of Aragon, Navarre, and Estremadura, where the clergy still exercise a considerable influence over the lower orders. By the constitution of 1876 non-Catholics are permitted to exercise their own forms of worship, but they must do so in private and without making any public announcement of their services. At the census of 1877 the total number of Protestants was 6654, a number below that of those entered as rationalists (9645). There are nine archbishoprics (Toledo, Madrid, Burgos, Granada, Santiago, Saragossa, Seville, Tarragona, Valencia, and Valladolid), and 45 bishoprics. The archbishop of Toledo is primate.

Education.

Education.—By the law of July 17, 1857, primary education was declared compulsory on all children of school age (originally fixed at six to nine), and made free to the poor, but the results of the census of 1877, though showing an advance in elementary education as compared with previous years, make it clear that this law is far from being efficiently carried out. At that date the total number who could both read and write was 4,071,823, equal to 24.48 per cent. of the population, as against 19.97 per cent. in 1860. The provinces in which the percentage of those able to read and write was greatest were Alava, Burgos, Pontevedra, Madrid, Santander; those in which it was least were the Canary Islands, Granada, Malaga, Almeria, Alicante, Castellon.

There are ten universities—those of Madrid (founded in 1836 to replace the long-celebrated university of Alcala), Barcelona, Granada, Salamanca, Seville, Valencia, Santiago, Saragossa, Valladolid, and Oviedo; that of Madrid is now the most celebrated and the best attended, while that of Salamanca, so renowned in the Middle Ages, is now in least repute.

Administration.

Political Administration.—Spain is an hereditary monarchy, the constitution of which rests on the fundamental law of June 30, 1876. The sovereign becomes of age on completing his or her sixteenth year. The sovereign is grand-master of the eight Spanish orders of knighthood, the principal of which is that of the Golden Fleece (Toison de Oro), founded in 1431 by Philip of Burgundy. The chain of this order surrounds the royal arms, in which are included, besides the arms of Castile, Leon, Granada, and the lilies of the royal house of Bourbon, the arms of Austria, Sicily, Savoy, Brabant, and others. The national colors are red and yellow. The flag is divided into three horizontal stripes—two red stripes, with a yellow one between bearing the royal arms.

The legislative authority is exercised by the sovereign in conjunction with the *cortes*, a body composed of two houses—a senate and a chamber of deputies. The senate is composed of members of three classes: (1) members by right of birth or office—princes, the wealthier nobles holding the rank of grandee (*grande*), a dignity conferred by the king either for life or as an hereditary honor, and the highest state officials; (2) members nominated by the king for life; and (3) members elected by the state corporations and by the most highly taxed subjects of the state for a period of five years. The members belonging to the first two classes must not exceed 180 in number, and there may be the same number of members of the third class. The chamber of deputies consists of members elected for five years, in the proportion of one deputy for every 50,000 of the population. The electors must be twenty-five years of age and must have paid land-tax of twenty-five pesetas (£1 [$4.86]) for one year, or an industrial tax of fifty pesetas [$9.72] for two years.

The executive administration is entrusted to a responsible ministry (*consejo de ministros*), in which the presidency belongs either to one of the ministers or to a president without portfolio. There are eight ministerial departments—the first secretaryship of state, to which belongs the management of foreign affairs, the secretaryships of grace and justice, finance, and the interior, the department for the promotion of material and intellectual interests (*secretaria de fomento*), and the secretaryships of war, marine, and the colonies.

The civil administration is under the secretary for the interior. In each province is a civil governor nominated by the crown, and the governor presides over a council, the members of which are elected by the representatives of each commune (*ayuntamiento*).

Justice.

Law and Justice.—Spanish law is founded on the Roman law, the Gothic common law, and the national code proclaimed at the meeting of the cortes at Toro in 1501 (the *leyes de Toro*). There is a court of first instance in each of the 501 *partidos judiciales* into which the kingdom[1] is divided; and a court of second instance in each of 15 *audiencias territoriales* into which the *partidos judiciales* are grouped; and there sits at Madrid a supreme court modelled on the French *cour de cassation*. The administration of justice is public. Except in commercial cases the parties to a suit must always be represented by sworn counsel (*abogados fiscales*).

Finance.

Finance.—The following statement (Table XI.) shows the equivalent in English money of the budget estimates for the years noted; it should be explained, however, that these estimates have only a limited value, inasmuch as the public accounts of Spain have not been audited since 1870, and have not been passed by the cortes since 1867:

Years.	Revenue.	Expenditure.	Years.	Revenue.	Expenditure.
1860-61	£15,928,440	£18,778,698	1881-82	£31,492,920	£32,584,598
1870-71	27,901,746	32,819,424	1882-83	31,289,769	31,573,083
1874-75	21,792,000	20,821,000	1883-84	32,095,075	32,058,999
1877-78	29,433,000	29,430,000	1884-85	31,444,682	31,008,969
1880-81	31,666,081	33,466,047	1885-86	34,900,575	35,885,869

The chief heads of revenue, according to the budget estimates of 1885–86, were—excise (including stamp duties and government monopolies), £10,534,480 [$51,197,572.80]; direct taxes on land, trade, mines, etc., £10,393,920 [$50,514,451.20]; taxes on Government salaries, registration, etc., £5,362,000 [$26,059,320]; customs, £5,360,000 [$26,049,600]. The chief items of expenditure were—the charges of the public debt, £10,966,937 [$53,299,313.82]; the charges of the ministry of war, £6,050,944 [$29,407,587.84]; those connected with the administration of state property, £5,748,593 [$27,938,161.98]; the charges belonging to the *ministerio de fomento*, £4,177,983 [$20,304,987.38]; those of grace and justice, £2,237,844 [$10,875,921.84]; those of marine, £1,756,022 [$8,534,266.92].

The expenses of quelling the insurrection in Cuba of 1868–78, and those subsequently arising out of a civil war in the Peninsula, raised the total amount of the Spanish debt on the 1st of January, 1881, to about £512,000,000 [$2,488,320,000]; but, as it was by that time manifest that Spain was unable to meet the obligations thus incurred, an arrangement was come to by which the capital and interest of the debt were reduced. The bulk of the debt now bears interest at the rate of 4 per cent., and on the 1st of October, 1884, the capital stood at 6356 million pesetas, or £254,250,000 [$1,235,655,000], and the total annual charge was 238 million pesetas, or £9,522,857 [$46,281,065.02]. The principal items are the perpetual foreign debt, amounting in October, 1884, to £78,840,000 [$383,162,400], a perpetual internal debt, amounting in October, 1884, to £77,840,000 [$378,302,400], and a redeemable debt (internal and external) amounting to £70,480,000 [$342,532,800].

Currency, Weights, and Measures.—The French monetary system and the metric system of weights and measures have been introduced—the latter in 1859, the former in 1871. In the case of the weights and measures the French names also have been adopted, with only the necessary linguistic changes. In the case of the currency the old Spanish name of *peseta* was retained for the unit (the franc), and the peseta is divided into 100 *centimos*. According to the present value of the peseta, therefore, 25 pesetas may be taken as about equal to £1 [$4.86]. Previously to the introduction of the French monetary system the peseta was the fifth part of a *peso duro*, which was equal to 20 *reales de vellon*, or rather more than a five-franc piece. The only paper money in Spain consists of the notes of the Banco de España.

Bibliography.—The most comprehensive work on the geography of Spain is the *Diccionario Geografico-historico e Statistico de las Provincias de España* of Madoz, 16 vols., 1846–50. A more summary account is contained in the *Reseñas Geografica, Geologica, y Agricola de España*, by D. Fr. Coello, etc., Madrid, 1859; and in *Die Pyrenäische Halbinsel*, by Dr. Moritz Willkomm, Leipsic, 3 vols., 1884–86. Numerous notices regarding the geography of Spain are to be found in the *Boletin de la Sociedad Geografica de Madrid*. See also F. Garrido, *La España Contemporanea*, Barcelona, 2 vols., 1865–67 (the French edition, Brussels, 1862, is comparatively meagre); Davillier, *L'Espagne*, Paris, 1873; A. J. C. Hare, *Wanderings in Spain;* A. Gallenga, *Iberian Reminiscences*, London, 1883; Webster, *Spain*, London, 1882; Harrison, *Spain*, Boston, 1882; Higgin, *Commercial and Industrial Spain*, London, 1886; together with the guidebooks of Ford (Murray) and O'Shea (Black).

The botany of Spain is very fully treated in various works by Willkomm. Besides the *Prodromus Floræ Hispanicæ*, Stuttgart, 3 vols. 4to, 1861–80, the most important are *Illustrationes Floræ Hispaniæ*, Stuttgart, 1881, etc., fol., and *Die Strand- und Steppengebiete der iber. Halbinsel*, Leipsic, 1852, 8vo. Of another flora by Don M. Colmeiro, entitled *Enumeracion de las Plantas de la Peninsula Hispano-Lusitana e Islas Baleares*, one volume has been published (Madrid, 1885). It is expected to be completed in 4 vols.

There is no recent general work on the zoology of Spain.

The geology of the Iberian Peninsula is treated in a series of articles, illustrated by several maps, by D. Federico de Botella, in the above-mentioned *Boletin*, vol. ii., 1877. See also Macpherson, *Succession Estratigrafica de los Terrenos Arcaicos de España;* W. K. Sullivan, *Notes on the Geology and Mineralogy of the Spanish Provinces of Santander and Madrid*. The geological maps of Spain already completed are those of De Verneuil and Collomb, Paris, 1864, 2d ed. (now out of print) 1868, and De Bottella y de Hornos, Madrid, 1879. A geological survey of the provinces of Spain is now in progress, and on the conclusion of the survey a map will be published in sixteen sheets on the scale of 1 : 400,000.

Among the more important annual or periodical official statistical publications are the *Estadistica General del Comercio Exterior de España; Boletin Mensual de Estadistica Demografico-Sanitaria; Situacion de los Ferrocarriles;* and *Estadistica Minera de España*.

The best topographical map of Spain is that of C. Vogel, in four sheets, in Stieler's *Hand Atlas*, on the scale of 1 : 1,500,000. Among other maps that may be referred to are that of D. Fr. Coello, scale 1 : 1,000,000, Madrid, 1861, and the *Mapa Itinerario Militar de España Formado por el Cuerpo de Estado Mayor del Ejercito en* 1865, scale 1 : 500,000. An excellent map on the scale of 1 : 50,000, indicating the elevations by means of contour lines at intervals of 20 metres, and by figures for particular spots (the elevations reduced to the mean level of the Mediterranean at the port of Alicante), and distinguishing cultivated and uncultivated ground, and in the former distinguishing huertas, gardens, oliveyards, vineyards, orangeries, etc., where they exceed an area of 10 hectares [25 acres] is now being published by the Instituto Geografico y Estadistico de Madrid. Of this map, however, only about 20 out of 1080 sheets have as yet been issued. Among those which have already appeared is that containing Madrid. (G. G. C.)

PART II.—HISTORY.

SECTION I.—ANCIENT HISTORY.

Plate VII.

Hispania was the name by which the Romans called the great peninsula made up of Spain and Portugal, but we know nothing certain as to the origin of the name, or whether it was in general use among the ancient inhabitants of the country.[1]

To the Greeks Spain, or rather its coast-line on the Mediterranean, was known vaguely as Iberia, a name we meet with Herodotus (i. 163) in connection with the Phœnician Tartessus, which is generally understood to have been the country about the mouth of the Guadalquivir and to be the Tarshish of Scripture. It was the Phocæans, a branch of the Ionian Greeks settled in Asia Minor, who according to Herodotus first opened up to the Greek world this remote region of the extreme West, which had hitherto been a land of mystery and enchantment, imagined to be the home of the setting sun, and known only by the reports of adventurous Phœnician mariners. The hero-god Hercules, it was fabled, had left traces of his presence and mighty working here, and the twin rocks at the entrance of the Mediterranean were called by his name, "the Pillars of Hercules,"—the "world's end" to the Greeks, nothing but the all-encircling ocean river lying beyond. The Greeks seem to have planted no colonies in Spain, with the exception of Emporium, on the coast just under the eastern spur of the Pyrenees, founded probably from Massillia (Marseilles) by the Phocæans, and perhaps of Saguntum. In fact they had but very hazy notions about the country, and Iberia, as they called it, was to them little more than a name for an indefinite extent of territory in the Far West, in the occupation of barbarous Celts and Iberians, with some Phœnician settlements for the purposes of trade on its southern coasts. Several of these places were just known to them by name; but even of Gades, rich and populous as it seems to have been in quite early days, nothing but vague hearsay had reached them, and Herodotus, who mentions it as Gadeira (iv. 8), merely defines its position as "on the ocean outside of (beyond) the Pillars of Hercules." Tarraco, one of the oldest and most important of the cities of Spain, and one of which we hear continually in the subsequent history of the country, was also in all probability a Phœnician colony. There are still here remains of very ancient walls, possibly Phœnician work. Gades, Tartessus, Tarraco, all seem to have been of Phœnician origin[1] and of unknown antiquity, and they were flourishing places in the 7th century B.C., when the Greeks first made a slight acquaintance with them,—an acquaintance, however, which they did not follow up. The result is that we really know nothing about Spain till the first war between Rome and Carthage (264–241 B.C.). There was, indeed, in the 4th century B.C., an embassy to Alexander the Great from the remote West, of Gauls and Iberians, and from that time learned Greeks began to discuss the geography of Spain. But again the country drops out of sight till the 3d century B.C., when we find a close connection established between it and Carthage, which, being itself a Phœnecian colony, would feel itself almost at home on the southern shores of Spain. According to Polybius, Carthage, (before the First Punic War) had acquired at least something like a protectorate over the Iberian tribes as far as the Pyrenees, the then recognized boundary between the Iberians and Celts,—between, in fact, Spain and Gaul. Spanish troops served as volunteers in Carthaginian armies. There must have been a good deal of Phœnician blood in the south of Spain for many centuries, and this no doubt prepared the way for Carthaginian ascendency in the country.

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[1] Humboldt derives it from the Basque *espana* (border), as signifying the part of Europe bordering on the ocean, but his conjecture seems strange and fanciful.

Carthaginian ascendency.

Not, however, till after the First Punic War and the loss of Sicily was there anything that could be called a Carthaginian empire in Spain. It was in 237 B.C. that Hamilcar Barca, the father of Hannibal, crossed the Straits of Gibraltar and set foot in Spain, not, however, with any commission from the home Government at Carthage, but with the deliberately formed design of making the country, with its warlike population and great mineral wealth, into a Carthaginian province, and ultimately into a basis of operations in a future war with Rome (see HAMILCAR, HASDRUBAL, HANNIBAL). There were rich mines in the mountains, which had drawn the Phœnicians some way into the interior, and among the native tribes there were the elements of a brave and hardy soldiery. A good army might very well be organized and paid out of the resources of Spain. All this Hamilcar clearly saw, and in the true spirit of a statesman he set himself to the work, not merely of subjugating the country, but of making the Spaniards into loyal subjects of Carthage. He encouraged marriages between his officers and soldiers and the native women: his own son Hannibal married a Spanish woman. He showed them how to work their gold and silver mines to the best advantage; in every way, in short, he made them feel that he was their friend. The great work of which he had laid the foundation was carried on after his death in 228 by his son-in-law Hasdrubal, under whom New Carthage, with its fine harbor, founded probably by Hamilcar, became the capital of the country. It would seem that by this time the Carthaginian empire in Spain was as firmly established over the southern half of the country as the fickle and uncertain temper of the native tribes would admit. The Spaniard of that day, as indeed more or less throughout his whole history, was particularly amenable to personal influence, and an Hamilcar or a Hannibal could sway him as he pleased. From 228 to 221 Hasdrubal was extending and strengthening the Carthaginian rule in Spain, while the Romans were fighting in Cisalpine Gaul. One precaution, indeed, they had taken, an understanding with Hasdrubal, which might be regarded as a treaty, that the Carthaginian conquests were not to be pushed east of the Ebro. West of that river there was one town, Saguntum, a Greek colony, in alliance with Rome; this Hasdrubal had spared. His successor, Hannibal, after two years' continuous fighting, which resulted in the submission of hitherto unconquered tribes and the undisputed supremacy of Carthage throughout almost all Spain, attacked and took the place in 218.

This was the beginning of the Second Punic War. Spain was now for the first time entered by Roman armies, under the command of the two Scipios,—the brothers Cneius and Publius. Six years of hard fighting ended in the defeat and death of these two brave men, but in 210 the son of Publius, the elder Africanus, struck a decisive blow at the Carthaginian power in Spain by the sudden capture of New Carthage. The war, however, still dragged on till 205, in which year it may be said that Spain, or at least that part of it which had been under Carthage, was fairly conquered by the arms of Rome.

Roman conquests.

Andalusia, Granada, Murcia, Valencia, Catalonia, Aragon, may be said to have become Roman territory. Rome had now to deal simply with the native Spaniards, without the fear of any foreign interference. Hence from 205 the reduction of the country into a Roman province was only a matter of time. It proved, however, to be a tedious and troublesome work, and more than once Rome's hold on Spain was seriously imperilled. An oppressive governor, or a governor without tact and sympathy, was sure to unsettle the restless and impressionable tribes, and to stir up all manner of dangerous jealousies and heart-burnings. The Scipios, the elder Africanus especially, knew how to manage the people, and yet even in 205, the year of those brilliant successes of Africanus, there was a great rising of several of the tribes, headed by a local chieftain, against the dominion of Rome. It was quelled after a sharp engagement; there was a general submission on the part of the Spaniards, and many of them became Roman tributaries. It was some time, however, before the country, or even the southern half of it, was really subdued into complete peace and order. The mountains and the forests were a formidable obstacle to the Roman legions, and favored that guerilla warfare which makes conquest slow and laborious. For a long period many of the tribes were rather the allies and dependents of Rome than her subjects, and might at any moment be roused into war. In fact Rome's dominion west of the Ebro—Further Spain (Hispania Ulterior), as the province was called—must for very many years have been little more than nominal. Rome's policy was to keep the native tribes disunited, and to have as many of them as possible under a friendly protectorate. There seem to have been wide differences between these tribes,—some, especially those in the interior and in the north, being fierce and utterly barbarous, and others in the south and southwest comparatively mild and civilized. The Celtiberi, in the interior, were a group of warlike tribes, and were always uncertain and intractable. At one time they would fight for Rome; at another they would serve as mercenaries for Rome's bitter foe, the Carthaginian. Continually were they breaking out into revolt and defying the arms of Rome. The "Celtiberian War" often figures in the pages of Roman histories, and it generally meant a war involving the greater part of Spain.

Cato.

In 195 the elder Cato had to put down a rising in the country, in which the Celtiberi took the lead, but he offered them favorable terms, and showed himself particularly anxious to conciliate them. His Spanish campaigns were so far a success as to establish the Roman power east of the Ebro, and along with peace and order came better administration and a development of the resources of the district now known as Hither Spain (Hispania Citerior). Cato is said to have disarmed the inhabitants of this part of Spain, and to have even compelled the Spaniards, from the Pyrenees to the Guadalquivir, to pull down their fortifications, but still the smouldering fires of rebellion were not trampled out.

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[1] For the Phœnician colonization of Spain, see PHŒNICIA, vol. xviii. p. 819.

Gracchus.

Some few years afterwards, in 179 and 178, we find the father of the famous Gracchi governor of Hither Spain, and fighting with the troublesome Celtiberi, winning victories over them, capturing one hundred and three of their towns, and then securing his conquests by showing himself as great in peace as he had been in war. He seems to have anticipated in Spain the work attempted by his sons in Italy, making grants of land on favorable conditions to the poorer natives. Much must have been accomplished by Gracchus towards producing contentment with the Roman rule, but in the west, in the valleys of the Douro and the Tagus, and in the region known as Lusitania, answering to Portugal, there seems to have been almost incessant fighting, and what one general won another general often lost.

Mummius.

Under Mummius, a governor of Further Spain (154),—the Mummius who in 146 took and sacked Corinth,—the Romans suffered a disastrous defeat from the Lusitanians, of which the Celtiberi took prompt advantage, and there was another Roman defeat, with a massacre of Roman citizens in one of the towns of the interior.

Marcellus.

These losses were avenged in 152 by Claudius Marcellus, grandson of Hannibal's illustrious antagonist, during whose command in Spain Corduba is said to have been established as a Roman colony. Marcellus was too humane and considerate to the Spaniards to suit the ideas of the Roman senate, which we may well suppose to have been greatly provoked by the trouble which Spain had given them. The new governors, Lucius Lucullus and Servius Galba, by a combination of perfidy and extortion, drove the country into a most formidable revolt, with which the Romans, whose hands were tied by the Third Punic War, could not for some time effectually deal.

Viriathus.

A guerilla chief of Lusitania (which had been specially ill-treated by the Romans), Viriathus, headed the revolt, and from 147 to 140 army after army of the Romans was cut to pieces; the formidable Celtiberi had joined his standard, and Spain seemed well-nigh lost to Rome. A treaty was even extorted by Viriathus from one of the Roman commanders, declaring the independence of the Lusitanians, and it is said to have been acknowledged and accepted by the senate. The brave man, however, could not hold together his fickle Spanish levies, and he fell at last by native treachery, encouraged by or at least connived at by the Romans.

Siege of Numantia.

The Celtiberi, however, were still in arms; the strong city of Numantia, the capital of the Arevaci, the most powerful Celtiberian tribe, witnessed more than once the defeat of a Roman consul before its walls (141 to 140). The besieging army became despondent and demoralized, and its commander, supplies failing him, had to retire, leaving his sick and wounded behind him. It was humiliation indeed for Rome to be thus baffled by a half-barbarous country-town of no great size, in the interior of Spain.

Scipio.

She now sent her best general, the younger Scipio, into the country, and in 133 the capture and destruction of Numantia gave Rome a hold over the inland district of Spain which she had never before had (see SCIPIO). The province of Hither Spain was rendered safe from Celtiberian incursions. Shortly afterwards Lusitania and its towns, after some obstinate fighting, were reduced to submission by the consul Junius Brutus, and thus Spain, with the exception of its northern coasts, the home of its most barbarous tribes, was nominally Roman territory. There must have been by this time a considerable mixture of Roman blood with the native population; there were several towns—Carteia, Valentia, Tarraco especially among them—with a Latin municipal constitution and with a number of Latin-speaking people.

Spain under Roman rule.

The growth of Roman civilization had fairly begun, and it was promoted by a commission sent out by the senate after Scipio's victories. Piracy in the Mediterranean was checked in the interest of native Spanish commerce, and the Roman administration generally favored the development of the country's prosperity. The extensive mountain districts were still the shelter of banditti, but, on the whole, order was well maintained, and Spain from this time flourished under Roman rule. It abounded in flocks and herds, and had a number of thriving populous towns, particularly on its Mediterranean shores. It seems, too, that it was never oppressed and impoverished by some of those forms of tribute,—such as the exaction of a tenth of the produce,—under which many of Rome's provincials smarted. Fixed money payments, and military service in the Roman armies, were the chief burdens which the conquered Spaniards had to bear. Rome on the whole, by comparison, dealt tenderly with them. Several of their towns had the privilege of coining the silver money of Rome; and the flourishing cities along the Mediterranean coast, which were so many centres of civilization to the adjacent districts, were treated rather as allies than as subjects. In these parts the Romanizing process went on rapidly and under favorable conditions, while the west and the north and a great portion of the interior remained barbarous, and Roman merely in name. In 105 it seemed possible that the Romans might be utterly swept out of the country; in that year a great wave of invasion passed over the inland regions from the Cimbri, who had destroyed two Roman consular armies on the Rhone. Spain to a great extent was cruelly ravaged, and Rome was too seriously menaced by the barbarians nearer home to be able to protect her. The country was saved by the brave Celtiberi, whose determined resistance forced the Cimbri back upon Gaul.

Sertorius.

Again in 97 and 96 we hear of a rising of these same Celtiberians against Rome, and of campaigns in the interior, in which for the first time we meet the name of the famous Sertorius, a name almost as conspicuous in ancient Spanish history as that of Hamilcar or Hannibal. For the remarkable episode of the eight years' wars of Sertorious in Spain against the generals of Sulla and against the great Pompey, and his almost successful attempt to render the country independent of the home Government at Rome, we must refer the reader to the article SERTORIUS. It was to his skill in winning the hearts of the Spaniards, more even than to his very considerable military ability, that he owed his successes. Rome was financially most grievously embarrassed by this tedious and difficult war, and Spain, with its Roman civilization and its Latinized towns on the Mediterranean, suffered severely.

Pompey.

By the year 71 the country had been reconquered by Pompey for Rome, and the two provinces of Hither and Further Spain were reorganized under a somewhat more stringent rule, the tribute in some districts of the latter province being raised, and some of the towns in both losing their municipal independence.

Cæsar.

In 61 the great Cæsar was governor of Further Spain, and carried the arms of Rome into the imperfectly conquered regions of the west and northwest, the country of the Lusitanians and of the Gallæci, and with a fleet from Gades is said to have occupied a point in the northwest answering to Coruña. But he was too short a time in Spain to reduce these barbarous regions to permanent subjection, and the work still remained to be accomplished. In the civil war with Pompey in 49 he was in Hither Spain, winning decisive victories over Pompey's generals, Afra-

The north unconquered.

Augustus.

nius and Petreius. Once more, in 45, he had to enter Further Spain at the head of an army, and to defeat his rival's sons at Munda, somewhere probably in the neighborhood of Cordova, a victory which made him undisputed master of the Roman world. Spain, however, the northern part at least, was not thoroughly subdued—"pacified," in Roman phrase,—till the reign of Augustus, whose ambition it was to advance the boundaries of empire to the ocean. In the north was a wild and warlike highland population, a collection of tribes known as the Astures in the northwest, and their neighbors the Cantabri to the east, between a mountain range and the coast, "the last," as Gibbon says (*Decline and Fall*, ch. i.), "to submit to the arms of Rome and the first to throw off the yoke of the Arabs." Cæsar's flying visit in 61 had done something to cow these tribes, but ever and again they would assert their independence. In 27 the emperor Augustus himself penetrated their strongholds, and he passed two years in Spain; decisive victories were won over the northern tribes, and their towns and villages were converted into military posts in the occupation of the legionary veterans. Such was the origin of Saragossa, a modern survival of the name of Cæsar Augusta then given to an old town on the Ebro, henceforth an important Roman centre in Spain. The successes of Augustus were commemorated by the same title bestowed on other ancient Spanish towns, Bracara Augusta (Braga) in the northwest, Asturica Augusta (Astorga) still further north, Emerita[1] Augusta (Merida) on the Guadiana, which became a Roman city of the first class,—"the Rome of Spain," as it has been called,—and Pax Augusta, perhaps the modern Badajoz. The work of consolidating the Roman dominion in Spain was completed in 19 by his friend and minister, Marcus Agrippa, and now at last the "Cantaber non ante domabilis," as Horace has it, acknowledged Rome's supremacy.

Roman conquest complete.

Spain was fairly conquered; the warlike peoples of the north were cowed and broken; the south was thoroughly Romanized, the population having adopted Latin manners and the Latin tongue. Some of the best specimens of Roman architecture, some of the finest Roman coins, have been discovered in the cities of Spain, which from the time of Augustus became rapidly prosperous, and were famous for their schools and their scholars. Spain, in fact, was more completely Roman than any province beyond the limits of Italy. The country which had hitherto harassed Rome with incessant risings and insurrections was at last peaceful and contented, a happy land which for the next 400 years may be said to have had at least no military history.

Three Roman provinces.

Under Augustus the old political constitution into two provinces, Further and Hither Spain, of which the Ebro had been the boundary, was set aside, and exchanged for a division into the three provinces of Lusitania, Bætica, and Tarraconensis, sometimes spoken of as the "Three Spains." Of these Bætica, so called from the Bætis (the Guadalquivir), and answering nearly to Andalusia inclusive of Granada, was the smallest; Tarraconensis, which embraced Hither Spain and the interior and all the north, was much the largest. Lusitania corresponds to modern Portugal. The centres of administration were—for Tarraconensis, Tarraco; for Bætica, Corduba; for Lusitania, Emerita Augusta. We may see, in part, on what principles this division of the country was adopted. Lusitania and Bætica had tolerably distinct features, the latter having been from the earliest times the most civilized and the most tractable district of Spain. North of the Tagus came a much wilder region, the home of excitable and warlike tribes; this in great part, so as to include the country of the Celtiberi, was thrown into Tarraconensis, which, and also Lusitania, were under the empire "Cæsaris provinciæ," the governors of them being nominated by the emperor. The smaller and quieter province of Bætica was a "senate's province"; and its finances were under the charge of the old republican official known as a "quæstor." The governor of Tarraconensis seems to have held decidedly the first position in the country; he had as a matter of course the greater part of the army under his command, and he was usually, it may be presumed, an ex-consul. The governorship, indeed, of this province must have been one of the best appointments in the emperors' gift.

Spain under the empire.

Under the empire Spain was divided for the general purposes included under the head of local administration into fourteen "conventus," that is, provincial parliaments or assemblies made up of a union or combination of so many communities or townships. The town or city which was the centre of each "conventus" was the place where justice was administered to the inhabitants of the district, and would, so far, answer to our assize-town. In Tarraconensis there were seven of these "conventus,"—Tarraco, New Carthage, and Cæsar Augusta being the chief; in Bætica, four,—Gades and Corduba being of the number; in Lusitania, the least populous and civilized district, three—Emerita Augusta the principal, Pax Julia, perhaps the modern Beja, and Scalabis not far from the mouth of the Tagus. Pliny (the elder), to whom we are indebted for these details, enumerates 360 cities in Spain in the time of Vespasian. These included every variety of township,—the "colonia" which originated in a camp or a settlement granted to old soldiers, the town whose inhabitants had all been made Roman citizens in the fullest sense ("municipium" in Roman phrase, under the empire), the town that had the inferior franchise ("jus Latii"), the "free town," which might at any time have its freedom taken from it, and the "tributary" town ("civitas stipendiaria"). Spain presented types of all these various communities till Vespasian, it is said, gave them all the "jus Latii," which opened an easy door for the provincials to the full privileges of citizenship. A native-born Spaniard might now rise to the imperial dignity, as Trajan did; and the Spaniards generally must have felt themselves to all intents and purposes Romans.

Re-arrangement of provinces.

The provincial constitution of Spain was revised and modified to some extent in the 2d century in the time, it would seem, of the Antonines and Hadrian. The vast and unwieldy province of Tarraconensis was subdivided, and the divisions distinguished as Gallæcia (the northwest), Carthaginiensis with New Carthage for its capital, Tarraconensis (the old name being then still retained for one division) with Cæsar Augusta for its capital, and the Balearic Isles, which had always been regarded as Spanish territory. Constantine accepted this arrangement, including, however, in it a strip of the western coast of Africa, part of the old Mauritania, which, from an ancient Moorish town, Tinge (Tangier), took the name of Tingitana among the later Roman provinces.

Frankish invasion.

Inroad of barbarians.

Spain in 256 A.D. was invaded and ravaged by the Franks; Tarraco was almost destroyed, and several flourishing towns reduced to mere villages. It was, however, but a passing storm,—the only interruption, in fact, to the peace and prosperity of the country during 400 years. With the departure of the Franks Spain soon recovered herself, and when we next hear of her early in the 5th century, we find commerce and civilization well established, and cities ranking among the finest and richest in the Roman world. In 409, however, the year of the sack of Rome under Alaric, a tide of barbarism swept over the country; Suevi, Alani, Vandals "ravaged," says a writer of the time, quoted by Gibbon (ch. 31), "with equal fury the cities and the open country." Spain, long so quiet and prosperous, was brought down to the lowest depth of misery. At this point the precise order of events is not quite clearly ascertainable. It seems that in 414 or 415 a Visigothic host entered Spain under their king, Ataulphus, Alaric's successor by election, who had married Placidia, the sister of Honorius, emperor of the West, son of the great Theodosius. Ataulphus was now Rome's ally, and fought as her champion in Spain against Suevi and Vandals. A new era seemed to have opened, and we may see in this alliance a prophecy of the ultimate fusion of Latin and German peoples,—the beginnings, in fact, of the modern world. To Ataulphus, who was murdered at his new capital Barcelona, succeeded after a brief interval in 415 Walia, a warlike and ambitious chief, who may be said to have established the Visigothic or West-Gothic kingdom in Spain on the ruins of the old Roman province. Walia concluded a treaty with the emperor Honorius, and, putting himself at the head of his brave Goths, in a three years' war he destroyed or drove into remote corners the barbarous hordes of Vandals, Alani, and Suevi that had settled down in the country. Spain, thus reconquered, was nominally subject to Rome, but soon became really independent and began to be the seat of a Christian civilization.

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[1] Emerita, from "emeriti," soldiers whose term of service had expired,—in fact, "veterans from the legions."

SECTION II.—SPAIN UNDER THE WEST-GOTHS.

Walia.

Theodoric.

Euric.

Recared.

The Jews in Spain.

The West-Gothic or Visigothic kingdom in Spain, founded by Walia, lasted for nearly three centuries, from 418 to 711, when it fell before the Arab or Saracen invasion. Toulouse was its headquarters; here was held the court of the West-Gothic kings, while Toledo became the centre of administration for Spain. The relations of the West-Goths with Rome varied from time to time: sometimes they were her friendly allies, sometimes, nominally at least, her dependants; sometimes they rose in revolt and were her open enemies. Walia, after his victories in Spain, professed to restore the country as once more a Roman province to the rule of the emperor Honorius, and again we hear of the oppressions of imperial officers and functionaries, which seem to have been even more intolerable to the Spaniards than the strifes and wars of Vandals, Alani, and Suevi. Nor were these troubles finally ended; Walia had by no means thoroughly consolidated his conquests; and the West-Gothic kingdom in Spain cannot be said to have been firmly established till the 6th century. In northern Spain, in Galicia more especially, the Vandals and Suevi still had settlements, and were quarrelsome neighbors. In 428 they routed an allied army of Romans and Goths, and overran the southern districts, plundering some of the chief cities on the coast before they quitted the country for Africa under their king, the famous and savage Genseric. The Suevi yet remained, but at the solicitation of the Romanized Spanish provincials of the southern cities, who felt themselves threatened with utter extinction by these barbarians, Rome offered its intervention, which was effectually carried out by the king of the West-Goths, Theodoric II., grandson of Alaric. Crossing the Pyrenees in 456, as Rome's representative and ally, Theodoric crushed the Suevi by a decisive victory in the northwest of Spain, near Astorga. It would seem that from this time the Suevic power was confined within the limits of Galicia, which became in fact a mere dependency of the West-Gothic kingdom. Theodoric's victories, so far from strengthening Rome's hold on Spain, greatly weakened it; and this was what he himself really intended. He did not even make a pretence of restoring the country to the imperial rule. His brother and successor Euric[1] (466–485) persistently defied the empire, completing Theodoric's work, and establishing by further successes in Spain, carried into its remotest western districts, the West-Gothic kingdom in that country in full and avowed independence. Euric was something more than a successful warrior: he aspired to be a legislator, and he had the "customs of the Goths" recorded in writing and embodied in a code. The work was continued by his successor Alaric II. in the beginning of the 6th century, under the superintendence of civil and ecclesiastical lawyers, and it was based mainly on what was known as the Theodosian code (see BREVIARIUM ALARICANUM). The result was that a thoroughly Roman character was impressed on the West-Gothic legislation, and that Roman institutions, ideas, and manners long survived in Spain. With the conversion of the West-Goths from Arianism to the orthodox faith in the latter part of the 6th century, under their king Recared (586–589), came in new influences and a great accession of power to the ecclesiastics. Recared was the first Catholic king of Spain. With the zeal of a convert he set himself to root out Arianism, burning Arian books of theology and frightening his Arian bishops into the profession of the Catholic belief. He seems to have been thoroughly successful, and richly endowed churches and monasteries grew up in every part of Spain. Pope Gregory the Great acknowledged the good work of Recared by a gift of sacred relics. Unhappily the seeds of bigotry and religious intolerance had been sown, and with the beginning of the 7th century came a savage persecution of the Jews, multitudes of whom had long been settled in Spain and had thriven, as elsewhere, by trade and industry. The Jew up to this time seems to have found in Spain a particularly safe and comfortable home. Now, at the instance of a West-Gothic king, he was so cruelly[2] oppressed and persecuted that even the Catholic clergy interposed to some extent on his behalf. A decree for the expulsion of the entire Jewish community was promulgated on one occasion with the sanction of the council of Toledo; but the Jew still held his ground in Spain and prospered and grew rich, and his presence in the country contributed to the rapid spread of Arab conquests in the next century.

Features of West-Gothic rule.

Among the most conspicuous features of the West-Gothic kingdom in Spain we may note elective[3] monarchy, the great and indeed overshadowing power of the church, an aristocracy which had in its hands a very large part of the administration, a uniform code of laws for all Spaniards, with both a distinctly Roman and ecclesiastical impress on it. The church on the whole seems to have been the guiding spirit, and the Spanish bishops and clergy were held in high esteem for their learning and virtue. It was they who mainly inspired the legislation of the great national councils of Toledo, which to the West-Goths of Spain were what the Witenagemot was to our Saxon ancestors. The church was the centre round which the whole of society moved. In this fact we see foreshadowed much of the future of Spanish history, the supremacy of ecclesiastics, the extraordinary powers of the Inquisition. It had from the first its evil side in tendencies to bigotry and persecution, but it was at the same time the means of giving Spain laws very far above the average ideas of a barbarous people,—laws indeed which in many respects were rational, humane, enlightened, often combining the wisdom of old Rome with the kindly spirit of Christianity. The West-Gothic code recognized the equality of all men in the eye of the law; such barbarisms as the assessment of a man's value according to his rank and position, or judicial combat or trial by ordeal, find no place in it. It had certainly great merits; its weakness seems to have been in leaving too much scope on one side to the king, on the other to the clergy. Between the royal and the ecclesiastical powers individual freedom was liable to disappear. There was a danger, too, of human thought and speculation being wholly absorbed into theology. In anything like general literature Spain seems to have been decidedly poor during this period, while among her neighbors in the south of Gaul Greek philosophy was a fashionable study, testifying to the presence of considerable intellectual activity. Spain under its West-Gothic kings and its Catholic clergy may have been a fairly well governed country, but long before the end came there must have been languor and decay amongst its people. After the conquest of Africa by Belisarius for the emperor Justinian, it seemed possible that the country might be once again annexed to the empire as a province; and an unsuccessful candidate for the throne,—which, it will be remembered, was elective,—went so far as to conclude a treaty of alliance, and actually to cede to the troops of the empire several towns on the Mediterranean coast. That a Gothic king should condescend to ask support from such a quarter, and allow himself to be spoken of as in any sense the empire's vassal, marks a very decided decline in the old independent spirit of the nation. We may certainly assume that repeated disputes as to the royal succession had undermined its power for resistance, and the numerous and not very well affected Jewish colony in their midst must have been a permanent source of danger. By the end of the 7th century northern Africa to the Straits of Gibraltar had passed wholly under Saracenic dominion. The struggle had been long and hard, and the West-Gothic kings, who had recovered the towns on the southern coasts, and even made some small conquests on the African shores, had done something to prolong it; but in 710 a little band of Saracens landed unopposed at Gibraltar, returned in safety, and urged their brethren at once to cross the straits and take possession of the country. In the following year (711) Ṭáriḳ, at the head of about 5000 Saracen volunteers entered Spain. A great Gothic army under Roderick, "the last of the Goths," was routed in the neighborhood of Xeres on the Gaudalete, and the Arab or Saracenic conquest of Spain, with the exception of the mountainous districts of the north, was accomplished with amazing ease and rapidity. Anything like a vigorous national resistance seems to have been too much for the Spaniards, enervated as they were by long familiarity with Roman civilization.[1] (W. J. B.)

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[1] Euric is said to have assassinated his brother Theodoric.

[2] Ninety thousand Jews were compelled to receive baptism (Gibbon's *Decline and Fall*, ch. 37).

[3] Limited, however, to pure Gothic blood.

Decline and fall of the West-Gothic power.

SECTION III.—MEDIÆVAL HISTORY.

The Arab invasion.

The Arab invasion of Spain had been intended by Músá, the governor of Africa, to be merely a plundering raid (compare MOHAMMEDANISM, vol. xvi, p. 596). A single unexpected success, turned it into a conquest. Ṭáriḳ had already made himself master of Cordova and Toledo when Músá arrived from Africa and rewarded his too successful lieutenant by consigning him to prison. But his military ability was too valuable to be dispensed with, and he was speedily released to aid in completing the conquest. Within four years the whole Peninsula, except the mountainous districts in the north, had submitted to the invaders. It was now Músá's turn to suffer from the jealousy of his superior. Recalled to Damascus by Walíd, he arrived just after the caliph's death, and at once fell under the displeasure of his successor Suleimán. His sons, who had been left to rule in Spain, were involved in his disgrace, and the father died broken-hearted on a pilgrimage to Mecca.

Causes of its success.

Few things in history are more remarkable than the ease with which Spain, a country naturally fitted for defence, was subdued by a mere handful of invaders. The usual causes assigned are the misgovernment of the Visigoths, the excessive influence enjoyed by the clerical caste, internal factions and jealousies, and the discontent of numerous classes, and especially of the Jews. All of these doubtless co-operated to facilitate the conquest and to weaken the power of resistance, but the real cause is to be sought in the fact that the Visigoths had never really amalgamated with the conquered population. The mass of the inhabitants regarded their rulers as aliens, and had no reason to resent a change of masters. This feeling was strengthened by the conduct of their new conquerors. The Arab invasion undoubtedly brought with it considerable bloodshed and destruction of property, but it was merciful when compared with the previous inroads of the German tribes, and in the end it proved a blessing rather than a curse to the country. To all who submitted the Arabs left their laws and customs, and allowed them to be administered by their own officials. The cultivation of the fields was left to the natives, and the overthrow of the privileged classes gave rise to a system of small holdings or properties, which was one of the causes of the flourishing condition of agriculture under Arab rule. The slaves found their lot much improved under a religion which taught that the enfranchisement of a slave was a meritorious action. The Jews, as they had suffered most under the Visigoths, were the chief gainers from a conquest which they had greatly contributed to bring about. But nothing was so influential in securing ready submission to the Arabs as their tolerance in religious matters. Even the most bigoted adherents of Islam found a practical check to their zeal for proselytism in the loss that would accrue to the exchequer. The Christians had to pay a poll-tax, which varied according to the class to which they belonged. All property was subject to the *kharáj*, a tax proportioned to the produce of the soil, but converts to Mohammedanism were excused from the poll-tax. A clerical chronicler of the 8th century, while bewailing the subjection of Spain to an alien race, says nothing against the conquerors as the professors of a hostile religion. His silence is an eloquent testimony to the haughty tolerance of the Arabs.

Tolerance.

As time went on, and the Arabs felt more secure in their position, their rule became not unnaturally harsher. Many of the treaties which had secured favorable terms to the conquered were broken, and the Christians were provoked to resistance by persecution. A notable instance of this was the edict making circumcision compulsory for Christians as well as Moslems. Greater hardships still were endured by the "renegades," most of whom had embraced Mohammedanism from a desire for safety or for temporal gain, and who found that return to the old faith was blocked both to themselves and to their children by the law which punished a perverted Mussulman with death. At the same time their social position was intolerable, and they were excluded from all lucrative offices and from all share in the government. Their discontent led to numerous and stubborn rebellions, but they belong to a later period, and in the 8th century the chroniclers record only a single rising, that of the Christians of Beja, and they seem to have been merely the tools of an ambitious Arab chieftain.

Mohammedan discords.

It was fortunate for the Arabs that they succeeded at first in conciliating the natives, as otherwise their rule in the Peninsula would have been short-lived. Internal discord offered the Christians an easy opportunity for successful revolt if they had chosen to avail themselves of it. The conquerors were united by religion but not by race. When the task of conquest was achieved, and the need for unity was removed by the submission of the vast majority of the natives, quarrels arose between the various races which had taken part in the invasion. Besides the Arabs proper, who regarded themselves as the true conquering race, there were Berbers or Moors, Egyptians, and Syrians. So difficult was it to prevent their quarrels that it was found necessary to subdivide the conquered territory and to allot separate settlements to the different tribes, a measure which only tended to perpetuate their differences. Matters were made worse by the constant efforts of ambitious chieftains to raise themselves to power or to ruin their more successful equals. The first forty years of Arab rule in Spain are a period of woful confusion, and it is difficult even to enumerate the names of the emirs who followed each other in rapid succession. The great empire of the Arabs began to fall to pieces as soon as it had reached its greatest extent. A movement whose end was conquest began to fail directly it ceased to conquer. The overthrow of the Omayyad dynasty by the Abbasids was a proof that disorder prevailed at the centre. The extremities inevitably displayed the same symptoms. Each new caliph sent a fresh emir to Spain; the governor of Africa claimed to interfere in the affairs of a province which had been conquered by one of his predecessors; and the native chiefs were often unwilling to submit to a new ruler whose arrival was the result of a revolution in which they had no share and which they would have prevented if they could. A capable and energetic governor, confronted with internal dissensions and always dreading the arrival of a successor to supersede him, could only devise one way of solving the problem. The Arabs were unable to live at peace, and the one means of preventing them from warring with each other was to find them new lands to conquer. Hence, came the frequent invasions of Gaul, now ruled by the degenerate Merwings, which resulted in the conquest of the provinces of Septimania and Narbonne, and at one time threatened to subject the whole of western Europe to the successor of Mohammed. But the battles of Toulouse (721) and of Tours (732) checked the advance of the Moslems, and by 759 they had been compelled to retire from all possessions beyond the Pyrenees. Thus thrown back upon the peninsula, it seemed probable that their empire in Spain would speedily succumb to the disruptive forces which had no longer any external outlet.

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[1] For the West-Gothic kingdom in Spain, Gibbon's *Decline and Fall* should be consulted, chapters 31, 36, 37, 38, 41, 51. In note 122 (ch. 38) he remarks on the obscurity of the subject, Spain having had during this period no chronicler like Bede for the Saxons or Gregory of Tours for the Franks. As to the West-Gothic laws, there is a good deal of easily accessible information in Guizot's *History of Civilization*, lectures 3, 6, 10, 11. Compare ROMAN LAW, vol. xx. p. 731, and SALIC LAW, vol. xxi, p. 226, section (11).

OMAYYADS.

'Abd al-Raḥmán.

From this fate the Arab power was saved by 'Abd al-Raḥmán (Abderame), the one survivor of the Omayyad dynasty, who succeeded after a long series of romantic adventures in escaping from the general massacre of his family (see vol. xvi. p. 600). His arrival in the Peninsula was welcomed by those Arab chieftains who had ends of their own to gain or who saw how impossible it was for Spain to be ruled from a distant centre like Damascus or Baghdad. The resistance of the Abbasid emirs, Yúsuf and 'Alí b. Moghíth, was overcome. 'Abd al-Raḥmán was enabled to found a new Omayyad dynasty at Cordova. He and his immediate successors seem to have contented themselves with the title of emir, but all connection with the eastern caliphate was cut off, and Spain became independent under its new rulers. The reign of 'Abd al-Raḥmán I. was spent in almost constant warfare. No sooner had he reduced the southern provinces than a revolt broke out in Saragossa under Ḥosein b. Yaḥya. Driven from Spain, where he had raised the black standard of the Abbasid caliph, Ḥosein fled to the court of Charlemagne and implored his assistance. The Frankish army restored Hosein to power, but on its return was almost destroyed by the Basque mountaineers in the famous valley of Roncesvalles (778). After a siege of two years Saragossa was taken, Ḥosein was put to death as a rebel, and the whole country up to the Pyrenees was compelled to submit to the Omayyad. A formidable rising of the sons of Yúsuf was put down in 786, and 'Abd al-Raḥmán was enabled to devote the last two years of his life to the arts of peace and to the construction of his famous mosque at Cordova. Before his death he settled the succession on his third son, Hishám, who had been born in Spain, and compelled his followers and his elder sons to swear fealty.

Hishám.

Al-Ḥakam.

Hishám's reign, which lasted only eight years (788–796), was comparatively uneventful. He was successful in foiling the attempt of his elder brothers to seize the throne, but a projected invasion of Gaul was repulsed by the courage of the count of Toulouse. Hishám was a devotee,—strict in the performance of religious duties and absorbed in works of charity. He completed the mosque which his father had begun, and endeavored to make Cordova the educational centre of Islam. His son and successor, Al-Ḥakam, was of a very different temperament. With a keen enjoyment of the pleasures of life, Al-Ḥakam disregarded the precepts of the Koran which forbade the use of wine, and his lax practices irritated the *faḳíhs*, the "scribes" of Mohammedanism. The inability of the Arabs to adapt themselves to a life of peace found expression in a number of isolated risings, of which the most notable took place in Toledo and Cordova. The inhabitants of Toledo had never forgotten that their city had once been the capital of Spain, and most of them belonged to the class of "renegades," who had no real attachment to the dominant faith. Al-Ḥakam determined to suppress their discontent by a notable act of cruel treachery. Feigning the most complete goodwill, he invited the chief citizens to a banquet in honor of the presence of his son in Toledo. As they entered the door they were conducted to an inner chamber and massacred by a band of assassins. More than seven hundred are said to have perished on this "day of the fosse" (807), and the citizens, deprived of their leaders, submitted with the torpor of despair. The fate of Toledo terrified the Cordovans, and postponed their rising for seven years. But in 814 the murder of a blacksmith by one of Al-Ḥakam's body-guard provoked a terrible outbreak. Besieged in his palace by the infuriated mob, Al-Ḥakam only escaped death by his own coolness and presence of mind. A detachment of his guard was sent to fire the houses of the citizens; the mob hurried off to save their families and goods; and a sudden charge of the emir and his soldiers threw them into complete disorder. With politic severity Al-Ḥakam destroyed a whole quarter of the city and condemned all the inhabitants to exile. Part of them found a new home in Africa, but others, after a temporary sojourn in Alexandria, conquered Crete, where they founded a dynasty, which lasted till 961, when the island was recovered by the Greeks. The *fuḳíhs*, the real instigators of the rebellion, were treated with conspicuous leniency, and their leader, Ṭalút, was even admitted to Al-Ḥakam's favor.

CHRISTIAN STATES.

By the end of the 8th century it had become evident that the Arabs had committed a great error in not reducing the whole Peninsula, and that the contemptuous indifference with which they had left the northern mountains to a handful of refugees was destined to bring its own punishment. The early history of the Christian states of Spain is wrapped in a mist of fable and legend, but it is not hard to discern the main outlines. A scanty band of warriors, headed by Pelayo, probably a member of the Visigothic royal family, found refuge in the cave of Covadonga, among the inaccessible mountains of Asturias. Their own bravery and the difficulties of the country enabled them to hold their own, and they became the rallying point for all who preferred a life of hardship to slavish submission. The formation of a Christian kingdom was the work of Pelayo's grandson, Alfonso I., who seized the opportunity when the Arabs were occupied in the disputes attending the accession of 'Abd al-Raḥmán I. After driving the Berbers from Galicia, Alfonso advanced with his victorious troops as far as the Douro. But he had not followers enough to colonize the conquered territory, and contented himself with the northern districts, leaving a desert to form a natural boundary between himself and the Moors. Alfonso's son and successor, Fruela I. (765–775), fixed his capital at Oviedo, but the greater part of his reign was occupied with the suppression of internal disorders, and he ultimately fell a victim to assassination. His throne was successfully usurped by his cousin Aurelia and his nephew Silo, both of whom sought security against domestic enemies in an alliance with 'Abd al-Raḥmân. On the death of Silo (784) a party among the nobles elected Fruela's son, Alfonso II., but for six years the western half of the kingdom obeyed a bastard son of Alfonso I. by a Moorish captive, nicknamed from his origin El Maurecato. Under Alfonso the Chaste, whose long reign lasted till 842, the Christian kingdom of Oviedo was firmly established. It is impossible to find any accurate account of his achievements. The monkish chroniclers are hardly trustworthy authorities for military history, and they prefer to confine themselves to the more congenial subject of the founding and endowment of churches. The discovery of the pretended tomb of St. James at Compostella is in their eyes the greatest event of the reign, and it undoubtedly aided to give a religious character to the war which was destined to be the great crusade of the west.

Alfonso II.'s reign witnessed the establishment of another Christian state in Spain. Charles the Great had been too much occupied elsewhere to avenge the great disaster at Roncesvalles, but he was only waiting for his opportunity. This was offered in 800 by the treachery of another governor of Saragossa, who had revolted against Al-Ḥakam and sought assistance from the Franks. Charles himself was on his way to Italy to assume the imperial crown, but he sent his son Louis across the Pyrenees. In his first campaign Louis reached the Ebro, but he had to return in 801 to vanquish the obstinate resistance of Barcelona. The administration of the "Spanish mark" was intrusted to Bera, a man of Gothic descent, who proved fully capable of the task imposed upon him. The attacks of the Arabs were repulsed and their last possessions beyond the Ebro were lost in 811, when Tortosa, after a siege of two years, succumbed to the forces which Louis the Pious had again led over the mountains. Henceforth the province was ruled by the counts of Barcelona, as representatives of the Frankish kings.

County of Barcelona (818-1150).

To avoid the difficulty of frequent transitions, it will be best to sketch in advance the main outlines of the history of the Christian states down to the formation of the three kingdoms of Aragon, Castile, and Navarre, leaving their relations with the Moors to be narrated in connection with the caliphate of Cordova. It is impossible to do much more than trace the dynastic and geographical changes, as their mutual quarrels are intricate and wearisome, and of little importance except as prolonging the rule of the Arabs in the Peninsula. The county of Barcelona may be dismissed with a few words. It continued for some time to be subject to Frankish suzerainty, and it suffered from the disorders that followed the break-up of Charles the Great's empire. Bera, its first count, was exiled, and his successor, Bernhard, played a prominent part in the intrigues of that troubled period. At one moment he added Septimania to the Spanish mark, at another he was disgraced and exiled; and finally he was treacherously murdered. In the later part of the 9th century all connection with Septimania was cut off, and Wilfrid the Hairy (d. 907) was able to make the county hereditary in his family. With its mixed population and its long line of coast the county of Barcelona, or Catalonia as it came to be called, was more involved in the affairs of Gaul than of Spain. Berengar I. annexed the county of Carcassonne and other districts north of the Pyrenees (about 1050–1076), and Berengar III. (1092–1131) obtained Provence by marriage. On the latter's death Catalonia and the transmontane territories were divided between his two sons, and in 1150 Berengar IV., by marriage with Queen Petronilla, obtained the kingdom of Aragon, with which Catalonia was henceforth united.

Kingdom of Oviedo or Leon.

The history of Oviedo is more important and more complicated. Alfonso II.'s successors, Ramiro I. (842–850) and Ordoño I. (850–866), had to contend both with the great nobles, who aimed at independence, and with the Basques, who had never learnt to submit to orderly rule. Alfonso III., in a long reign of nearly fifty years (866–910), won the title of "The Great" from the success which attended his arms. While his plundering raids extended as far as Coimbra and Lisbon, he really advanced his frontiers to the Douro, and in order to defend these more exposed territories he transferred his capital from Oviedo to Leon, on the further side of the mountains. In accordance with the universal custom of the Germans, Alfonso divided his territories among his three sons, Garcia receiving the southern districts with Leon as a capital, Ordoño II. western Galicia, and Fruela II. the original district round Oviedo. In 931, however, the kingdom was again united under Ramiro II., a son of Ordoño II., and henceforth called after the new capital, Leon. Under Ramiro, a great warrior against the Arabs, we first hear of a district that was destined to become the most important in Spain. The border territory, a march to the southeast of Leon, previously Bardulia, was now known as Castile, from the number of castles that had been raised to hold it against the infidels. Its count, Fernan Gonzales, was the most powerful noble in the kingdom of Leon, and sought to make himself independent. Ramiro reduced him to submission and then bound him to his side by marrying his eldest son to the count's daughter. Ordoño III. (950–957) sought to emulate his father's achievements against the Arabs, but was hampered by the revolt of his brother Sancho and his father-in-law Fernan Gonzales. Sancho I. (957–966) found an enemy in his recent ally, who attempted to place a rival king upon the throne, and he could only procure restoration to his kingdom by an alliance with the caliph of Cordova. This alliance lasted during the minority of his son, Ramiro III. (966–982), who was deposed by the malcontent nobles in favor of his uncle Bermudo II. (982–999). The latter, too mild a ruler for such troubled times, had a hard struggle against domestic treachery and foreign enemies, and left a desolate kingdom to his son Alfonso V. Alfonso succeeded in restoring order, and to his reign are attributed the most important of the *fueros*, on which were based the local institutions of his kingdom.

Rise of Navarre, Castile, and Aragon.

Meanwhile a new kingdom had sprung up to the east of Leon, which for a time seemed likely to become the chief state of Christian Spain. The district in the western Pyrenees bordering on the Bay of Biscay was the most defensible position in the Peninsula. It was there that the Basques had held out against the German invaders, and that the Suevi had found a refuge from the Visigoths. The sovereignty of the Moslems and of the Franks had been in turn acknowledged, but had never been more than nominal. About the beginning of the 10th century Sancho founded here the kingdom of Navarre, and he succeeded in extending his rule as far as the lower Ebro. His means of defence were primitive but efficient. When attacked by the infidels in overwhelming numbers he retired to the inaccessible mountains, and recovered the lost ground as soon as the enemy had turned his back. His grandson, Sancho the Great (970–1035), profited by the disasters which befell Leon. He married the sister of Garcia, count of Castile, and when his brother-in-law fell a victim to a conspiracy he seized the opportunity to avenge his death by annexing the northern portion of his country. In 1034 he picked a quarrel with Bermudo III. (1028–1037), the son and successor of Alfonso V., and conquered eastern Leon as far as the river Cea. More important still were his acquisitions in the southeast of Navarre. Partly by marriage connections, and partly by the sword, he obtained possessión of the counties of Aragon, Sobrarbe, and Ribagorça, which had for years been struggling to maintain their independence against the Mussulman governor of Saragossa. These considerable territories Sancho divided on his death (1035) among his four sons, and the division is an important event in the history of Spain. Garcia, the eldest, received Navarre, with a small district on the right bank of the Ebro; Ferdinand, the second son, obtained Castile, with the addition of the district of Palencia, which had been wrested from Leon; the counties of Ribagorça and Sobrarbe passed to Gonzalo, and that of Aragon to Ramiro, a bastard.

The death of Sancho the Great seemed to offer Bermudo III. an opportunity for recovering his lost territories, and he at once collected his forces to attack Ferdinand. In a pitched battle near the river Carrion, Bermudo was defeated and killed, and the conqueror at once annexed Leon with its dependencies—Galicia and Asturias—to his new kingdom of Castile (1037). The eldest brother, Garcia, resented a change which threatened to deprive Navarre of the pre-eminence which it had enjoyed under his father. To gratify his jealousy he did not scruple to ally himself with the emirs of Saragossa and Tudela. But in the battle of Atapuerca (1054) the unnatural coalition was defeated, Garcia lost his life on the field, and Ferdinand added to Castile the district on the right of the Ebro, leaving the rest of Navarre to his nephew, Sancho IV. Meanwhile Ramiro, equally ambitious and successful, got rid of his brother Gonzales, and seized upon Sobrarbe and Ribagorça to form, with his own inheritance, the kingdom of Aragon. Henceforth the history of Christian Spain centres round the two great states of Castile and Aragon. Leon, much to the disgust of its inhabitants, becomes a province of the former, and Navarre is soon afterwards deprived of independence by its more powerful neighbor.

Omayyads (822-1031).

'Abd al-Raḥmán II.

We must now return to the history of the Arabs. Under 'Abd al-Raḥmán II. (822–852), one of the mildest and most cultivated of the Omayyad dynasty, began a period of disorder and anarchy which might have ruined his power if the northern states had been prepared to take advantage of it. Toledo, which had recovered its independence soon after the "day of the fosse," was not reduced until after a desperate struggle of eight years, and then its fall was mainly due to internal quarrels. More serious was the growing spirit of insubordination among the Christian population of the south. In spite of the tolerance with which they were treated, the priests persisted in preaching against the rule of the infidel. Under the leadership of Eulogius and his friend Alvaro, a fanatical sect was formed which sought to emulate the glory of the early martyrs. So averse was the Government to resort to persecution that it was only by publicly blaspheming Mohammed that they could bring themselves under the penalties of the law. Eleven persons were put to death for such conduct, who are celebrated in Spanish history as the "martyrs of Cordova." It was in vain that the moderate party denounced their conduct as wanton suicide; the enthusiasts persisted in their defiant conduct.

Mohammed.

Mohammed (852–866), sterner and more narrow-minded than his predecessor, was not unwilling to take repressive measures, and the execution of Eulogius, who had been chosen archbishop of Toledo, seems to have checked for a time the thirst for martyrdom. But the movement had succeeded in provoking a feeling of distrust between the two religions, and it was difficult to return to the old attitude of easy tolerance. The "renegades" found their position altered for the worse, and under Mohammed they were jealously excluded from all the higher offices of state.

A series of revolts showed how prevalent was the feeling of discontent. The Gothic family of Beni-Casí, which had embraced Mohammedanism in order to advance itself, had become extremely powerful in Aragon. Músá, the head of this family, made himself master of Saragossa, Tudela, and Huesca, concluded a close alliance with Toledo, which had again recovered its independence, and claimed to be the "third king in Spain." Músá's death in 862, in a war with Ordoño I. of Oviedo, enabled Mohammed to regain Tudela and Saragossa, but his troops were soon expelled by Músá's sons, and the Beni-Casí, with the help of Alfonso III., were for a long time able to bid defiance to the authority of the emir. About the same time an independent state was formed in the west by Ibn-Merwán, a renegade of Merida. But by far the most formidable of these risings was that of 'Omar b. Ḥafṣún, who began as a brigand in the mountains of Andalusia, but whose castle at Bobastro became the centre of all the dissatisfied Christians and renegades of the south. Neither Mohammed nor his son and successor Mondhir (886–888) could reduce this impregnable fortress, and for years 'Omar was the real ruler of Andalusia. His authority was far greater than that of the emirs had ever been; his administration of justice was rude but efficient; and the Arab historians maintain that a girl laden with treasure could in his time cross the mountains in safety.

'Abdallah.

The premature death of Mondhir, a brave and chivalrous prince, gave the succession to his brother 'Abdallah (888–902), who ascended the throne at a very critical moment. Not only had the rising of the Christians and renegades assumed an almost national character, but the Arab nobles had taken advantage of the general disorder to assume the independence that was so congenial to them. 'Abdallah, considering the latter danger the more formidable, sought to gain over the Spaniards, and even offered Ibn Ḥafṣún the government of Regio, on condition that he would acknowledge himself as sovereign. But the negotiation came to nothing, and the only result was to provoke the indignation of his own race against the emir. Luckily for him the Spaniards had an old debt to pay off against the Arabs, who had long treated them with insufferable contempt. In various districts a desperate civil war broke out, which was destructive of all law and order, but was not directly aimed against the central Government. The most violent struggle was in the province of Elvira, where for a time the natives got the upper hand, and it was only after a desperate conflict that the Arab domination was maintained by the heroism of two successive leaders, Sauwár and Sa'íd. In Seville a similar contest arose, and 'Abdallah, after attempting in vain to hold the balance between the two parties, was at last compelled to espouse the cause of the Arabs. An insurrection, in which the life of Mohammed, the emir's eldest son, was in imminent danger, was punished with ruthless severity; but it was the Arab nobles who profited by the success to make themselves absolute masters of the province. The central authority was almost powerless. Most of the provincial governors had thrown off all connection with Cordova, and the others only rendered obedience when it was convenient to themselves. But at the moment when matters seemed at their worst the tide turned. In 890 'Abdallah won his first victory over Ibn-Ḥafṣún, and during the remainder of his reign he gradually recovered power in the revolted provinces. The work was continued by his son and successor, 'Abd al-Raḥmán (or Abderame) III. (912–961), the greatest of the rulers of Cordova.

'Abd al-Raḥmán.

Under this prince, who at last assumed the title of caliph, the unity of Mussulman Spain was for the time restored.

No sooner had 'Abd al-Raḥmán completed the first part of his task by the reduction of the family of Ibn-Ḥafṣún than he found himself confronted by two dangers. In Africa the Fatimites were establishing a great empire, and it was almost certain that they would turn their attention to Spain as soon as their power was secure in the southern continent. In the north the Christian states had profited by the long anarchy among their old foes and were assuming a very threatening attitude. Alfonso III. had moved his capital across the mountains to Leon, and Sancho had recently created the kingdom of Navarre. As regards Africa, 'Abd al-Raḥmán contented himself with encouraging and subsidizing the princes that still held out against the Fatimites, and with obtaining possession of Ceuta, so as to have complete command of the straits. The northern danger was the more pressing. In 914 Ordoño II. made a successful raid into the territory of Merida, and two years later he defeated the army which had been sent to avenge the insult. Although Merida had not yet returned to submission, 'Abd al-Rahmán was determined to conciliate his subjects by proving his ability to defend them. He spared no pains to collect a magnificent army, and his efforts were rewarded in 918 by a great victory over the combined forces of Leon and Navarre. This was the first of a series of successful campaigns, in the course of which he penetrated as far as Sancho's capital, Pamplona. But his victories brought him little beyond glory and revenge. As soon as his troops were withdrawn, the enemy showed himself to be really unconquered. In 921 Ordoño is said to have advanced within a day's journey of Cordova, and in 923 Sancho excited a panic in Mussulman Spain by the capture of Viguera. But the disorders in Leon that followed Ordoño II.'s death were a great blow to the Christians, and enabled 'Abd al-Raḥmán to complete his work of internal reorganization and to turn his attention to resisting the Fatimite conquest of Mauretania. On the death of Sancho, his widow Tota recognized the caliph as suzerain of Navarre.

In his later years 'Abd al-Rahmán was less uniformly successful. The Arabs were disgusted by his policy of excluding the nobles from all share in the government and of filling the chief offices with "Slavs," the generic title for all foreign servants of the court. Ramiro II. had succeeded in restoring unity to Leon, and resumed the warlike policy of his predecessors. In 939 he inflicted a serious defeat upon the army of the caliph at Alhandega, and was only prevented from following up his victory by a quarrel with the famous count of Castile, Fernan Gonzales. The divisions which followed Ramiro's death were an additional advantage to 'Abd al-Raḥmán; and in 960 he gained the most conspicuous success of his reign when his troops restored the deposed Sancho I. to the throne of Leon. This was almost his last act, as he died in October, 961.

"Among the Omayyad princes of Spain 'Abd al-Raḥmán III. incontestably holds the first place. His achievements bordered on the fabulous. He had found the empire in a state of anarchy and civil war, divided amongst a crowd of chiefs of different race, exposed to constant raids from the Christians of the north, and on the verge of being absorbed either by Leon or by the Fatimites. In spite of innumerable obstacles he had saved Andalusia both from itself and from foreign rule. He had given to it internal order and prosperity and the consideration and respect of foreigners. He found the treasury in disorder; he left it in the most flourishing condition. A third of the annual revenues, which amounted to 6,245,000 pieces of gold, sufficed for the ordinary expenditure; another third was kept as a reserve; the rest was devoted to buildings. The condition of the country was equally prosperous. Agriculture, industry, commerce, the arts and sciences, flourished together. The foreigner was lost in wonder at the scientific system of irrigation, which gave fertility to lands that appeared most unpromising. He was struck by the perfect order which, thanks to a vigilant police, reigned in the most inaccessible districts. Commerce had developed to such an extent that, according to the report of the superintendent of the customs, the duties on imports and exports constituted the most considerable part of the revenue. A superb navy enabled 'Abd al-Raḥmán to dispute with the Fatimites the empire of the Mediterranean, and secured him in the possession of Ceuta, the key of Mauretania. A numerous and well-disciplined army, perhaps the best in the world, gave him a preponderance over the Christians of the north. The most haughty sovereigns were eager for his alliance. Ambassadors were sent to him by the emperor of Constantinople and by the sovereigns of Germany, Italy, and France."—Dozy, iii. 90.

Al-Ḥakam II.

The new caliph, Al-Ḥakam II. (961-976), was distinguished as a patron of literature and a collector of books. The number of volumes in his library was reckoned at 400,000, and he is said to have read and annotated them all. For politics he had comparatively little taste. Naturally averse to war, he was only forced into hostilities by the obstinate refusal of Sancho I. to fulfil the treaty which he had signed on his restoration, and he hastened to conclude peace on an empty renewal of the treaty. The disorders which arose during the minority of Ramiro III. put an end to all danger on the side of Leon, and the death of Fernan Gonzales in 970 removed a ruler who had always been a thorn in the side of the infidel. The most notable event of Al-Ḥakam's reign is the rise to influence of a man who was destined to play a more prominent part in the history of Spain than any of the caliphs, not excluding 'Abd al-Raḥmán III. Mohammed Ibn-abí-'Ámir was the descendant of a family which had long been distinguished in the civil administration, but had never been admitted to the higher nobility of the sword. From his earliest youth he was inspired with the thought that he was destined to rule. His ability and the favor of Al-Ḥakam's favorite wife, Ṣobḥ, combined to bring about his speedy advance, and by the time of the caliph's death he held a high office in the court. Al-Ḥakam had done all in his power to secure the succession of his son by Ṣobḥ, Hishám, a boy of ten years of age. But the chief eunuchs, dreading the influence which a minority would give to Moṣhafí, the *ḥájib* or chief minister, sought to give the crown to Moghíra, a brother of Al-Ḥakam. With the help of Ibn-abí-'Amir, Moṣhafí defeated the plot; Moghíra was put to death, and Hishám succeeded to his father's throne. But he never really ruled.

Hishám II.

Ibn-abí-'Ámir, still aided by Ṣobḥ, whose lover he was popularly supposed to be, gradually rose to absolute power. Moṣhafí, a man of little real ability, was charged with peculation and deposed, and his younger rival was appointed *ḥájib* in his place. To free himself from all danger from the mob at Cordova, the all-powerful minister transferred the government and the court to Zahrá, which he built for the purpose. There the young caliph was immured in a magnificent palace, and was carefully secluded from all contact with public affairs. His education was purposely neglected, and he never made the slightest effort to free himself from his gilded imprisonment. To remove all obstacles to his authority, Ibn-abí-'Ámir reorganized the army. He filled the ranks with Moors from Africa and with Spaniards from Leon, Castile, and Navarre, whom he bound to his cause by lavish generosity. The old tribal distinctions among the Arabs, so long the source of jealousy and quarrels, he completely disregarded in the forming of regiments, and thus completed the work of assimilation which 'Abd al-Rahmán III. had commenced. Though trained to the study of the law and experienced only

Almanṣór.

in civil affairs, he speedily mastered the art of war and conciliated the popular favor by victories such as no caliph had ever won. In 981 he defeated Ramiro III. and his allies in a pitched battle, took Zamora and Simancas, and was only prevented by a storm from capturing Leon. On his return he assumed the name of Almanṣór (victorious by the help of God), by which he is usually known in history. Bermudo II., whom the nobles of Leon raised to the throne in place of the defeated Ramiro, could only secure himself by paying tribute to the ruler of Cordova. In 985 Almanṣór invaded Catalonia, which had hitherto been respected as a Frankish fief, drove the count Borrel into exile, and took and sacked Barcelona. When Bermudo II. sought to free himself from the harsh conditions that had been imposed upon him and drove the Moslem troops from his kingdom, Almanṣór took a terrible revenge. In 987 he stormed Coimbra and razed it to the ground. In the next year he advanced into the heart of the kingdom. Leaving Zamora, where Bermudo awaited him, on one side, he marched against the city of Leon, and took it after an obstinate resistance. The fortifications were utterly destroyed, with the exception of one gate, which was left to commemorate the victor's triumph. Zamora was then attacked, and Bermudo fled to his northern territories, which were all that were left to him.

In spite of these successes Almanṣór had to face more than one conspiracy on the part of those who were jealous of his pre-eminence. The most formidable of these was fomented by his former patroness, Ṣobḥ, who found herself more and more thrust into the background. She succeeded in gaining over her son, but Almanṣór soon recovered his ascendency over the feeble caliph, from whom he extorted a document transferring all powers to himself. A refusal of Bermudo II. to continue the payment of tribute led to the last and most famous of his campaigns, in which he took Compostella and carried off the gates and bells from the shrine of St. James, the patron saint of the Christians. At the same time his generals were gaining victories in Mauretania, and his power was almost equally dreaded on both sides of the straits. His death in 1002 deprived the Spanish Moslems of the greatest ruler and warrior, considering his origin, that their race had produced. His campaigns against the Christians, which are reckoned by the Arab historians as more than fifty, were almost uniformly successful. Three capitals—Leon, Pamplona, and Barcelona—had been conquered by him. His home administration was as successful as his generalship, and much of his attention was devoted to the construction of roads and bridges, so as to facilitate communication between all parts of Spain. He was a zealous, if not an intelligent, patron of literature, but his real interests were always practical. Finding that he was suspected by the people of a laxness in religious belief, he did not hesitate to prove his orthodoxy by an act of politic vandalism. Taking the chief *ʻulemá* into the library of Al-Ḥakam II., he begged them to collect all the books on philosophy, astronomy, and other prohibited sciences; and when they had completed their task he ordered the condemned books to be burnt on a vast pile.

Almanṣór had been absolute in everything but name. He had desired at one time to take the final step and to supersede the incapable Hishám II. in the caliphate, but he dreaded the inveterate attachment of the people to the Omayyad dynasty. He had, however, taken steps to secure the continuance of his family in power. His son, ʻAbd al-Melik Moẓaffar succeeded to the office of *ḥájib*, and ruled with the same authority and success as his father. But the position was really untenable. An hereditary monarchy is intelligible, but an hereditary line of chief ministers is not. The early death of ʻAbd al-Melik (1008) gave the government to the weaker hands of his brother ʻAbd al-Raḥmán. The latter was hated by the Mohammedan clergy, partly because he indulged in the use of wine, and partly because his mother had been born a Christian. She was the daughter of a Sancho, either the king of Navarre or the count of Castile, and her son was nicknamed Sanchol, or the little Sancho. The Amirids were not popular. Their exaltation irritated, not only the families that claimed a higher rank by birth, but also those who thought themselves their equals. Without having any actual grievance to complain of, the people vaguely desired a change of rulers. It was easy under the circumstances to effect a revolution. When Sanchol returned from a campaign against Leon in 1009 he found that his power had been completely overthrown. Mohammed, a great-grandson of ʻAbd al-Raḥmán III., had headed an insurrection in the capital and had gained possession of the caliph's person. Sanchol was put to death, and the magnificent palace which his father had erected at Zahrá was razed to the ground. The Amirids fell, and with them ended the grand period in the history of Moslem Spain.

Mohammed.

Mohammed was not long content with the office of *ḥájib*. Scrupling to kill the unfortunate Hishám, who had never made any opposition to the acts that had been committed in his name, he closely imprisoned him and buried the corpse of a Christian who bore a strong personal resemblance to the caliph. Mohammed was now raised to the caliphate, and assumed the title of Al-Mahdí (guided by God). But his reign was not destined to be long or untroubled. He had been raised to power by a combination of orthodox Moslems, of the so-called "Slavs" (foreign slaves serving in the royal harem and in the army of the caliph), and of Berbers, and he alienated each in turn. The Berbers, who formed an important part of the army, were the first to revolt. Raising the standard of Soleimán, a member of the Omayyad family, they obtained assistance from Count Sancho of Castile, marched upon Cordova, and inflicted a serious defeat upon the troops which Mohammed imprudently led out to meet them. Mohammed endeavored to strengthen his position by producing Hishám II., whom he had given out as dead. But the Berbers refused to be turned from their purpose, and occupied Cordova in November, 1009. The wretched Hishám was compelled to abdicate in favor of Soleimán, and returned to his prison. Mohammed, who had escaped to Toledo, now turned for assistance to the Christians, who, by a sudden change of circumstances, had become the arbiters of Mohammedan affairs. With the help of troops from Catalonia he recovered Cordova, which had to pay in constant sieges a terrible penalty for the levity with which it had welcomed the fall of the Amirids. In pursuing the Berbers, however, Mohammed was again defeated. The Slavs, who had hitherto supported him for their own ends, determined to desert the unsuccessful caliph. Hishám II. was again dragged from prison to assume the throne, and Mohammed was murdered in his presence. Wáḍiḥ, the leader of the Slavs, was now *ḥájib*, and aspired to play the part of Almanṣór. But his resources were at an end. An attempt to increase the taxes roused general indignation, and he was put to death by his own followers (1011). Two years later the nominal reign of Hishám II. came to an end. Cordova was taken by Soleimán and the Berbers, and the caliph disappeared (1013). His fate remains one of the unsolved secrets of history.

Soleimán.

Soleimán was now formally proclaimed caliph, but his power was more nominal than real. The provincial governors had taken advantage of the civil war to make themselves independent, and Soleimán's authority was only recognized by five towns—Cordova, Seville, Niebla, Oksonoba, and Beja. Even within this district he soon found an opponent. The Slavs were unwilling to submit to the domination of the Berbers, whose excesses the caliph was unable to check. Their most powerful leader, Khairán, had been badly wounded in the late struggle, but on his recovery he determined to avenge his defeat. He found a capable ally in ‘Alí b. Ḥammúd, a descendant of the famous son-in-law of the Prophet, but whose family had almost ceased to be Arab in their long residence in Africa. ‘Alí relied not only upon the Slavs but also upon the Berbers, who regarded Soleimán with contempt, and looked upon ‘Alí as a fellow-countryman. Soleimán's government was easily overthrown (1016), but Khairán's attempt to discover Hishám II. was unsuccessful, and he had to acknowledge ‘Alí as caliph and to content himself with the office of *ḥájib*. The Ḥammúdite dynasty, thus established in Cordova, was not destined to enjoy a long tenure of power. Khairán revolted against a sovereign who was too able and spirited for the part of a Hishám II., and set up an anti-caliph in the person of another Omayyad, ‘Abd al-Raḥmán IV., a great-grandson of ‘Abd al-Raḥmán III., who took the name of Mortaḍá. ‘Alí was murdered in his bath (1017), but his supporters rallied round his brother Ḳásim. For five years a confused civil war raged which was complicated by the hostility to Ḳásim of ‘Alí's son, Yaḥyá. In 1023 Mortaḍá was slain in battle, and the Omayyad party gave the crown to another ‘Abd al-Raḥmán, a brother of the detestable Mahdí. Two months later the young prince was murdered, but his successful rival, Mohammed b. ‘Abd al-Raḥmán was driven from Cordova in 1025. The Ḥammúdite caliph, Yaḥyá, now occupied the capital, but was slain in attempting to reduce the rebellious *wáli* of Seville to obedience. Hishám III., a brother of ‘Abd al-Raḥmán Mortaḍá, was now raised to the throne. But all central government was by this time at an end; no revenues could be drawn from the rebellious provinces; and in 1031 Hishám abdicated a title which had ceased to have any meaning, and sought peace and retirement in the neighborhood of Saragossa. His death five years later was almost unnoticed even in Cordova. With him ended the Omayyad dynasty, which had ruled in Spain for nearly three centuries, and which had produced princes worthy to be ranked with the greatest of their contemporaries. Its decline dates from the time when it allowed power to slip from its hands and to be wielded by ambitious ministers.

Ham-múdites.

Decline of the Omayyads.

Ever since the death of Almanṣór Moslem Spain had been gradually splitting up into a number of independent principalities. With the extinction of the Omayyads the last semblance of unity disappeared. "The Berber generals shared the south; the Slavs ruled in the east; the rest was divided either among successful adventurers or among the small number of noble families who had been fortunate enough to escape the blows which ‘Abd al-Raḥmán and Almanṣór had struck at the aristocracy. Finally, the two most considerable towns, Cordova and Seville, were organized as republics" (Dozy). Into the history of the numerous dynasties which were established during this period it is impossible to enter here, but the reader will find the subject not only fully but attractively treated in the fourth volume of Dozy's *Histoire des Musulmans d'Espagne*. See also Plate VII.

States of Castile and Aragon formed.

It was of additional moment that this disruption of the Mussulman power was contemporary with the formation of the great Christian states of Aragon and Castile. They were not slow to profit by the opportunity held out to them. It was in this century that the Christian cause found a champion in the famous Ruy Diaz Campeador, who under the name of "The Cid" became the traditional hero of Spanish mediæval history. Ferdinand I. of Castile (1037–1067) captured the strong places of Viseu, Lamego, and Coimbra, and was only diverted from the conquest of Toledo by the humble submission of the emir, who undertook to pay tribute to the Christian king. The unfortunate division of his territories between his three sons gave occasion to civil wars, which were only terminated in 1072 by the reunion of the whole kingdom under Alfonso VI. Following up his father's successes, Alfonso made himself master of Toledo, which once more became the capital of a Christian state. Meanwhile Ramiro I. of Aragon (1035–1063) drove the Moors from their last possessions in the counties of Aragon and Sobrarbe. His son, Sancho Ramirez (1063–1094), joined Alfonso VI. in an attack on Navarre which resulted in the partition of that state between the two kings, and commenced a war against the emir of Saragossa which ended, under his successors Pedro (1094–1104) and Alfonso I. (1104–1136), in the conquest of Huesca and Saragossa. The latter town became henceforth the recognized capital of Aragon.

Relations with Rome.

This period is also important in another aspect. Hitherto the Christian kingdoms of Spain had been naturally isolated from the rest of Europe. But the papacy, under the guiding hand of Hildebrand (Gregory VII.) was now making his ecclesiastical supremacy a reality, and was not likely to tolerate independence even in the most distant members of the church. Aragon, which lay nearest to the other states of Western Christendom, made little difficulty about complying with the papal demands. Ramiro not only agreed to adopt the Roman ritual in his kingdom, but even sent tribute to Alexander II. Castile, lying farther distant, was more inclined to resent dictation. At a council at Burgos (1077) it was formally decided to retain the Gothic ritual. But Alfonso VI. realized the danger of isolating his state from the rest of Europe, and of his own accord conceded the demands of Gregory VII. From this time Christian Spain was directly connected with Rome, and became the most faithful, if not the most servile, of Roman Catholic countries.

Almoravid campaigns in Spain (1069–91).

The Christian victories of the 11th century seemed likely at one time to annihilate the Mohammedan power in Spain. From this fate, however, it was saved, not by any internal strength, but by the arrival of assistance from Africa. The emir of Seville, Al-Mo‘tamid, the most powerful of the Moslem princes, watched with profound misgiving the progress of the Castilian arms. When Toledo fell before Alfonso VI. he determined to appeal to Yúsuf b. Táshufín, the king of the Almoravids,—a confederation of Berber sectaries that had recently established a vast empire reaching from the Senegal to Algiers. Yúsuf, who had established his capital at Morocco in 1069, was at this time eighty years of age, but he did not hesitate to accept the prospect of a new field of conquest and adventure. In 1086 he sailed from Ceuta to Algesiras, the cession of which he had demanded as the price of his aid, and was at once joined by the forces of the emirs of Andalusia. Alfonso VI. hastened to obtain assistance from the king of Aragon and the count of Barcelona, and with a larger force than had ever before been assembled in the Christian cause he met the Moors in the battle of Zalláḳa (Sacralias), a few miles from Badajoz (October, 1086). After an obstinate struggle victory declared for the infidels, and Alfonso had great difficulty in escaping with his life. Luckily for the Castilians, Yúsuf was recalled to Africa by the death of his eldest son, whom he had left at Ceuta, and his victory, which might have been as decisive as that of Ṭáriḳ, was not followed up. Alfonso even ventured to resume his aggressions, and laid siege to the important towns of Murcia and Almeria. Mo‘tamid, seeing that the danger was as great as ever, proceeded to Africa in person in order to urge the return of Yúsuf. The Almoravid prince, on whom the attractions of Andalusia had made a profound impression, crossed again to Algesiras (1090), and this time the predictions of the princes who had foreseen the risk of calling in so powerful an ally were fully verified. Postponing the task of resisting Alfonso, Yúsuf set to work to make himself master of Andalusia. Mo‘tamid himself had to fly from his territories, after a futile appeal for aid to the king of Castile. Captured by the Africans, the emir of Seville was condemned to end his life in close imprisonment. In the course of a few years the whole of Moslem Spain was reunited under the king of Morocco, and the death of the Cid in 1099 enabled the Moors to recover Valencia, which he had taken in 1094. This was the last event of the reign of Yúsuf, who in 1103 handed over the government to his son ‘Ali and returned to Africa, where he died three years later at the ripe age of a hundred years.

Alfonso VI. of Castile.

Alfonso VI. of Castile had raised his kingdom to such pre-eminence in the Peninsula that he had assumed the title of "emperor of Spain." But a great disaster clouded his later years. In 1108 his only son Sancho perished with the flower of the Castilian chivalry on the fatal field of Ucles, and most of Alfonso's conquests passed into the hands of the victorious ‘Ali. In 1109 the emperor died, leaving the succession to his daughter Urraca, the widow of Count Raymond of Burgundy. In order to secure the unity of the Christian kingdoms, Urraca was married to Alfonso I. of Aragon (1104–1134), who imitated his father-in-law in assuming the imperial title. But the marriage failed to produce the desired result. Urraca induced the Castilian nobles to revolt against the Aragonese rule and to set up Alfonso VII., her son by her first marriage. A civil war ensued, which was only ended in 1127 by the separation of the kingdoms. Alfonso I. retained Aragon and Navarre, while Castile, with Leon and Galicia, passed to Alfonso VII. Alfonso of Aragon renewed the war against the Moors which he had so gloriously begun by the capture of Tudela and Saragossa, but in 1134 he was completely defeated in the battle of Fraga, a disaster which hastened his death. As he had no children, he bequeathed his territories to the great crusading order of the Templars. The Aragonese, however, refused to recognize this testament, and gave the crown to his brother, Ramiro II. (1134–1137), who was brought out of a monastery to continue the dynasty. Ramiro fulfilled his duties by marrying a sister of the duke of Aquitaine, who bore him a daughter, Petronilla. At the age of two the child was betrothed to Raymond Berengar IV. of Barcelona, and Ramiro, leaving the administration of the kingdom to his son-in-law, hastened to return to his cloister. Thus a permanent union was effected between Aragon and Catalonia, both of which passed in 1162 to Petronilla's son, Alfonso II. But, if Catalonia was gained, another province, Navarre, was lost. The Navarrese had long desired to recover their independence, and on the death of Alfonso I. they refused to acknowledge Ramiro, and chose a ruler of their own, Garcia Ramirez. Ramiro, who needed Garcia's generalship against a threatened attack from Castile, recognized him, first as a vassal of Aragon and afterwards as an independent king. Thus Navarre regained its place among the kingdoms of Spain, though it never enjoyed its old importance.

Temporary union of Castile and Aragon.

Navarre independent.

Crusading orders.

The main interest of Spanish history in the 13th century centres round the war against the Moors, which was beginning to attract the interest and assistance of the other European states. It was the age of the great crusades, and Christendom was absorbed in the struggle against the infidel, both in the East and West. Spain, like Palestine, had its crusading orders, which vied with the Templars and Hospitallers both in wealth and military distinction. The order of Calatrava was founded in 1158, that of St. James of Compostella in 1175, and the order of Alcantara in 1176. The kingdom of Portugal, which had risen with great rapidity in the 12th century, had a no less distinguished order, that of Evora. These military priests, debarred by their profession from the ordinary interests of humanity, gave a firmness and consistency to the Christian cause which had too often been sacrificed to the dynastic quarrels of the temporal princes.

Struggles of Almoravids and Almohades.

The empire of the Almoravids, like so many of its predecessors, had soon begun to fall to pieces. It was too large and unwieldy for permanence. Its real centre was at Morocco, and the attention of the caliphs was absorbed in the affairs of Africa, while the extortion and misgovernment of their viceroys excited discontent among the Mohammedans of Spain. This state of things gave a great advantage to Alfonso VII. of Castile, who revived the title of emperor of Spain, allied himself with Raymond Berengar of Barcelona and Aragon, and sought to emulate the achievements of his grandfather. For the second time the Moorish power in Spain was only saved from dissolution by the arrival of reinforcements from Africa. As happened so often in Mussulman history, a movement which began with religious reform ended with the formation of an empire. Mohammed b. ‘Abdallah, an Arab from Mount Atlas, gave himself out as the expected Mahdí, and formed a sect known as the Almohades (Unitarians). His disciple, ‘Abd al-Mu'min, was chosen as his successor, and soon overthrew the power of the Almoravids. Táshufín, ‘Alí's son, made a vigorous but ineffectual resistance, and the conqueror crossed the sea to complete his work by the reduction of Spain (1146). The success of ‘Abd al-Mu'min, if less rapid than that of Yúsuf, was quite as complete. The Almoravids appealed to the Christians, and both Castile and Aragon came to their aid. Alfonso VII., with the help of the Genoese and Pisan fleets, besieged and took Almeria, while Raymond Berengar captured Tortosa. But these successes were only temporary. In ten years the Almoravids had been driven from the mainland, and only a small remnant found refuge in the Balearic Islands. Almeria was again wrested from the Castilians, and in 1157 Alfonso VII. died, the last of the series of "emperors of Spain." His territories were divided between his two sons, the elder, Sancho, succeeding to Castile, while Leon went to his brother Ferdinand. The quarrels which resulted from this partition would probably have been fatal to the Christian cause but for the exertions of the great knightly orders. The successors of ‘Abd al-Mu'min (d. 1163), Yúsuf and Ya‘ḳúb Almanṣór, continued to advance the power of the Almohades, and the latter inflicted a crushing defeat at Alarcos (1195) upon Alfonso VIII. of Castile, who had succeeded his father Sancho in 1158. Castile was at this time distracted by the feuds of the great families of Lara and Castro, and the count of Castro, who had been worsted by his rival, rendered conspicuous service to the infidels in the battle. Even Sancho of Navarre, out of jealousy of the rival kings, concluded an alliance with the Almohades.

Separation of Castile and Leon.

Downfall of the Almohades.

Luckily for the Christians Ya‘ḳúb, the most formidable opponent they had had to face since the great Almanṣór, died in 1199, and his death was followed by a rising of the Almoravids which took five years to suppress. Meanwhile successful efforts had been made by the pope and clergy to arrange the differences among the Christian states, and a confederation was formed between the five kings of Castile, Aragon, Leon, Navarre, and Portugal. When Ya‘ḳúb's successor Mohammed al-Násir, had succeeded in restoring order in Andalusia and prepared to march against the Christians, he was confronted by the allies in the famous battle of Las Navas de Tolosa, in the Sierra Morena (July 16, 1212). After an obstinate struggle the

Christians gained a decisive victory, and their success decided the fate of Spain. The religious impulse which had constituted the original strength of the Almohades had come to an end; they were regarded as infidels by the orthodox Moslems, and their first failure necessarily led to their downfall. The cruelties with which they sought to repress the rising discontent only excited popular feeling against them, and when Al-Motawakkil, a descendant of the family of Ibn Húd which had once ruled in Saragossa, raised the standard of revolt in Andalusia, the bulk of the population joined him, and Al-Ma'mún, the last of the Almohades who held any power in Spain, fled to Africa in 1232. The chief result of their rule was to depress the Arab element in the Mussulman population of Spain. Hitherto the Arabs, though numerically in a minority, had retained the preponderance due to their original prestige. Henceforth the infidels of Spain can only be considered and spoken of as Moors.

Castile and Leon reunited.

After the fall of the Almohades the triumphs of the Christian arms were rapid and decisive. The separation of Castile and Leon, which had been productive of so much disaster, was finally terminated in 1230 by the accession of Ferdinand III., the son of Alfonso IX. of Leon and Berengaria of Castile. The province of Estremadura had been annexed to Leon by Alfonso IX., and now formed part of the united kingdom which under Ferdinand III. rapidly extended itself southwards. In 1233 the Castilian army won a great victory over the Moors under Al-Motawakkil, and three years later Ferdinand himself captured Cordova, so long the capital of the Mohammedan rulers and one of the most wealthy and beautiful cities of Europe. In 1237 Al-Motawakkil was assassinated, and with him perished the last semblance of Moorish unity. The numerous emirs became independent rulers, and the most powerful of them, Mohammed Ibn al-Aḥmar of Granada, became a tributary of Castile and ceded the strong town of Jaen (1246). In 1248 Seville, the second of the Mohammedan cities, submitted to Ferdinand, who within a few years annexed Xerez de la Frontera, Medina Sidonia, and Cadiz. By these acquisitions the frontier of Castile was extended to the southern coast before Ferdinand III.'s death in 1252. A considerable number of Moors submitted to the rule of Castile, but the Christians had become intolerant during the long war, and most of the conquered population sought a new home either in Granada or in Africa.

Successes of Aragon.

Meanwhile Aragon had taken a no less important part in the struggle. Pedro I. (1196–1213), the successor of Alfonso II., had excited the discontent of his subjects, partly by seeking coronation from Pope Innocent III., and partly by his excessive taxation. The "union" of nobles and towns compelled the king to diminish his exactions. Pedro took part in the battle of Navas de Tolosa, but his attention was diverted from Spanish affairs by his relationship with Raymond of Toulouse, which involved him in the Albigensian crusade, where he met his death. His son James I. (1213–1276), however, resumed the war against the infidels, and won in it the title of "The Conqueror." With the help of his Catalonian subjects, at that time perhaps the most accomplished sailors in the world, he conquered the Balearic Islands (1229–1233), which had long been a stronghold of the Moslem and a centre for piratical attacks upon the Christian states. Still more important was his reduction of Valencia (1238), which had once before been conquered by Ruy Diaz. The last achievement of the great king was the conquest of the province of Murcia (1266), the last of the Moorish territories in Spain except Granada. Murcia, though reduced by Aragon, was handed over to Castile. By the acquisition of Algarve Portugal had already acquired frontiers which correspond roughly to those which it has at the present day.

Cessation of the crusade.

From the latter half of the 13th century the crusading energy of the Spaniards came to a sudden standstill, and the Moors were allowed to retain possession of Granada for more than two centuries. The causes of this abrupt termination of the war before it had reached what seemed to be its natural and legitimate end have often been discussed. In the first place Castile was henceforth the only state which was directly interested in the war. By the acquisition of Seville and Murcia it had separated Granada both from Portugal and Aragon, neither of which states had henceforth any conterminous frontier with the Moors. The state of Granada, though small when compared with Castile, was by nature easily defensible, as was made amply apparent in the last campaigns under Ferdinand and Isabella. The attention of Castile was often distracted by foreign interests or by internal dissensions. Again, the Moors were more concentrated and homogeneous in Granada than they had been when their rule was more extensive. The large subject population, many of whom were Christians or renegades, had been a great source of weakness, and this no longer existed. They, like their opponents, had given up the tolerance that had once distinguished them, and hardly any but true Mohammedans can have remained in Granada. Something, too, must be attributed to the wily policy and well-timed submission of Mohammed Ibn al-Aḥmar, who even gave assistance to Ferdinand III. against the other Moorish emirs.

Moorish Granada.

With the termination of the crusade Spanish history loses what little unity it had possessed for the last two centuries, and it becomes necessary to follow the fortunes of each state separately. Into the history of Granada it is as impossible as it would be tedious to enter within the limits of this article. It is a long record of revolution and civil war, in which nothing above the most petty personal interests are concerned. There is no change of dynasty, but one perpetual struggle between members of the same family. It would not be easy to enumerate even the names of the successive rulers, many of whom were several times deposed and restored to power. Even during the final struggle, when the existence of the kingdom was at stake and the one hope of resistance lay in unity, the national cause was sacrificed to the jealous rivalry of three claimants of the throne. The history of Castile and Aragon, on the other hand, assumes a new character and interest when the attention of kings and people ceased to be absorbed in the overwhelming excitement of a great religious war.

CASTILE (1252-1479).

Constitution of the kingdom.

The constitution of Castile traced its origin back to the institutions of the Visigoths, which had been carried by the original refugees into the mountains of Asturias, but it had been profoundly modified by the circumstances under which the kingdom had risen to greatness. The war with the infidel, while it had given strength and unity to the monarchy, had at the same time compelled the granting of considerable independence to the nobles and the great towns. The religious character of the war had enabled the clergy to retain greater powers than they possessed in any other European country, though they had lost that omnipotence which they had enjoyed under the Visigoths. Their councils and synods, which had once formed the sole constitutional machinery of the country, had been superseded by the secular assembly of the cortes. The early history of the cortes is wrapped in great obscurity, but its main outlines are fairly discernible. Originally a meeting of the great nobles and royal household, it had attained the position of a national assembly in 1162, when the deputies of the chief towns were admitted to membership. Its powers and procedure developed gradually, and naturally varied according to the character of the different kings. Its first functions were the approval of legislation and the granting of extraordinary taxation, though it is difficult to say when its sanction of such measures was regarded as essential. The assembly consisted of the three estates—clergy, nobles, and citizens—who deliberated sometimes separately and sometimes together. Representation existed only in the case of the third estate, whose members were elected at first by all free citizens, and afterwards by the municipal magistrates. The number of cities which sent deputies varied very much at different times. As to what constituted the right of attendance in the case of the nobles and clergy there is great obscurity, but it probably depended partly upon tenancy-in-chief, and partly upon royal summons. As both classes were exempt from taxation, their functions were less important than those of the third estate, and on more than one occasion we find meetings of the cortes in which the upper orders took no part. The weakness of the assembly, as contrasted with the English parliament, lay mainly in the absence of any class like the knights of the shire to form a link between the burgesses and the great nobles. In early times, probably the most effective check upon the royal power lay in the independent privileges claimed and exercised by the chief feudatories. Their tenants were bound to feudal service ; and the right of private war made them petty sovereigns on their own estates. The long feud of the families of Castro and Lara is only a notable example of the difficulties which the central power had to contend with. For the protection of their privileges, both nobles and towns claimed the right of forming an armed union or *hermandad*, which resembled the right of "confederation" exercised in later times by the nobles of Poland. The ordinary administration, except when war was going on, was local rather than central. The nobles had judicial powers within their domains, though it appears that these were granted by the crown rather than derived from their territorial position. The bishops and higher clergy administered ecclesiastical jurisdiction as in other countries, and at the same time exercised the same powers as the secular lords over the large estates which the piety or superstition of generations of benefactors had conferred upon them. The connection with Rome, though established in the 11th century, had not become very close before the middle of the 12th century ; the appointment to most of the benefices was in the hands of the crown, and the church of Castile was more independent even than that of England. In the cities and great towns, most of which included a considerable extent of adjacent territory, the administration both of justice and of local affairs was in the hands of elected corporations, which had received grants of liberties at the time when they had served as important outposts against the attacks of the infidel. In theory, probably, there existed in all cases a right of appeal to the crown, but this was a right which, in the nature of things, was rarely exercised. The attempt of subsequent kings to control or supersede the local administration of justice by the appointment of *corregidores* was always resisted as an encroachment upon traditional liberties. Even the taxes, though granted by a central assembly, were assessed and collected by the local officials, and jealous care was taken to secure that they should only be applied to the purpose for which the grant had been made.

Alfonso the Wise.

Ferdinand III., "The Saint," was succeeded in 1252 by his son, Alfonso X., "The Wise." The new king gave up the military policy of his father, and the only territorial acquisition of his reign, the province of Murcia, was won for him by the arms of Aragon. On the other hand, he was a great student and patron both of literature and science, especially of astronomy. He invited to his court the most distinguished scholars, not only in Christian but also in Arabic lore, and he raised the university of Salamanca to rank with the great schools of Paris and Oxford. He also turned his attention to legislation, and his code, the *Siete Partidas*, is one of the great legislative monuments of an age which produced the *Etablissements* of St. Louis and the great statutes of Edward I. Compiled under the influence of the civil and canon laws, the *Siete Partidas* was in some respects disadvantageous, especially as admitting papal encroachments upon the ecclesiastical power of the crown. Though drawn up under Alfonso X., it did not finally supersede the ancient *fueros* until 1348, when it was formally approved by the cortes. But Alfonzo's reign, though distinguished in the history of literature and law, was not on the whole a prosperous period for Castile, and it was to a great extent his fault that the opportunity of driving the Moors from the Peninsula was allowed to slip. On the fall of the Hohenstaufen he came forward as a candidate for the imperial dignity, and through the period known as the "great interregnum" he and Richard of Cornwall, chosen by rival parties among the electors, bore the empty title of king of the Romans. The expense of bribing the electors and of maintaining a magnificent court involved Alfonso in pecuniary difficulties and compelled him to alienate his subjects by imposing heavy taxes and by debasing the coinage. But the hardships inflicted on the country by the king's futile ambition were as nothing compared with those which arose from a disputed succession to the crown. By the old custom of Castile nearness of blood gave a superior claim to priority of descent, so that the second son of a king would be preferred to the children of the eldest son. The *Siete Partidas* recognized the more modern rule of succession; but as that code had not yet been accepted by the cortes, its ruling had no binding force. The question arose in 1275, when Alfonso's eldest son, Ferdinand de la Cerda, perished in a campaign against the Moors, leaving two sons, Ferdinand and Alfonso. The king's second son, Sancho, was at once declared heir to the crown, but the widow, Blanche, announced her intention to uphold the rights of her children, and she received support both from Pedro III. of Aragon and from her brother, Philip III. of France. A long war followed, which was further complicated when Alfonso X., having quarrelled with his son, proposed a partition between the rival claimants. So far did the dispute go that the Moors, instead of being attacked in Granada, were called upon to give their assistance to the factions among their enemies.

Sancho IV.

The result of these internal quarrels was to increase the already excessive power of the noble families, and this was productive of further disturbances in the reign of Sancho IV. (1284–1295). The family of Castro seems to have sunk into comparative insignificance, but the Laras had found a new rival in the house of Haro. The whole state was divided by their feuds, and the king found himself degraded from the position of arbiter to that of a partisan. The condition of affairs became even worse when the death of Sancho gave the crown to his infant son Ferdinand IV. (1295–1312). In an early stage of society a minority is always an evil, and Castile at this period had more than a fair share of such misfortunes. The crown was contested, not only by the late king's brother John, but also by Alfonso de la Cerda, who returned from France to maintain a claim which had already been negatived by the accession of Sancho. The king of Aragon supported Alfonso, while the rulers of Portugal and Granada mixed themselves up in the quarrel to obtain advantages for themselves. The regency had been bequeathed by Sancho to his widow, Maria de Molina, but her marriage had been declared uncanonical by the pope, so that a slur was cast upon the legitimacy of her son. Nothing but the great skill and capacity displayed by the regent could have secured victory under such discouraging circumstances. By mingled submission and defiance she disarmed one opponent after another, induced the pope to ratify her marriage, and

Ferdinand IV.

finally succeeded in transferring the government to her son on his coming of age. Ferdinand's harshness provoked a renewal of the conflict; but ultimately the treaty of Camillo (1305) put an end to the struggle, and compensated the princes of La Cerda with lavish cessions of territory. Alfonso preferred to remain an exile rather than to abandon his claims, but his son accepted the profferred conditions and became the founder of the great house of Medina Sidonia. But the treaty made little difference to the country. Disorder and civil war had become a chronic disease in Castile and Ferdinand IV. was himself too deeply imbued with the spirit of the age to maintain peace with a strong hand. The story that is told about his death illustrates his character. In spite of a solemn promise made twice during his reign that every accused person should have a fair trial, he ordered two brothers of the name of Carvajal to be put to death without the pretence of judicial forms. They summoned him to appear before the supreme tribunal within thirty days, and on one morning within that period he was found dead in his bed. The cause of his death was never ascertained, but the people regarded the event as a judgment, and he has received from this story the name of "The Summoned" (*El Emplazado*).

Alfonso XI.

Ferdinand IV.'s death was followed by another and still longer minority, as his son, Alfonso XI. (1312–1350), was only two years old at the time. The regency was claimed by the late king's brother Don Pedro and by his uncle Don John, and from this dispute arose a civil war fiercer and more destructive than any of its predecessors. The central authority ceased to exist; both nobles and towns had to protect themselves as best they could; the royal domains were seized upon by rapacious neighbors, and the person of the young king was only saved by his being concealed in the cathedral of Avila. At last the mediation of the pope and of Maria de Molina brought about a compromise, and the administration was divided between the two regents,—Pedro taking the southeastern and John the northwestern provinces (1315). But a few years later they were both killed in a joint campaign against the emir of Granada, and the disorders broke out with worse violence than ever (1319). Four "infants," as the members of the royal family were called, contended for the government, and the assumption of power by the king himself at the age of fifteen failed to put a stop to their feuds. The character of Alfonso XI. was as harsh and brutal as was to be expected in a man who had been educated in such troubled times. He invited his cousin, a younger Don John, to a banquet in the royal palace, and treacherously murdered him. His treatment of his first wife, whom he divorced in order to marry a daughter of the king of Portugal, provoked her father, Don John Emanuel, a nephew of Alfonso X., to head a rising which took years to suppress. The Portuguese princess was also repudiated by her husband, who had been inspired with a passion for the beautiful Eleanor de Guzman, and the forces of Portugal were added to those of the Castilian rebels. After a long struggle (1335–1337) Alfonso XI. succeeded in reducing his opponents to submission, while he conciliated Alfonso IV. of Portugal by restoring his daughter to her position as queen. The restoration of unity was extremely opportune, as Spain was threatened at this moment by a new invasion from Africa. Abu'l Ḥakam, the head of the Merinids and emir of Fez, crossed over to Gibraltar with a huge army in 1339, and was acknowledged as suzerain by the ruler of Granada. Assistance was obtained both from Aragon and Portugal, and in 1340 Alfonso XI. marched to the relief of Tarifa, which was besieged by the Moors. On the banks of the Salado the Christians won a great victory, which destroyed the last chance of a revival of the Mohammedan power in Spain. Abu'l Ḥakam fled to Africa, and in 1344 Alfonso concluded a glorious war by the reduction of Algesiras. In the hope of cutting off all connection between Granada and Africa, Alfonso laid siege to Gibraltar in 1350, but before he could accomplish his design he was carried off by the Black Death. His victories over the infidel have led the Spanish historians to gloss over the acts of cruelty and treachery which have left an ineffaceable stain upon his character. His reign, troubled as it was, constitutes an important epoch in the history of Castilian liberties. In 1328 he issued two laws which formed the firmest basis of the powers of the cortes. He recognized the right of that assembly to be consulted in all important matters of state, and he solemnly pledged himself and his successors not to impose any new tax without its approval and consent. These concessions were to some extent counterbalanced by his restriction of the right of electing deputies to the *regidores* or magistrates of each city. This narrowing of the franchise was a great blow to the popular rights, and it gave the crown facilities for tampering with the elections which were frequently abused in later days. But at the time the municipal magistrates enjoyed considerable independence, and for several generations the cortes showed no signs of subservience. In fact Alfonso's position made him dependent upon the support of the citizens against the great lords, so that he was not likely to aim at diminishing the power of the former class. Another important event of the reign was the granting by the cortes, for the expenses of the Moorish war, of the *alcavala*, a tax of a twentieth upon every sale of real or personal property. This tax, one of the most ruinous that can be conceived, illustrates the want of economical insight in the 14th century, and was destined in later times to seriously impede the industrial and commercial development of Spain.

Pedro I.

The atrocities of Alfonso XI.'s reign sink into insignificance when compared with those committed by his son and successor, Pedro I. (1350–1369). The story of the latter's rule is mainly derived from the narrative of his avowed enemies, but there is no reason to doubt the substantial accuracy of the charges which have given him the name of "The Cruel." Some of his actions may perhaps be attributed to a politic desire to destroy the ascendency of the great nobles, whom the princes of the royal house had often headed against the crown; but most of them can only be explained by a thirst for bloodshed which almost amounted to mania. He ascended the throne at the age of sixteen, and was at once urged by his mother Maria of Portugal to avenge the wrongs which she had endured at the hands of her rival, Eleanor de Guzman. The unfortunate Eleanor was strangled in prison, and her sons could only secure safety by flight. The eldest, Henry of Trastamara, found a refuge first in Portugal and afterwards in France. A wife was now found for the young king in Blanche, daughter of the duke of Bourbon, in the hope of strengthening his throne by a French alliance. But Pedro had formed a connection with Maria de Padilla; and, when he was at last induced to go through the marriage ceremony with Blanche, he quitted her immediately to return to his mistress, whose brothers he advanced to the chief offices of state. A conspiracy of nobles, headed by Alfonso of Albuquerque, lately the king's favorite, was suppressed with ruthless severity. Pedro now concluded a second marriage with Juana de Castro, although Blanche was still living, but he again returned to Maria de Padilla. Another conspiracy, backed up by the pope and the French king, was more successful. After standing a long siege in Tordesillas, Pedro was compelled to concede the demands of the coalition and to acknowledge Blanche as his lawful queen. But his submission was only feigned. Seizing the opportunity of a hunting-party to escape from the imprisonment in which he was kept at Toro, he rallied a mercenary army round him and took terrible vengeance upon his opponents (1355–56). Henry of Trastamara, who had joined in the rising, escaped to France, where he took part in the war against the

English. It would be wearisome to catalogue the long list of cruelties, beginning with the murder of the unfortunate Blanche of Bourbon, of which Pedro was guilty during the next ten years. It seems almost incredible that such a monster should have been allowed to reign in a country which had already shown so much independence as Castile. But several causes combined to secure him against deposition. In the first place, it was upon the nobles and the Jews that his hand fell with such severity, while to the citizen class he was on the whole a lenient ruler. This explains why it was that the cortes made little or no opposition when he endeavored to secure the succession to his own children. In 1362 he solemnly swore that he had been lawfully married to Maria de Padilla, and his four children by her were recognized as heirs to the crown. His son Alfonso, however, died in the same year, and only two daughters, Constance and Isabella, survived their father. Another point in Pedro's favor was the outbreak in 1356 of a war with Aragon, which lasted almost without intermission for the rest of the reign, and in the course of which the Aragonese king was joined by Henry of Trastamara. Much as the Castilian nobles hated Pedro, they hated Aragon still more, and they were unwilling to accept a king who might seem to be forced upon them by the neighboring kingdom. This war was in a way harmful to the interests of both kings. They were both eager to depress the powerful nobles in their territories, but their continued hostilities only enabled these nobles to extend their power. On more than one occasion this community of interest was on the verge of leading to an agreement which would probably have excluded the house of Trastamara forever from Castile, but each time national and personal enmity combined to revive the quarrel. Though Castile was larger and possessed of more resources than its rival, the presence of a large number of Castilian exiles in Aragon made the combat fairly even. But in 1365 Henry of Trastamara obtained new and more formidable auxiliaries. Charles V. of France, who was now beginning to reorganize that country after the English wars, was only too glad to allow the disorderly bodies of disbanded soldiers to seek employment in Spain under the leadership of Bertrand du Guesclin. To these formidable enemies Pedro did not venture to offer resistance and fled to Bayonne, while his half-brother Henry was everywhere acknowledged as king (1366). But Pedro succeeded in convincing the Black Prince of the justice of his cause and of the impolicy of allowing the French king to gain overwhelming influence in the Peninsula. Before the end of the year Edward's army had crossed the Pyrenees, a number of English mercenaries in Du Guesclin's service deserted to the banner of their old leader, and in April, 1367, was fought the great battle of Najera or Navarrete, near Logroño. Du Guesclin was taken prisoner; Henry of Trastamara fled to France; and Pedro was restored to his throne. But the Castilian king had learnt no wisdom from adversity. His barbarity disgusted his allies, who were further alienated by his failure to furnish his promised supplies. The fever had already begun to decimate his troops and to weaken his own health when the Black Prince quitted Castile. His departure gave another opportunity to Henry of Trastamara, who had obtained fresh reinforcements from Charles V. In 1369 the battle of Montiel was decided in Henry's favor. Pedro was taken prisoner, and was killed in a personal struggle with his rival, into whose tent he was brought. His two surviving daughters had been left as hostages at Bordeaux, and were married to two brothers of the Black Prince,—John of Gaunt, and Edmund Langley, duke of York.

Henry II.

Henry II. (1369–1379) was of illegitimate birth, and his marriage with the heiress of the La Cerdas was hardly sufficient to remove all doubts as to his claim to the succession. But within his kingdom he met with little opposition. The Castilians were glad to settle down under an orderly government after the late reign, and the few malcontents exiled themselves to join the foreign claimants of the throne. The most important of these was Pedro I. of Portugal, whose grandmother belonged to the legitimate line of Castile, and John of Gaunt, who came to Spain to vindicate the rights of his wife Constance. Pedro I. proved for a time a formidable enemy. He allied himself with the Moors, who seized the opportunity to recover Algesiras, and with the king of Aragon, who annexed the border districts of Castile. But Pedro was an incapable warrior, and soon abandoned his own claim to obtain the English support by acknowledging John of Gaunt. But this enabled Henry to renew his alliance with France, and with the help of French troops he invaded Portugal, besieged Lisbon, and compelled Pedro to make peace. Two years later a treaty was concluded with the king of Aragon, by which his conquests were restored. For the remainder of his reign Henry's throne was secure, and he left the kingdom in peace to his son John I. (1379–1390). The chief interest of the new reign centres round the relations with Portugal. The first renewal of the war was the work of the Portuguese king Ferdinand, who again supported the English claims upon Castile. But the alliance with England was not popular in Portugal, and in 1383 a treaty was concluded, which, however, proved productive rather of evil than of good. Beatrix, the only daughter of Ferdinand, was married to the Castilian king; and it was agreed that her children, whether male or female, should succeed to the throne of Portugal. A few months later Ferdinand died. Beatrix was at once proclaimed queen, and her mother undertook the regency. But the idea of union with Castile, which would involve the subordination of the smaller kingdom, was intensely unpopular at Lisbon. A rising overthrew the authority of the queen-mother, and the administration was intrusted to John, a brother of the late king. John of Castile at once entered Portugal to enforce what he considered to be the rights of his wife. But his high-handed measures only added strength to the opposition, and made the new regent the leader of a national movement. In 1384 the Castilian forces laid siege to Lisbon, which held out with obstinate resolution for five months, when the besiegers retired. Exulting in their success, the Portuguese determined to have nothing more to do with Beatrix; and an assembly of the cortes gave the crown to the regent John. The Castilian king now made a determined effort to uphold his failing cause, but at the great battle of Aljubarrota (August, 1385) his army suffered a crushing defeat. It was now the turn of the Portuguese to take the aggressive, and the arrival of John of Gaunt enabled them once more to take up his cause. It was only the aid of France and the dislike of the Castilians for the foreign-bred Constance and her husband that enabled John to make head against his numerous enemies. In 1387 he succeeded in terminating the English part of the quarrel. His eldest son Henry, the first heir to the crown who received the title of prince of Asturias, was betrothed to Catherine, daughter of Constance, in whose favor John of Gaunt renounced all claims on behalf of his wife (1387). The war with Portugal now sunk into a chronic struggle on the frontier, but was still going on when John I. died in 1390.

John I.

Henry III.

With the accession of Henry III. (1390–1406), a boy of eleven, Castile was again face to face with the difficulties of a minority, and these were the more formidable on account of the absence of any prince of the blood-royal to assume the regency. By the will of the late king the administration was intrusted to a council to be formed by joint representation of the three estates. But the composition of this body was altered so as to give more power to the great nobles and prelates, and their quarrels soon involved the kingdom in the troubles of a civil war, from which it had been comparatively free in the last two reigns. Luckily for Castile, the young king, who assumed the government in 1393, showed himself to be a man of equal insight and resolution. By throwing himself boldly upon the support of the third estate, and by giving them the predominance in the cortes, he succeeded in taking efficient measures against the nobles. All domain-lands which had been alienated during his minority had to be restored, and all confederations among the barons were declared illegal and dissolved. The discontent which these measures provoked was promptly suppressed before it could develop into insurrection. At the same time the country enjoyed the blessings of external peace. Henry's marriage with Catherine of Lancaster secured him against hostilities not only from England but also from Portugal, whose queen was Catherine's sister. Unfortunately for the kingdom which he ruled with such wisdom and success, Henry III. died in 1406 at the age of twenty-seven, leaving an infant son to succeed him.

John II.

The minority of John II. was the most orderly period of his reign (1406-1454). The government was wielded by the able hands of his uncle Ferdinand, to whom the Castilians would have given the crown if he had been willing to supplant his nephew. Even after his accession to the throne of Aragon in 1412 he continued to give his advice to the queen-mother. The administration during these years was strong and orderly. The fortress of Antequera was taken from the Moors, and the Castilian nobles were kept in the same subjection as in the late reign. A new and disastrous period commenced in 1417, when the death of his mother transferred the reins of government to John II. at the age of fourteen. Averse to the cares of business and absorbed in personal pleasures, the young king was only too ready to allow himself to be guided by any one who would take the responsibility of rule upon his own shoulders. Before many years had elapsed he had fallen completely under the influence of Alvaro de Luna, grandmaster of the order of St. James and constable of Castile. The minister, possessed of all the qualities which would have endowed a great monarch, set himself to increase the royal power. Not only were the nobles depressed to a condition of impotence which they had never yet experienced, but steps were also taken to diminish the powers of the third estate. Many of the lesser towns in Castile, as in England at the same period, found that the right of representation involved pecuniary burdens which they were eager to get rid of. This made it easy for the minister to reduce the number of towns sending deputies to the cortes to some seventeen or eighteen of the larger cities. This diminution of the third estate, though not resented, was an insidious blow at its real interests, and made it easy for Charles V. and his successor to reduce the cortes to impotence. The arbitrary government of John II., which might have been endured if it had been really directed by the king himself, was intolerable to the nobles when it was known to be inspired by his minister. The reign is filled by a series of conspiracies, in which the domestic malcontents found powerful allies in John II.'s cousins, John and Henry of Aragon. But Alvaro de Luna was a warrior as well as a politician, and succeeded in foiling all direct attempts to effect his overthrow. His ultimate fall was due to the ingratitude of the king whom he had served too well. John's second wife, Isabella, of Portugal, disgusted at the small amount of influence which the minister allowed her to exercise, set herself to effect his overthrow. Once deprived of the royal favor, Alvaro de Luna had no further support to rest upon. The very absolutism which he himself had built up was turned against him, and he was executed after a trial which was notoriously unfair. A year later John II. followed him to the grave, and the crown passed to his son, Henry IV., the feeblest sovereign that ruled in Castile before the 17th century. His mind was as feeble as his body, and the contempt of his subjects has fixed upon him the title of "The Impotent." His first favorite, the marquis of Villena, was supplanted, after Henry's marriage with Joanna of Portugal, by Beltran de la Cueva, whom scandal declared to be the queen's paramour. The birth of a daughter did nothing to check these rumors, and the unfortunate infanta was only known as "la Beltraneja." The government was not exactly oppressive, but it failed to command respect, and personal jealousies and ill-feeling were sufficient to produce a revolt. The leaders were the marquis of Villena and Carillo, archbishop of Toledo, both of whom had objects of their own to serve. In 1465 the rebellion broke out, and its first act was the formal deposition of Henry at Avila, after an absurd ceremony in which the king was represented by a puppet. The conspirators denounced the infanta Joanna as illegitimate, and offered the crown to Henry's brother Alfonso. In the course of the civil war which followed, Alfonso died (1468), and his partisans at once put forward the claims of his sister Isabella. But the infanta, who already displayed a wisdom and moderation beyond her years, refused to be involved in hostilities with her elder brother, and she succeeded in arranging a treaty by which she was recognized as Henry IV.'s heiress. The king himself struggled hard to evade these conditions, and after his death in 1474 Joanna's cause was espoused by her uncle, Alfonso V. of Portugal. But Isabella succeeded in securing her accession to the throne, and her marriage with Ferdinand of Aragon, by paving the way for the union of the two kingdoms, begins a new period in which for the first time there is a real history of united Spain.

Henry IV.

Isabella.

ARAGON (1213-1479). Constitution.

The kingdom of Aragon which we left in the reign of James the Conqueror (1213–1276), consisted of the three provinces of Aragon, Catalonia, and Valencia. Each province retained its own laws and institutions, and Valencia and Catalonia regarded with the keenest jealousy any attempt to govern them on the principles which prevailed in Aragon. The powers of the crown were far more limited than in the neighboring kingdom of Castile. The great nobles, or *ricos hombres*, formed a small and exclusive class, whose privileges made them almost the equals of the monarch. All conquests had to be divided between them, and the king was forbidden to confer a fief or honor upon any person outside their ranks. They possessed and exercised the right of private war, and were entitled at will to renounce their allegiance to their sovereign. The smallness of their numbers made them much more united than the nobles of Castile, and proportionately more formidable. The difference between the two kingdoms was recognized by Ferdinand the Catholic with his usual acuteness when he said that "it was as difficult to divide the nobles of Aragon as it was to unite those of Castile." But the privileges of the nobles, great as they were, were not the only check upon the royal power. Each province had its own cortes, which possessed from a very early date the right of granting taxes and approving legislation. In Valencia and Catalonia the cortes consisted, as in Castile, of the ordinary three estates; but in Catalonia, where a maritime life had inspired the inhabitants with a passionate love of freedom, the commons enjoyed a predominance which was hardly to be paralleled in any other country in the Middle Ages. The cortes of Aragon, which were more important, and whose history has been more carefully elucidated, consisted of four estates or arms (*brazos*). Besides the great prelates and the *ricos hombres*, both of whom had the right of appearing by proxy, there was a separate chamber of smaller landholders. This contained the *infanzones*, or lesser tenants-in-chief, and the *caballeros* or knights, who were tenants of the greater barons but whose military rank gave them the right of personal attendance. The fourth chamber alone was representative, and consisted of the deputies of the towns. Their presence is first mentioned in 1133, thirty years before anything is heard of popular representation in Castile. Their numbers were naturally small, as the kingdom was of very limited extent, but it seems to have been early established that a town which had once sent deputies was permanently entitled to the privilege, and this preserved them from having their rights tampered with by the crown as was done in Castile. Besides their legislative and taxative functions, the Aragonese cortes were also a supreme court of justice, and in this capacity were presided over by the *justiciar*, an official whose unique powers have attracted the attention of all writers on Spanish history. In its origin the office had nothing very remarkable about it, and it is only the peculiar circumstances of the kingdom which forced it into such prominence. The justiciar was not at first intrusted with any political functions, but the difficulty of adjusting the relations between the king and the barons led to his being called in as mediator. By the 14th century he had become almost the supreme arbiter in all constitutional questions. To him the people could appeal against any infraction of their liberties, while the king regarded him as his chief councillor and as the most efficient barrier against armed rebellion, which was the only alternative method of settling disputes between his subjects and himself. As the justiciar thus became the pivot of the constitution, it was of great importance to secure that he should exercise his functions with firmness and impartiality. As the *ricos hombres* were exempted from corporal punishment, he was always chosen from the lesser nobles or knights, and was made responsible to the cortes under penalty of death. The dignity of the office was enhanced by the character of its successive holders; and the mediæval history of Aragon abounds with instances of their fearless opposition to the crown and of their resolute resistance to despotism on the one hand and to anarchy on the other.

Pedro III.

Alfonso III.

The glorious reign of James (I.) the Conqueror was disturbed towards its close by quarrels which arose from his scheme of partitioning his conquests among his children. The death, however, of his youngest and favorite son put an end to these projects, and the most important of the provinces passed into the hands of Pedro III. (1276–1285). Under Pedro and his son and successor Alfonso III. (1285–1291), attention was almost wholly diverted from internal affairs to the conquest of Sicily. By his marriage with Constance, the daughter of Manfred, Pedro could put forward a claim to succeed to the Hohenstaufen in Naples and Sicily, but it is not probable that he would have been able to make any use of the claim if the Sicilian Vespers (1283) had not thrown that island into his hands. The result was a long series of wars with the Angevin rulers of Naples, but the hold upon Sicily was steadily retained. These wars had a notable influence upon Aragonese history, as they compelled the kings to purchase the support of their subjects by concessions which could only with great difficulty have been extorted from them. Thus in 1283 Pedro III. granted the famous "General Privilege," the Magna Carta of Aragon. By this the crown formally laid down a number of rules to secure all classes against oppression. The General Privilege is quite as important a document as the English charter; it is even more full and precise, and its numerous confirmations show that it was as highly prized. It had the additional advantage of being issued to a people already possessed of institutions sufficiently developed to employ and defend the national liberties. But if Pedro's concessions were for the advantage of his country, his successor went to an extreme which was equally harmful. In 1287 Alfonso III. signed the famous "Privilege of Union," by which his subjects were formally authorized to take up arms against their sovereign if he attempted to infringe their liberties. The right of revolt, while it is and must be the ultimate safeguard against oppression, becomes at once liable to abuse when it is formulated and discussed. The act of 1287 gave an unlimited license to disorder, which could always disguise itself under the pretence of defending liberty. Until it was repealed there was always a danger that the constitution would succumb, not to the tyrannical usurpations of the crown, but to the selfish interests of the nobles.

James II.

Alfonso IV.

Pedro IV.

On the death of Alfonso III. the crown passed to his brother James II. (1291–1327). The new king handed over Sicily to his younger brother Frederick, thus creating a separate dynasty in that island. In the hope of depressing the greater barons, James II. strengthened the hands of the justiciar and sought to conciliate the clergy and citizens to the crown. By these steps he succeeded in avoiding any open conflict during his reign, and at the same time he sought to secure external unity by an edict which declared the three provinces of Aragon, Catalonia, and Valencia to be forever indivisible (1319). But his successor, Alfonso IV. (1327–1336), did not hesitate to break this edict, in spirit if not in letter, by carving out great fiefs for his second wife, Eleanor of Castile, and her children. By this measure he gave rise to the difficulties, and indirectly to the triumphs, of his son, Pedro IV. (1336–1387). Pedro's reign is a great epoch in Aragonese history, as to him is due the arrest of the tendencies which threatened to divide and destroy the kingdom. He began by recalling his father's excessive grants to his stepmother and his half-brothers. The intervention of Alfonso XI. of Castile on behalf of his sister failed to make any impression upon the king, and it was only the pressing danger from the Moors, which was removed in 1340 by the Castilian victory on the Salado, that induced him at last to consent to a compromise. The same desire to unite all the possessions of the Aragonese crown is apparent in his treatment of the king of Majorca, James II., the descendant of James I.'s younger son, who had received from his father the Balearic Islands with Roussillon and Cerdagne as a vassal kingdom. As James II. showed inclination to evade his legal duties towards his suzerain, Pedro seized the first opportunity to pick a quarrel with him. In 1344 all the territories of the king of Majorca were declared to be united to Aragon; and, though James II. made an obstinate resistance, he met with little support from his former subjects, and the hopeless struggle was ended by his death in 1348.

These high-handed measures not unnaturally excited the misgivings of the nobles of Aragon, whose privileges were not likely to be very scrupulously respected by a prince with such an obvious sense of his own rights and duties. In 1347 chance gave them an eminent and capable leader. There was no law against female succession in Aragon, and there was the precedent of Queen Petronilla in its favor. On the other hand, there was a strong prejudice against it, and as a rule preference had been given to males, although further removed from the direct line. Pedro IV. had an only daughter, Constance, and he was eager to secure the succession to her in preference to his brother James, who was popularly regarded as the heir to the throne. This unconcealed intention excited the indignation of James, who was already discontented at the harsh treatment of the king of Majorca. He had no difficulty in inducing most of the chief nobles, including his half-brothers, to form a "Union," which was also joined by several of the towns in their discontent at the projected settlement of the succession (1347). Pedro was taken by surprise and could only gain time by concessions. He promised to convoke annual meetings of the cortes, to choose his councillors with the approval of the estates, to revoke his will in favor of his daughter, and to recognize his brother as his heir. Soon after this agreement, which left the Union master of the situation, James died; and men were not slow in attributing his death to the machinations of the king. This event was of the greatest advantage to Pedro, as it deprived his opponents of their leader, and from this moment the rebellion began to be split up by personal rivalries. The king and his advisers were not slow to avail themselves of the opportunity thus offered. The opposition was strongest in Aragon and Valencia, and Pedro succeeded in gaining over the Catalonians, who were always prone to act in isolation from the other provinces. With the troops thus acquired he met the army of the Union at Epila (1348) and won a complete victory. He followed up his success by destroying all the charters which gave any sanction to armed resistance to the crown, and especially the Privilege of Union of 1287. His elder half-brother Ferdinand, who had succeeded James as leader of the revolt and as heir-apparent to the throne, fled to Castile, but the chief nobles were severely punished, and the power of the crown was raised to a height which it had never before attained.

Thus Aragon, following the tendencies of the age, became centralized under a powerful monarchy, and the forces of feudal disunion received a final check. But Pedro IV. was far from establishing anything like a despotism. While destroying the Privilege of Union, he took a solemn oath to respect the political and personal liberties of his subjects, and enjoined the same oath upon his successors. At the same time he strengthened the powers of the justiciar, whose preeminence dates from this reign. The position of the king was immensely strengthened by the birth of a son, which destroyed the claims of his half-brothers. The later part of his reign was occupied with a war against Henry II. of Castile, which has been referred to above, and with resistance to James III. of Majorca, who made an unsuccessful effort to recover the territories of his father. Pedro concluded a second marriage with Sibilla, daughter of a Catalonian knight, and her influence involved him in a quarrel with his eldest son, whom he attempted to deprive of the office of lieutenant-general, which custom assigned to the heir to the throne. But he found that the authority of the justiciar was now strong enough to restrain the crown as well as the nobles. Dominic de Cerda, who now held the office, pronounced that the infant was legally entitled to the dignity from which he had been ousted, and compelled the king to restore him.

John I.

The brief reign of John I. (1387–1395) was mainly occupied with wars in Sicily and Sardinia. The expense which these involved, which was increased by the luxury of a magnificent court, excited the most lively discontent on the part of the cortes. The remonstrances of his subjects were resented by the king, but they were backed up by the authority of the justiciar, and John I. gave way so far as to banish the unpopular favorites from the court. On the king's death his daughters were passed over, and the crown was transferred to his brother Martin, who was occupied in restoring the Aragonese supremacy in Sicily.

Martin.

Under Martin a private war between the great families of Urrea and Luna was put down, and the dependence of the great nobles was more firmly secured. But the death in 1409 of the king's only son, Martin the younger, brought the kingdom face to face with the difficulty of a disputed succession. There were two male claimants,—the count of Urgel, a great-grandson of Alfonso IV., and the duke of Gandia, a grandson of James II. The former was the undoubted heir if the succession was absolutely limited to males, while the latter was advanced in years and could only bring forward the old contention of nearness to the royal stock. But, although precedent was in favor of the exclusion of females, there was no definite rule to prevent the succession of their male descendants. Of such claimants there were two,—Louis of Calabria, the son of John I.'s daughter Violante, and Ferdinand, infant of Castile, the son of Martin's sister Eleanor. Moreover, Martin the younger had left an illegitimate son, Frederick, count of Luna, and if the question had arisen a century earlier, before the clergy had obtained so much power, it is probable that his claims would have been preferred. The question was still unsettled on the death of the elder Martin in 1410, with whom ended the male line of the counts of Barcelona. A prolonged civil war seemed inevitable, and for two years the kingdom endured the evils of an interregnum. If the dispute was to be settled by force of arms, the count of Urgel seemed likely to carry all before him, as he had the pretty unanimous support both of the Catalans and of the powerful family of Luna. But his followers, confident in their superiority, allowed themselves to indulge in acts of violence which alienated the more orderly part of the population. The justiciar, Juan de Cerda, who had acted with such impartial firmness in the reign of John I., succeeded in forming a patriotic party which determined to settle the dispute by a legal decision. Jealousy of the De Lunas gave to this party the support of the rival house of Urrea. They succeeded in procuring the appointment of a joint commission of nine members,—three from the cortes of each province. After a careful examination of all the claims, the commissioners decided, on what principle it is difficult to determine, in favor of the infant Ferdinand, who was then acting as regent of Castile for his nephew John II. (1412).

Ferdinand I.

As far as ability and merit went, the choice was probably the best that could have been made. By mingled firmness and concession Ferdinand succeeded in restoring order and unity to the kingdom and its dependencies. A revolt headed by the disappointed count of Urgel in the next year was suppressed, and its leader was punished with the confiscation of his territories and perpetual imprisonment.

Thus the house of Trastamara succeeded in obtaining the crown of Aragon as well as that of Castile. Ferdinand I., the first king of the new dynasty, did not live long to wield the sceptre which he had so fortunately acquired. On his death in 1416 the crown passed to his son Alfonso V. (1416–1458).

Alfonso V.

The new prince played little part in Aragonese history, as his attention was almost wholly absorbed in the affairs of Italy. To his inherited possessions of Sicily and Sardinia he added the kingdom of Naples after a seven years' contest with the Angevin claimant, René le Bon of Provence (1435–1442). From this time he never quitted his new kingdom, where his politic rule and his patronage of literature acquired for him the name of "The Magnanimous." During his absence the government of Aragon was intrusted to his brother John, as lieutenant-general. The arbitrary character of this prince, which is so clearly visible in his subsequent history, seems to have been foreseen by his subjects. In order to secure the justiciar from undue influence on the part of the crown, a law was made in 1442 that the office should be held for life, and that its occupant could only be dismissed by the king with the express approval of the cortes. In 1461 this provision was followed up by another law which directed that all complaints against the justiciar should be heard before a commission regularly chosen from the four estates.

Relations of Aragon and Navarre.

The history of John, both as regent for his brother and later as king in his own right, centres round the family quarrels which finally led to a formidable rebellion against him. His first wife was Blanche, widow of Martin of Sicily and heiress of Navarre. This little kingdom, which comprised territory on both sides of the Pyrenees, had been more closely connected with

France than with Spain since its separation from Aragon on the death of Alfonso I. (1134). In the 13th century it was united to the French crown by the marriage of Jeanne of Navarre with the French king Philip IV., but it again became independent on the death of Louis X. in 1315. His daughter Jeanne was the undoubted heiress of Navarre, and, though she was kept out of her rights by her uncles, Philip V. and Charles IV., she was allowed to succeed after their death. In 1329 she was crowned at Pamplona with her husband, Philip of Evreux. Her son, Charles the Bad (1349–1387), obtained an unenviable notoriety for the part which he played in French history during the troublous period of the English wars. His son, Charles III. (1387–1425), was a peace-loving prince, who devoted more attention to art and literature than to politics. The marriage of his daughter Blanche with John of Aragon brought the mountain-kingdom once more into close connection with the western peninsula. By her marriage contract, Navarre was to pass on her death to her children and not to her husband, but a later agreement enjoined her son, before assuming the sovereignty, to obtain "the goodwill and approbation of his father." When Blanche died in 1442, John seems to have considered that this later stipulation justified him in retaining the title of king of Navarre, though he intrusted the administration of the kingdom to his son, Charles of Viana. For some time no difficulty was made about this arrangement. But in 1447 John married a second wife, Joanna Henriquez, a descendant of the royal family of Castile, and a few years later he sent Joanna to share the government of Navarre with his son. This appointment coupled with the arrogant conduct of his stepmother, was regarded as an insult by Charles of Viana, who was not slow to remember that by right he was entitled to the crown. The old parties of Navarre, the Beaumonts and Agramonts, seized the opportunity to renew their feuds,—the former espousing the cause of the prince, the latter that of the queen. Before long the dispute developed into civil war, and John marched into Navarre to assist his wife, who was besieged in Estella by her stepson. At Aybar the hostile forces met in open conflict, but the superior discipline of the royal troops gave them a complete victory, and Charles fell a prisoner into his father's hands (1452). The prince was released after a short imprisonment, but the reconciliation was only a hollow one. The birth of a son to Joanna Henriquez (1452), afterwards famous as Ferdinand the Catholic, was a serious blow to the interests of the elder son. The queen scarcely concealed her desire to secure the succession to her own child, and her influence over her husband was unbounded. Charles found that his defeat had given the supremacy in Navarre to the hostile party, and after a vain attempt to recover his power he went to Naples to appeal to his uncle Alfonso V. But his hopes in this quarter were destroyed by Alfonso's death in 1458. Of his possessions, Aragon, Sicily, and Sardinia passed to his brother John II., while Naples, as a private acquisition of his own, was bequeathed to his natural son Ferdinand. The Neapolitan barons, dreading the gloomy and tyrannical character of their new ruler, offered to support Charles of Viana as a candidate for the throne, but he refused to oppose his cousin, and retired to Sicily, where he spent the next two years in seclusion. In 1460 he was induced to return by the solicitations of his father, who seems to have been disquieted by the popularity which the prince had obtained among the Sicilians. The intrigues of Joanna were not long in exciting the old mistrust between father and son, and her hostility towards Charles was increased by his attempts to obtain the hand of Isabella of Castile, whom she had already fixed upon as a suitable bride for her own son Ferdinand. In 1461 Charles was induced to meet his father at Lerida, and was at once imprisoned. When asked about the cause of this arbitrary proceeding, John only replied with obscure hints at a conspiracy. But his subjects were not prepared to acquiesce in this unnatural treatment of a prince whom they had learned to love and whom they regarded as their future ruler. The Catalans, always easily moved, rose in arms and marched upon Lerida, and it was only by a hasty retreat that John was able to escape with his court to Saragossa. But the revolt speedily spread from Catalonia to the other provinces, and even to Sicily and Sardinia, while it found supporters in the king of Castile and in the faction of the Beaumonts in Navarre. Surrounded by enemies, John II. found it necessary to yield. He not only released his son, professing that he did so at his wife's request, but appointed him lieutenant-general of Catalonia and promised not to enter that province without the permission of the cortes. But no sooner had Charles of Viana regained his liberty than he died, on September 23, 1461; and the circumstances led ready credence to be given to the suspicion that he had been poisoned during his captivity.

John II.

The crown of Navarre now devolved by right upon Charles's elder sister Blanche, who had been married to and afterwards repudiated by Henry IV. of Castile. But she had incurred her father's enmity by the support which she had given to her brother; and John II. was not unwilling to curry favor with France by securing Navarre to his second daughter Eleanor of Foix, whose son Gaston had married a sister of Louis XI. The unfortunate Blanche was committed to the guardianship of her younger sister, and after two years of imprisonment in the castle of Orthez she died of poison. But Eleanor reaped little advantage from the crime which all historians impute to her. Her father retained the crown of Navarre till his death, and she only survived him a few weeks. She was succeeded by her grandson Francis Phœbus, but he only lived for four years, and his sister and heiress Catherine brought the crown of Navarre by her marriage to the French house of D'Albret, from which it was wrested by Ferdinand the Catholic in 1512. This third union with Aragon proved permanent, although the district north of the Pyrenees was subsequently annexed to France.

Meanwhile the troubles of John II. were by no means removed by his son's death. In Aragon the young Ferdinand was acknowledged as heir, and was then sent with his mother to Catalonia to receive the oath of allegiance from that province. But the Catalans rose again in rebellion, and besieged Joanna and her son in the fortress of Gerona. As John II. was unable to advance through the revolted province to his wife's relief, he purchased the assistance of Louis XI. by a promise of 200,000[1] gold crowns, as security for which he pledged the counties of Roussillon and Cerdagne (1462). The Catalans replied to this alliance by throwing off their allegiance to John and proclaiming a republic. As, however, Gerona was relieved by the French, and the royal troops succeeded in reducing several of the chief towns, they determined to appeal for foreign aid. The crown was offered first to Henry IV. of Castile and then to the constable of Portugal, who was descended from the old counts of Barcelona. On the death of the latter in 1466 the rebels turned to the traditional rivals of the house of Aragon, and offered the crown to René le Bon, the head of the Angevin house. René, whose life had been spent in putting forward claims which he had never been able to enforce, accepted the offer and sent his chivalrous son John of Calabria to assist the Catalans (1467). John II.'s fortunes were now at their nadir. He had lost his eyesight, and the death of his wife in 1468 deprived him of the companion and adviser who had for years directed and inspired his policy. John of Calabria, whose enterprise was secretly encouraged by the treacherous king of France, was steadily regaining much of the ground which had been lost by the Catalans before his arrival. But the old king, whose sight was restored by a surgical operation, fought on with a dogged obstinacy worthy of a better cause. The death of the duke of Calabria in 1469 deprived his opponents of their leader, and from this moment their ultimate defeat was inevitable. The fall of Barcelona (1472) completed the reduction of Catalonia. But John did not venture to abuse the victory which he had so hardly won. He granted a general amnesty, and took a solemn oath to respect the Constitution and liberties of the conquered province. The only notable event of the remaining years of John II.'s reign was an attempt to recover Roussillon and Cerdagne. But Louis XI. kept a firm hold by arms upon the provinces which his diplomacy had won, and they were only restored to Aragon in 1493 when Charles VIII. ceded them to Ferdinand the Catholic. In 1479 the death of John II., at the ripe age of eighty-two, transferred the crown to his son, Ferdinand, who ten years before had concluded his marriage with Isabella of Castile.

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[1] [300,000 crowns or c. 171,000 for silver coin. See ROUSSILLON, vol. xxi. p. 34. At the valuation of the ancient golden crown, the pawn would equal $210,000 by weight.—AM. ED.]

Ferdinand the Catholic.

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SECTION IV.—MODERN HISTORY.

Ferdinand and Isabella

The history of Spain as a united state dates from the union of Castile and Aragon by the marriage of Isabella and Ferdinand. The marriage took place in 1469, before the accession of either sovereign. In 1474 the crown of Castile was claimed by Isabella on the death of her brother Henry IV., whose daughter Joanna was universally believed to be illegitimate. It was contended by the partisans of Ferdinand that female succession was prohibited in Castile, and that he was entitled to the crown as the nearest male heir after his father. Ultimately the question was settled in Isabella's favor, and she obtained the most important rights of sovereignty, though the government was carried on in their joint names. It is possible that Ferdinand would have refused to accept this arrangement, if concerted action had not been necessary to oppose the party which espoused the cause of Joanna. A number of the Castilian nobles, headed by the marquis of Villena, dreaded the danger to the privileges of their order that might arise from the establishment of a strong government. They found an ally in Alfonso V. of Portugal, who was Joanna's uncle by the mother's side, and who cherished the design of obtaining the Castilian throne by a marriage with his niece. In 1476 the confederates were routed in the battle of Toro, and Alfonso departed to France with the chimerical plan of seeking assistance from Louis XI. The treaty of St. Jean de Luz between France and Castile in 1478 ruined these hopes, and in the next year Alfonso was compelled, by the treaty of Lisbon, to abandon the cause of his niece. This terminated the war of succession in Castile; and Joanna, known from her reputed father as La Beltraneja, retired into a convent. A few months before the treaty of Lisbon the death of John II. (January 20, 1479) gave to Ferdinand the succession of Aragon, Sicily and Sardinia. Navarre, which had been brought to John II. by his first wife, passed to his daughter by that marriage, Eleanor, countess of Foix. Two provinces of the Aragonese crown, Roussillon and Cerdagne, had been pledged by John to Louis XI. of France, and were still retained by that monarch. The union of Castile and Aragon effected in 1479 was merely a personal union. Each province retained its own institutions and its own laws, and each would have resented the idea of absorption in the other.

Administrative reforms.

The first care of the two sovereigns was to reform the system of government, especially in Castile, where the recent civil wars had given rise to serious disorders. One of their chief objects was to depress the nobles, whose privileges, acquired during the long struggle against the Moors, were inconsistent with a strong centralized government. In accordance with true policy and with the spirit of the age Ferdinand and Isabella sought to counterbalance the nobles by relying upon the burgher class. The *Santa Hermandad*, or Holy Brotherhood, which was organized in 1476, was a popular confederation of the whole kingdom for police and judicial purposes. Its affairs were managed by local courts,—from which appeals could be made to a supreme tribunal,—and by a general junta composed of deputies from all cities, which was convened once a year. A body of 2000 cavalry was at the disposal of the association, and a special code of laws for its guidance was compiled in 1485. The institution was completely successful in maintaining order and in diminishing the independence of the local jurisdiction of the great nobles. About the same time the lavish grants from the royal domain, which had enriched the nobles at the expense of the crown, were revoked, the central judicial courts were made more efficient by the introduction of trained lawyers, and steps were taken to codify the numerous laws that had been made since the *Siete Partidas* of Alfonso X. The grand-masterships of the great orders of St. Iago, Calatrava, and Alcantara, which conferred powers too great to be entrusted to a subject, were on successive vacancies secured to the crown. Trade was encouraged by protective measures, by the breaking down of the barriers between Castile and Aragon, by a strict reform of the currency, and by the commutation for a fixed impost of the detested *alcavala*, a tax of one-tenth upon all sales and transfers of property.

The increased prosperity of the country is well illustrated by the steady rise of the revenue. "In 1474, the year of Isabella's accession, the ordinary rents of the Castilian crown amounted to 885,000 reals [$116,484.60 plate reals]; in 1477 to 2,390,078 [$314,594.02 plate reals]; in 1482, after the resumption of the royal grants, to 12,711,591 [$1,713,663.17 plate reals]; and finally, in 1504, when the acquisition of Granada and the domestic tranquillity of the kingdom had encouraged the free expansion of all its resources, to 26,283,334 [$3,359,746.33 plate reals], or thirty times the amount received at her accession. All this was derived from the customary established taxes, without the imposition of a single new one" (Prescott, ii. 575). No attack was made upon the liberties of the subjects; the cortes of Castile were frequently convened; the same towns were called upon to send deputies; and the only innovation was the frequent neglect to summon the nobles. The numerous *pragmaticas*, or royal ordinances, were mostly limited to administrative matters or to the interpretation of the law. The credit for the domestic administration rests mainly with Isabella. Ferdinand busied himself more with military and diplomatic affairs, and comparatively few innovations were made in Aragon. The *Hermandad* was introduced, and in some other points the example of Castile was followed. But the advanced constitutional liberties of Aragon were uncongenial to Ferdinand. He summoned the cortes as rarely as possible; and when that assembly met he spared no pains to influence its composition and its decisions. The centralizing tendencies of the reign were carried still further in both provinces in the later period when Ximenes, who became archbishop of Toledo in 1495, exercised the chief influence. Five councils were entrusted with the administration of affairs: the "royal council," the chief court of justice; the "council of the supreme" for ecclesiastical business; the "council of the orders" for the great military fraternities; the "council of Aragon" for the management of that kingdom and of Naples; and the "council of the Indies" for the great discoveries of Columbus and his companions.

Religious unity.

The political unity of Spain was to be based upon its religious unity. Both Ferdinand and Isabella were imbued with that stern spirit of orthodoxy with which the Spaniards were inspired by their long crusade against the infidel. No institution of their reign was so important as the Inquisition, which was authorized by a bull of Sixtus IV. in 1478, and constituted for the two kingdoms in 1483 under the presidency of Torquemada. Its extension to Aragon was bitterly protested against by the liberty-loving people, but was forced upon them by the iron will of Ferdinand. The activity of the Holy Office was at first directed against the Jews, whose obstinate adherence to their faith in spite of persecution was punished by an edict for their expulsion in 1492. Their departure deprived Spain of many industrious inhabitants; but its importance has been much exaggerated by authors who have failed to notice that it was followed, not by the decline of Spain, but by the period of its greatest prosperity. In spite of their orthodoxy, however, Ferdinand and Isabella were by no means slavish adherents of the papacy. The claim of the popes to appoint to important benefices was strenuously resisted, and the chief control of ecclesiastical affairs was successfully vindicated for the crown.

The steady extension of the royal power in Spain was due in no small degree, as Machiavelli has pointed out, to the constant succession of enterprises in which the attention of the nobles was absorbed. These enterprises may be summarized under three heads: (1) the union of the Peninsula; (2) the extension of colonial empire; and (3) the acquisition of foreign territories.

Union of the Peninsula.

(1) Under the first head the most important achievement was the final extinction of the Moorish power in Spain. The war which began in 1481 was carried on in a desultory manner for ten years, and was completed in 1492 by the conquest of Granada. The Moors, who had fought with the courage of despair, received very lenient terms from their conquerors. They were secured in the free exercise of their religion, and were allowed to retain their own laws, customs, and language. In some points, such as the trade with Africa, they obtained privileges which were not even shared by the Castilians. But the spirit of proselytism was too strong in Spain to allow this treaty to be observed. The measures taken by Ximenes to bring about the conversion of the Moors provoked a revolt in 1500, which was put down with great severity. They were compelled to choose between conversion or banishment, and although most of them accepted the former alternative, the Moriscoes, as they were now called, found themselves henceforward in the hopeless position of a proscribed and hated minority. In 1493 Ferdinand extorted from the fears and hopes of Charles VIII. of France the restoration of Roussillon and Cerdagne by the treaty of Barcelona. In 1512, after Isabella's death, he annexed Navarre. The whole Peninsula was now united, with the exception of Portugal, and steps had been taken for the acquisition of that kingdom by marriage. Isabella, Ferdinand's eldest daughter, was married to Alfonso, the son and heir of John II. of Portugal. After the death of that prince his widow married Emanuel, who succeeded to the Portuguese crown in 1495. Isabella herself died in giving birth to a son, but the connection was still maintained by the marriage of Emanuel to her younger sister Mary. The fruits of this persistent policy were not reaped, however, till the reign of Philip II.

Colonial empire.

(2) Maritime discovery was the task of the age, a task forced upon it by the Turkish occupation of the Levant, which had closed the old commercial routes to the East. The foremost pioneers in the work were the Portuguese and Spaniards, whose efforts brought them into rivalry with each other. The treaty of Lisbon in 1479 secured the western coast of Africa to Portugal, but enabled Spain to complete the annexation of the Canaries. The Spaniards now turned further westwards, and a wholly new problem was created by Columbus's discovery of the West Indies in 1492. His voyage had been undertaken under the patronage of Isabella, and the new territories were regarded as pertaining to Castile. To solve any difficulties that might arise, a bull was obtained from Alexander VI. in 1493, which granted to Spain all discoveries west of an imaginary line drawn 100 leagues to the west of the Azores and the Cape Verd Islands. As this arrangement excited Portuguese discontent, it was modified by a treaty at Tordesillas in 1494, which removed the boundary line to 370 leagues west of the Cape Verd Islands. This modification had important results for the Portuguese, as giving them their subsequent claim to Brazil. In the meanwhile Spain redoubled its exertions. In 1498 Columbus landed on the continent of South America, and in a few years the whole western Atlantic coast was explored by subsequent adventurers. In 1512 Ponce de Leon discovered Florida, and in the next year Balboa crossed the Isthmus of Darien and gazed for the first time upon the Pacific. No exertions were spared by the Government to encourage settlement in its new territories; but the regulations of colonial trade, and especially the provision that it should pass through the single port of Seville, were conceived in a narrow and selfish spirit which prevented the full development of their resources.

Acquisition of Naples.

(3) The foreign affairs of the reign, which were almost wholly connected with Italy, were conducted by Ferdinand on behalf of Aragon, just as the extension of the colonies was directed for the benefit of Castile. Charles VIII.'s invasion of Naples, which was ruled by an illegitimate branch of the house of Aragon, was undertaken in the full belief that the support or at least the neutrality of Spain was secured by the treaty of Barcelona. But Ferdinand, jealous of the rapid success of the French, seized the first pretext to disregard the treaty, and became a member of the league which was formed at Venice in 1495 against Charles. His troops, under the famous Gonsalvo de Cordova, took a prominent part in restoring Ferdinand II. to the Neapolitan throne. With the accession of Louis XII. came a great change in Ferdinand's policy, and he determined to advance the claim to Naples which he himself possessed as the legitimate head of the Aragonese house. By the treaty of Granada in 1500 Naples was to be divided between France and Spain, and the reigning king Frederick could make no resistance to such overwhelming forces. But a quarrel naturally arose about the terms of the partition, and by 1504 Gonsalvo de Cordova succeeded in expelling the French from Naples, which was henceforth annexed to the crown of Aragon.

Death of Isabella.

In 1504 the unity of Spain was interrupted for a time by the death of Isabella. The successive deaths of the infant John (1497), of Isabella of Portugal (1498), and of her infant son Miguel (1500) had left the succession in Castile to the second daughter, Joanna; she was married to the archduke Philip, son of Maxamilian I., and ruler, through his mother Mary of Burgundy, of the Netherlands and Franche-Comté. Unfortunately Joanna, who was the mother of two sons, Charles and Ferdinand, had already given signs of that insanity which was to cloud the whole of her subsequent career. Philip, who had visited Spain in 1502, had then excited the distrust of his wife's parents, and Isabella by her will left the regency in Castile to her husband until the majority of their grandson Charles. But Ferdinand, in spite of his brilliant successes, was not popular among the Castilian nobles, who seized the opportunity to support the more natural claims of Philip to govern on behalf of his wife. Ferdinand showed his disgust by actions which threatened to undo all the previous objects of his policy. He concluded a treaty with Louis XII. in 1505, by which he undertook to marry the French king's niece, Germaine de Foix. To her Louis resigned his claims upon Naples, but in case of her death without issue his share in the kingdom by the treaty of Granada was to revert to France. Thus Ferdinand was willing to gratify his spite and to perpetuate the division between Aragon and Castile, under the penalty of forfeiting his recent conquests in Italy. His second marriage was concluded in March, 1506, and two months later he resigned the regency in Castile to Philip, and soon afterwards sailed to Naples.

But the division of the Peninsula was not destined to last long. On September 25, Philip died at the age of twenty-eight, and the devotion of Ximenes secured the restoration of the regency to Ferdinand. Joanna, who had been devotedly attached to her husband, lost all semblance of reason after his death, and made no attempt to exercise any influence over the conduct of affairs. The remaining part of Ferdinand's reign is uneventful in the history of Spain. The government was carried on on the same system, but with more avowed absolutism, as during the lifetime of Isabella. Ximenes, whose energies found insufficient occupation in the compilation of his Polyglott Bible and in the foundation of the university of Alcala de Henares, fitted out and headed an expedition to Oran in 1509, which resulted in extensive but short-lived conquests in northern Africa. Ferdinand threw himself with more energy than ever into the current of European politics. By joining the league of Cambray he wrested from Venice five important towns in Apulia which had been pawned to the republic by Ferdinand II. As a member of the Holy League against France he succeeded in conquering Navarre in 1512. Navarre had passed to the French family of Albret by the marriage of Catharine de Foix with Jean d'Albret, and it was the close connection with France which gave Ferdinand a pretext for its invasion. In 1515 his new conquest was formally incorporated with the kingdom of Castile. This was Ferdinand's last success; and he died on January 23, 1516. His will recognized Joanna as his heiress in Aragon, and his grandson Charles as the regent in both kingdoms. Until his arrival, the administration of Castile was intrusted to Cardinal Ximenes and that of Aragon to his own natural son, the archbishop of Saragossa.

Death of Ferdinand.

Hapsburg rule (1516-1700).

With the death of Ferdinand begins the period of uninterrupted Hapsburg rule in Spain, which lasted for nearly two centuries. In the course of this period the monarchy obtained absolute authority, and Spain, after rising for a time to be the foremost state in Europe, sank to the position of a second-rate power, from which it has never since emerged. At first the condition of affairs was by no means promising for the crown. The unity of Spain, which had advanced with such rapid strides after the marriage of Ferdinand and Isabella, had been seriously shaken by the selfish policy pursued by the king since his wife's death. Aragon and Castile were distinct kingdoms, and the former was again divided into the three provinces of Aragon, Catalonia, and Valencia, each of which had its own cortes, its own privileges, and the most warmly-cherished traditions of independence. Classes were everywhere divided against each other, and within each class jealousies and quarrels were frequent. The foreign possessions of the two crowns were a source of weakness rather than of strength. France stood ready at the earliest opportunity to contest the possession of Navarre with Castile, and that of Naples with Aragon.

Charles I. (emperor Charles V.).

The difficulties of domestic government were increased by the fact that the prospective ruler was a youthful foreigner, who had never visited Spain, and who was completely ignorant of the customs and even of the language of the country. Charles had been born and educated in the Netherlands, of which he had been nominal ruler ever since the death of his father in 1506. All his friends and advisers were Flemings, who cared nothing for Spanish interests and had already acquired an evil reputation for selfish greed. The first symptom of discontent in Spain was excited by Charles's demand to be recognized as king, in utter disregard of his unfortunate mother. In Aragon the demand was unhesitatingly refused, but in Castile the vigorous measures of Ximenes secured Charles's proclamation. The regent, however, had great difficulties to face. The nobles, delighted to be rid of the strong government of Ferdinand, wished to utilize the opportunity to regain the privileges and independence they had lost. In this crisis the loyal devotion of Ximenes saved the monarchy. Throwing himself upon the support of the citizen class, he organized a militia which overawed the nobles and maintained order. A French invasion of Navarre was repulsed, and to avoid any danger from the discontent of the inhabitants all the fortresses of the province, with the single exception of Pamplona, were dismantled. These distinguished services were rewarded with more than royal ingratitude by Charles, who came to Spain in 1517, and who allowed the aged cardinal to die on November 8th without even granting him an interview.

The young king soon felt the loss of so able and experienced an adviser. His Flemish ministers, with Chièvres at their head, regarded Spain as a rich booty to be plundered at will. The Castilians, the proudest nation in Europe, found all the places of honor and profit seized by greedy foreigners. The cortes had shown their loyalty by acknowledging Charles as joint-king with his mother and by granting him an unprecedented service of 600,000 ducats [$1,360,800]. But they had accompanied their grants with eighty-eight significant demands, which the young king accepted but made no pretence of fulfilling. In Aragon and Catalonia more difficulty was experienced. Nearly two years were wasted in obtaining the recognition of the royal title, and no supplies were forthcoming. Valencia was not visited at all, and the attempt to induce the people to do homage to a viceroy was a failure. A civil war broke out in the province between the privileged nobles and a *germandada*, or brotherhood, of the burgher class. The Government exasperated parties by supporting each in turn, but ultimately threw in its lot with the nobles.

Meanwhile the death of Maximilian had given Charles the succession to the considerable Hapsburg territories in Germany, and in 1519 the German electors had chosen him to be king of the Romans. He was now the first prince in Europe; and it was necessary for him to leave Spain to look after his interests in Germany and to cement their alliances which he needed against the inevitable hostility of France. But his elevation by no means increased his popularity in Castile. The Castilians had already plenty of grounds for complaint in the rapacity of the Flemings and in Charles's failure to perform his promises to the cortes. But these were as nothing compared with the prospect that Castile might no longer be the primary state of their king, and that their revenues might be employed in the attainment of objects in which they had not the slightest interest. While opinions were thus excited, Charles, who had been reduced to great straits by military preparations and his promises to the German electors, summoned the cortes to meet at Santiago (Compostella) in Galicia, and thence transferred them to Coruña in order to embark as soon as he had obtained the supplies he needed. The place of meeting was carefully chosen so as to isolate the assembly and to expose it to royal influence or intimidation. The lead of the opposition was taken by Toledo, which refused to send its two deputies, as being too favorable to the crown, but sent other representatives to remonstrate with Charles and to encourage the other cities. They were driven from Coruña, and the deputies of Salamanca were excluded from the cortes. By these and similar means the desired grant was extorted. Charles hastened to quit Spain with the first favorable wind, leaving Adrian of Utrecht as regent in Castile, and two native nobles in Aragon and Catalonia. His departure was really necessary for his other interests; but it must have seemed reckless to the Spaniards at a time when Valencia was in the flames of civil war and Castile was on the verge of rebellion. Before starting he had ordered the removal of the magistrates of Toledo, and had sent a new governor to reduce the city to obedience. The citizens, headed by a young noble, Juan de Padilla, resisted this order and raised the standard of insurrection. Other cities hastened to join the movement, and a central committee, known as the "Holy Junta," established itself at Avila. The unfortunate regent, a churchman of distinguished piety and gentle character, found himself face to face with difficulties that would have taxed all the resources of Ximenes. His attempt to reduce Segovia by arms was a lamentable failure, and he had to confess his utter defeat by disbanding his forces. The nobles, alienated by the appointment of a foreigner to the regency, made no attempt to check a movement against a Government they detested. The insurgents had matters their own way, and Padilla, advancing to Tordesillas, made himself master of the person of Joanna, in whose name it was intended to conduct the government. But this movement was less advantageous than it at first appeared. Joanna refused to transact any business or to sign any document, and this public proof of her incapacity served to justify Charles's contention that he was the only possible ruler. The Castilians were not prepared to get rid of the monarchy, so that it was necessary for the rebels to consider the possibility of coming to terms with Charles. The "Holy Junta," which had moved from Avila to Tordesillas, drew up a series of demands, which, if acceded to, would have established a constitutional monarchy in Spain. But their envoys to Germany found it impossible even to secure an audience from the king, and meanwhile the failure of the insurrection was decided. The very ease with which the rebels had triumphed proved an evil, because it encouraged internal dissensions which opposition might have healed. Especially Burgos showed its jealousy of the leading position which had been assumed by Toledo. Class differences, the bane of every country in the Middle Ages, supplied the final stumbling-block. Many of the demands of the communes were diametrically opposed to the interests of the nobles, whose eyes were at last opened to the danger of their attitude of neutrality. Their chief grievance had been removed by Charles's appointment of the admiral and constable of Castile as joint-regents with Adrian. An army was raised, and on the field of Villalar the forces of the communes were utterly defeated (April 23, 1522). Padilla, who had shown more enthusiasm than ability, was executed, and one city after another was reduced to submission. A portion of the victorious army was sent to the assistance of the nobles in Valencia, where the *germandada* was at last crushed. The return of Charles to Spain in June, 1522, completed the triumph of the monarchy. In 1523 he convened the Castilian cortes, and compelled them to grant supplies before presenting their petitions for redress, thus establishing a precedent which was conclusive for the future.

Rising of the communes.

Charles's reign belongs to the history of Europe rather than to that of Spain, and has been sufficiently treated elsewhere (see CHARLES V.). His enormous inheritance was increased by the successes of Cortes in Mexico and of Pizarro in Peru, by his own annexation of the Milanese, and by his conquests in northern Africa. In the government of this vast empire Spain played an important but on the whole a subordinate part. Its soldiers and its subsidies were Charles's most effective weapons, and to render them more readily available it was necessary to depress still further the liberties of the country. The independence of the towns had been crushed at Villalar, but only by the intervention of the nobles; and these had now to pay the penalty of their selfish loyalty. In 1538, after Charles had for a time concluded his struggle with France by the truce of Nice, he proposed to raise supplies in Castile by an excise upon commodities. The nobles objected on the ground of their exemption from taxation, and the emperor had to give way. But he took his revenge by excluding them altogether from the cortes, which henceforth consisted only of thirty-six deputies from eighteen towns, a body that was powerless to oppose the wishes of the crown.

The vast enterprises in which Charles was involved exhausted his energies, and the failure of his policy in Germany reduced him to despair. In 1555–56 he resigned all his dignities, and ended his life in 1558 in retirement at Yuste. From this time the house of Hapsburg is divided into two branches of Spain and Austria. Charles's brother Ferdinand became king of the Romans and obtained the German territories of the family, to which he had added the crowns of Bohemia and Hungary. Philip II., Charles's only legitimate son, succeeded to the Spanish and Burgundian inheritance, with the addition of Milan. Philip II., like his father, played a great part in European history (see PHILIP II.), but with this important difference that Castile was definitely the central point of his monarchy, and that his policy was absolutely directed by Spanish interests. In character and education he was a Spaniard of the Spaniards, and after 1559 he never quitted Spain. He gave the country a capital, which it had never yet possessed, by fixing his residence at Madrid. Castile, under the direct supervision of the king, was subjected to the most crushing despotism. Aragon, Catalonia, and Valencia were governed as mere provinces, in the same manner as Milan, Naples, and Sicily. The continuance of the old divisions of the country, while it lessened its strength, was an immense advantage to the royal power. It was easy for the king to employ the forces of one province to crush the liberties of the others. And Philip possessed a formidable weapon in the Inquisition, which he did not scruple to use for secular purposes. Political independence was crushed with the same relentless severity as religious dissent. Hitherto Aragon had preserved its mediæval privileges almost intact. The king was not entitled to the allegiance of the province until he had solemnly sworn to observe its "fueros." For the decisions of the cortes unanimity was required, so that each deputy had a practical right of veto. The authority of the justiciar rivalled that of the crown. It was natural that Philip should seize the first opportunity of attacking institutions which could thwart his will. In 1590 Antonio Perez (see PEREZ), a minister who had incurred the king's displeasure, fled to Aragon and appealed to its fueros for protection. Philip had him brought before the Inquisition, and when the people rose in defence of their liberties they were crushed by troops from Castile. The justiciar was put to death, and his successors became nominees of the crown. The cortes were assembled in 1591 at Tarragona, and compelled to abolish the most obnoxious fueros.

Philip II.

Their control over the judicial administration was abrogated, and the necessity of unanimity was only retained in certain specified cases, notably the granting of supplies. To avoid any danger from the few privileges that were left, a citadel was built in Saragossa for the reception of a royal garrison. The creation of a regular standing army completed the edifice of absolutism, while the militia which had been established by Ximenes was retained and extended for the suppression of local disorders.

Philip's internal administration was everywhere successful in obtaining the objects which he set before himself. A rising of the Moors in the Alpujarras was crushed by the military ability of his famous half-brother, Don John of Austria. In 1580 a claim to the crown of Portugal, which Philip derived from his mother, was successfully asserted. Thus the unity of the Peninsula was at last completed, while the colonial territories of Spain were immensely extended. Unfortunately, no attempt was made to conciliate the Portuguese to their new ruler. The kingdom was treated as a conquered province; all who had resisted the Spanish invasion were punished as traitors; the native nobles were excluded from all share in the government, which was entrusted solely to Spaniards; the commerce of the country was ruined by provisions which conferred a practical monopoly upon Spain. The result of this short-sighted policy was that the Portuguese stifled their discontent, and eagerly awaited the first opening for the recovery of their independence.

Outside Spain Philip's policy proved a complete failure. His religious intolerance excited the revolt of the Netherlands, which ended in the loss of the seven northern provinces. His grand schemes against England were utterly ruined by the destruction of the Spanish Armada. And, finally, his endeavor to establish a preponderant Spanish influence over France was foiled by the accession and triumph of Henry IV. The treaty of Vervins, by which he acknowledged his humiliating defeat, was almost the last act of Philip II.'s reign, which ended with his death on September 13, 1598.

Philip II. left to his son and successor, Philip III., an empire which was nominally undiminished, as the independence of the United Provinces had never been recognized, and the war for their reduction was still going on. But the unwieldy mass was suffering from internal exhaustion. The resources of Spain and the New World had been squandered in the prosecution of schemes of ambition which had ended in failure. The attention of the people had been distracted from peaceful industry to the unprofitable occupation of war. The soldiery of Spain, once reckoned invincible, had lost their prestige in the marshes of Holland. The enormous taxes, from which nobles and clergy were exempted, fell with ruinous severity upon the productive classes. Castile had suffered most, because it was most completely subject. The provinces which retained their liberties longest were more prosperous, even though they had no share in the riches that were poured into Castile from the western colonies. But they, too, had suffered from the king's reckless ambition and from an economic policy which followed the most glaring errors of the Middle Ages. Every other consideration had been sacrificed to the accumulation of specie, with the result that prices were forced up to an abnormal height, while the wealth of the country bore no proportion to the currency. The nobles were carefully excluded from all political affairs and ceased to take the slighest interest in the administration. When this exclusion came to an end after Philip II.'s death, they appear as mere courtiers, rivalling each other in the extravagance of their expenditure, but contributing nothing to the efficiency of the state. The government had been centralized by successive kings, but it was carried on without either wisdom or impartiality. The administration of justice was venal and incompetent. The people had been deprived of their liberties, but they failed to receive compensation in increased order and security. Spain had to pay dearly for its short period of glory. Its rapid decline in the 17th century was the inevitable penalty for the faults and errors of the 16th.

Philip III.

"God," said Philip II., "who has been gracious in giving me so many states, has not given me an heir capable of governing them." His successor was the natural product of his father's system; the exhaustion of Spain was inevitably accompanied by the degeneracy of its rulers. Philip III., who was twenty-one years old at his accession, had been brought up among priests and women, and showed all the defects of his education. Spanish writers are never weary of dilating upon his piety and his devotion. The cares of government he left entirely to his favorite, the duke of Lerma, while he contented himself with the performance of religious duties and the ceremonies of a stately court. The change of rulers was significantly marked in a quarrel with the province of Biscay, which still retained its ancient privileges intact. An attempt was made in 1601 to impose new duties by a royal ordinance; the Biscayan deputies protested vigorously against this encroachment upon their liberties, and openly threatened to seek another ruler. Philip III. hastened to avert the storm by withdrawing the obnoxious ordinance. Thus the policy of centralization was abandoned, and the tendencies to division and isolation were confirmed.

The Moors expelled from Spain.

The piety of Philip III., which was as disastrous to Spain as the more masculine bigotry of his predecessors, found characteristic expression in the persecution of the Moriscoes. Ever since the suppression of their first revolt in 1502,—a revolt which was provoked by the breach of the compact made on the fall of Granada,—the conquered Moors had been cruelly oppressed. Charles V. renewed the edict of 1502 in 1526, and the overt profession of Mohammedanism was extinguished in Spain. But in secret they continued to cherish the faith of their ancestors, and this was enough to exasperate a monarch who preferred to have no subjects at all rather than to rule over heretics. An edict of Philip II. in 1566 forbade them to speak or write in Arabic, and ordered them to renounce all their traditional habits and ceremonies. Futile remonstrances were followed by a desperate rising, which was quelled in 1570. The most obstinate of the rebels were exiled to Africa, but most of them sullenly submitted. Philip III. determined to prove his zeal for orthodoxy by completing the work which his father had left unfinished. In 1609 all the Moriscoes were ordered to depart from the Peninsula within three days, and the penalty of death was decreed against all who failed to obey, and against any Christians who should shelter the recalcitrant. The edict was obeyed, but it was the ruin of Spain. The Moriscoes were the backbone of the industrial population, not only in trade and manufactures, but also in agriculture. The haughty and indolent Spaniards had willingly left what they considered degrading employments to their inferiors. The Moors had introduced into Spain the cultivation of sugar, cotton, rice, and silk. They had established a system of irrigation which had given fertility to the soil. The province of Valencia in their hands had become a model of agriculture to the rest of Europe. In manufactures and commerce they had shown equal superiority to the Christian inhabitants, and many of the products of Spain were eagerly sought for by other countries. All these advantages were sacrificed to an insane desire for religious unity.

The resources of Spain, already exhausted, never recovered from this terrible blow. Under these circumstances it was an absolute necessity that the ambitious schemes of previous rulers should be abandoned; and it was fortunate that Lerma was personally inclined to a policy of peace and that events occurred to favor its adoption. The accession of James I. in England gave a convenient opportunity for concluding the long war that had been carried on with Elizabeth. English mediation brought about a twelve years' truce in 1609 with the United Provinces, which amounted to a practical recognition of their independence. The death of Henry IV. and the regency of Mary de' Medici enabled Lerma to arrange an alliance with France, which was cemented by a double marriage. Louis XIII. married the infanta Anne of Austria, and Elizabeth of France was betrothed to the son and heir of Philip III. For the moment Spain occupied a higher position in Europe than it had held since the defeat of the Armada. James I. was weakened by quarrels with his parliament and by the want of a definite policy. France under the regency had abandoned the attitude of Henry IV. and was distracted by internal squabbles. The empire was in the feeble hands of Mathias, and the Austrian Hapsburgs were still divided by the family jealousies that had arisen from the deposition of Rudolph II. The Turks had declined since the days of Soliman the Magnificent with a rapidity characteristic of Oriental powers. In the midst of these states Spain, subject to an apparently absolute monarchy, enjoyed much the same prestige as in the best days of Philip II. With the consciousness of power the old ambitions revived. An arrangement was being discussed for the recognition of the archduke Ferdinand as the successor of Mathias in the Austrian territories. Philip III., however, advanced a claim to Hungary and Bohemia on the ground that his mother was a daughter of Maximilian II., whereas Ferdinand was only descended from that emperor's brother. The claim was by no means indisputable, but it was inconvenient to Ferdinand to have to discuss it. He agreed, therefore, to purchase the support of Spain by ceding Alsace, and the vacant imperial fief of Finale in Italy (1617), and on these terms he succeeded in effecting his designs. Thus a prospect was opened to Spain of connecting its Italian possessions with the Netherlands and of forming a compact Spanish dominion in central Europe. At the same time the old policy of advancing Roman Catholicism was resumed, as the success of Ferdinand promised to secure a signal victory for the Counter-Reformation in Germany. But this forward policy was distasteful to Lerma, who found it necessary to retire in 1618. His withdrawal from affairs was not accompanied by any loss of the royal favor, and the offices which he had held were conferred upon his son, the duke of Uzeda.

The alliance between the two branches of the house of Hapsburg was not finally completed by the arrangement with Ferdinand. It was vigorously urged by Oñate, the Spanish representative at Vienna, by Khevenhüller, the Austrian envoy at Madrid, and by the Spanish party, headed by Zuñiga, which had always opposed the policy of Lerma. But neither Uzeda nor the royal confessor Aliaga was in favor of an alliance by which Spanish blood and treasure were to be expended in securing the interests of Austria. Philip III., however, was gained over by an appeal to his religious feelings, and in January, 1620, he undertook to send assistance in men and money to Ferdinand II. Thus Spain was involved in the Thirty Years' War, which had been commenced in 1618 by the revolt of Bohemia against Ferdinand, and the acceptance of the crown by the elector-palatine Frederick V. Spanish troops from Italy aided Tilly to win the battle of the White Hill, and Spinola led an army from the Netherlands against the Palatinate. But the party of peace was still strong in Spain. Frederick V. was the son-in-law of James I., and his complete humiliation would hinder the long-cherished project of a marriage between Prince Charles and the Spanish infanta. The truce with Holland would expire in April, 1621, and if the war was to be resumed with the Dutch it was essential to isolate them by concluding the alliance with England. Moreover, the finances of Spain were by no means in a condition to support the extraordinary expenses of a European war. All these considerations pointed to peace, and Philip III. was on the point of recalling Lerma, when he died in March, 1621. His reign had not been glorious or advantageous to Spain, but it contrasts favorably with those of his successors. Spanish literature and art, which had received a great impulse from the intercourse with foreign countries under previous rulers, reached their zenith during his lifetime. Three writers have obtained European fame—Cervantes, who produced the immortal *Don Quixote* between 1605 and 1613, and two of the most fertile of romantic dramatists, Lope de Vega and Calderon. In the domain of art Spain produced two of the greatest masters of the 17th century, Velasquez and Murillo.

Thirty Years' War.

Philip IV.

The time which Philip III. had spent on his devotions was given by his successor to the more secular pleasures of hunting and the theatre. But Philip IV. shared to the full his father's disinclination to burden himself with the cares of government. The office of first minister was given to Zuñiga, the chief advocate of an aggressive policy in the late reign. Lerma and Uzeda were banished from the court. But the chief influence over the administration was exercised from the first by the royal favorite, the count of Olivares, who succeeded to Zuñiga's office on the latter's death. Olivares was a man of considerable industry and ability, though his reputation has suffered from the inevitable comparison with his great contemporary and rival, Richelieu. He conceived the plan of restoring Spain to its former greatness by returning to the policy of Philip II., regardless of the change in the internal resources of the country. All ideas of peace were abandoned, and Spain plunged headlong into the European struggle. The truce with the United Provinces was unpopular because the commercial progress of the Dutch was fatal to the trade of the Spanish Netherlands, and Amsterdam had already begun to take the place of Antwerp. The expiration of the truce in April, 1621, was followed by an immediate renewal of the war. To make the war successful it was imperative to secure the alliance with England, but this was sacrificed because the emperor insisted upon confiscating the Palatinate, which was conferred upon Maximilian of Bavaria. The match with the Spanish infanta was broken off, and Prince Charles married Henrietta Maria of France. The alienation of England was enough in itself to ensure the ultimate failure of the Dutch War. On the mainland the successive stadtholders, Maurice and Frederick Henry, held their own even against the experienced Spinola, and after the latter's recall in 1629 had a distinct advantage. But it was by sea that the Dutch gained their most conspicuous successes. In 1628 the Spanish treasure-fleet was captured by Admiral Hein, whose booty was estimated at seven millions of guilders [$2,842,000]. The greater part of Brazil, together with Malacca, Ceylon, Java, and other islands, were conquered by the Dutch sailors. Instead of conquering the northern provinces, Spain had to make great exertions to defend the frontiers of the southern Netherlands.

In central Europe the fortune of war was more favorable to Spain and her allies. The crushing defeat of the elector-palatine was followed by the humiliation of the Protestant champion, Christian IV. of Denmark. Ferdinand II. enjoyed for a moment greater power than any other successor of Charles V., and the Edict of Restitution seemed to complete the triumph of the Catholic reaction in Germany. But the revival of the Hapsburg power awakened the jealousy of France, which in 1624 had fallen under the strong rule of Richelieu. The Spaniards had occupied the Valtelline, an important pass which connected Lombardy with Tyrol. A French army expelled the conquerors in 1624, and the treaty of Monçon restored the pass to the community of the Grisons. For a time

France was occupied with the suppression of a Huguenot rising, but no sooner had La Rochelle fallen than Richelieu again interfered to thwart the designs of Spain in the question of the Mantuan succession. The Spaniards endeavored to exclude the duke of Nevers, the rightful heir to the duchy, on account of his connection with France. But Richelieu forced the Spanish troops to raise the siege of Casale, and ultimately extorted the treaty of Cherasco (1631), by which the emperor recognized the succession of the duke of Nevers in Mantua. The occupation of Pinerolo in this war gave the French an opening into Italy and threatened the ascendency which Spain had so long exercised in the Peninsula. Meanwhile the victories of Gustavus Adolphus had destroyed the imperial and Catholic ascendency in Germany. The Spaniards were ignominiously driven from the positions which they occupied on the Rhine.

The death of Gustavus Adolphus at Lützen inspired the Roman Catholic powers with new hopes. Spain determined to strain every nerve to turn the tide of victory. Philip IV.'s brother Ferdinand, the cardinal-archbishop of Toledo, was sent to raise troops in Italy and to lead them through Germany into the Netherlands. In 1634 Ferdinand effected a junction with the imperial forces, and their combined efforts won a signal victory at Nordlingen. The Lutheran princes, headed by John George of Saxony, hastened to make terms with the emperor in the treaty of Prague (1635). The Swedes were left almost isolated in Germany, and a speedy termination of the war seemed inevitable. At this crisis Richelieu decided to embark in the war as a principal, and concluded a close alliance with the Dutch against Spain. For two or three years the new policy of France seemed likely to be attended with failure. The French troops, unaccustomed to war, were no match for the trained veterans of Spain. Not only were they repulsed from the Netherlands, but the cardinal-infant actually invaded France (1636) and inspired a panic in the capital itself. His success, however, was only temporary, and before long the superior policy of Richelieu gave France the upper hand. The occupation of Alsace, which fell into French hands after the death of Bernhard of Saxe-Weimar, interrupted the connection between the Netherlands and Italy. In the latter peninsula the French gained ground and restored the regent of Savoy, whom the Spaniards had expelled. Finally, more important than all, the alliance with Holland gave France the superiority by sea. The destruction of a great Spanish fleet in the Downs, where it had taken refuge under the neutral flag of England, made it almost impossible to send reinforcements from Spain to Brussels. By striking at the points of connection, Richelieu was breaking the unwieldy Spanish empire to pieces. At this moment his task was immensely facilitated by the outbreak of internal dissensions.

Olivares had been inspired by the success of his great rival with the idea of strengthening Spain by a vigorous policy of centralization. The monarchy consisted of a number of scattered provinces, each ruled by a separate council at Madrid, and each possessed of its own separate institutions. They were held together only by the predominance of Castile and by religious unity. This system Olivares determined to abolish by elevating the royal power to equal absolutism in all the provinces. The dangers from foreign enemies were to be met by forming Spain into one indissoluble whole. But the spirit of provincial independence was still strong, and it was artfully encouraged by the intrigues of Richelieu, who wished to absorb the attention of Spain in its domestic affairs. An edict ordering all able-bodied men to arm for the war, under penalty of confiscation, provoked a revolt in 1640 among the Catalans, who were jealously attached to their old privileges, and whose proximity to the French frontier had already exposed them to intolerable hardships. The Castilian troops were driven from the province, and Catalonia formed itself into a republic under the protection of France. This event exerted a magical influence upon Portugal, where Richelieu's emissaries had also been active, and where the antipathy to Castile was national rather than provincial. In December, 1640, a revolution was successfully accomplished in Lisbon, and the crown was assumed by a native noble, John of Braganza, in whose veins ran the blood of the ancient kings. These disasters were fatal to Olivares, to whose system of government they were not unnaturally attributed. In 1643 he was compelled to resign his post, and Philip IV. announced his intention of ruling alone.

The revolt of Catalonia and Portugal, together with the undisguised discontent shown by several of the other provinces, could not but hamper Spain in the conduct of the European War. The conquest of Roussillon in 1642 enabled the French to give effectual assistance to the Catalans, who acknowledged Louis XIII. as count of Barcelona. The successive deaths of Richelieu (1642) and Louis XIII. (1643) made no difference to the policy of France, which was directed by Mazarin under the regency of Anne of Austria. The French had now completely made up the military inferiority which had foiled their efforts at the beginning of the war. In 1643 Enghien (afterwards the great Condé) won the first of a brilliant series of victories at Rocroi, and his success was the more important because it placed the domestic authority of the regent upon a firm footing. The disasters of Spain were increased by the formidable rising of Masaniello in Naples (1647), which was carried on by the duke of Guise and was suppressed with difficulty in 1648. This was followed by the loss of the Austrian alliance through the treaty of Westphalia. As it would have been impossible for Spain to contend single-handed against the hostile coalition, the opportunity was seized to make terms with Holland. This was only achieved by consenting to great sacrifices. Not only did Spain surrender all claims to sovereignty over the northern provinces, but it also ceded to them the northern districts of Brabant, Flanders, and Limburg, with the strong fortresses of Maestricht, Hertogenbosch (Bois-le-Duc), Bergen-op-Zoom, and Breda. The Dutch retained all their conquests in America and the Indies, and secured themselves from the rivalry of Antwerp by a clause which enjoined the permanent closing of the Scheldt. This marks the final recognition of the United Provinces as an independent state, and also the transference to the northern powers of the maritime supremacy hitherto claimed by Spain.

France and Spain were now left face to face with each other. For the next four years the disturbances of the Fronde gave the Spaniards a great opportunity, of which they were not slow to avail themselves. In the Netherlands they recovered Gravelines, Ypres, and Dunkirk, while Don John of Austria, a natural son of Philip IV., took Barcelona and reduced the Catalans to submission. But the triumph of Mazarin in 1653 enabled France once more to devote itself to the war, although at the same time it drove the great Condé into the Spanish service. The military operations now reduced themselves to a duel in the Netherlands between the rival generals Condé and Turenne. The old tactics, which were adhered to with Spanish obstinacy, were now out of date, and the once invincible infantry was almost useless against the quick movements of light-armed troops which had been introduced by Gustavus Adolphus. The struggle was finally decided by the intervention of England. Both powers had earnestly sued for the support of Cromwell. The rapid advance of the French power was a cogent reason for England to assist Spain, but the religious bigotry that still prevailed at Madrid made the alliance impossible. At last Mazarin gained over the Protector by promising to banish the Stuarts from France and to cede Dunkirk. Reinforced by 6000 Ironsides, probably the best soldiers in Europe, Turenne was irresistible. Dunkirk was reduced after an obstinate defence and handed over to the English, to the great scandal of Roman Catholic Europe. One after another the fortresses of Flanders fell into the hands of the French, and, though the death of Cromwell lost them the support of England, it was impossible for Spain to continue the war. In 1659 Mazarin and Don Luis de Haro, the successor of Olivares, met on a small island in the Bidassoa, and there arranged the treaty of the Pyrenees. Spain had again to make great sacrifices. Besides Artois and several fortresses in the Netherlands, Roussillon and Cerdagne were ceded to France, and thus the Pyrenees were fixed by law as the boundary between the two countries. Louis XIV. was to marry the infanta Maria Theresa, who was to receive a large dowry, but was to renounce all eventual claims to the Spanish crown. The only concessions made by France were the pardon of Condé, the recognition of Catalonia as a province of Spain, and the promise to give no more assistance to the Portuguese.

Regency of Maria Anna.

Charles II.

Now that Spain was freed from external hostilities, it seemed possible that the reduction of Portugal might be at last accomplished. But the alliance of France was speedily replaced by that of England, and Catherine of Braganza was married to Charles II. Louis XIV., too, tried to obtain from the Spanish Government an acknowledgment of his wife's claims to the succession, and failing in this he continued to send secret assistance to the Portuguese. A French general, Schomberg, defeated Don John of Austria in 1663, and two years later routed the Spanish forces at the battle of Villa Viciosa. This final disaster crushed the declining energies of Philip IV., who died on September 17, 1665. As his son Charles II. was only four years old, he bequeathed the government to his widow Maria Anna of Austria, with a special junta to advise her in the conduct of affairs. As the Spanish monarchy had declined, its authority had been exercised by a series of chief ministers,—Lerma, Olivares, and Haro,—and this was the only way in which the unity of the executive power could now be maintained. The favor of the queen-mother raised to this position her confessor, Father Nithard, a native of Styria. He was a man of ability and experience, and set himself to cope with the most glaring evils of the state. He endeavored to diminish the public expenditure by limiting the salaries of officials, and by putting an end to the abuses which hindered the commerce with the colonies. But he was soon called upon to face unexpected difficulties. Louis XIV. advanced a claim, on behalf of his wife, to certain territories in the Netherlands in virtue of the so-called "law of devolution." This was an old custom by which the children of the first marriage succeeded, to the exclusion of all later descendants. As Spain resisted the claim, the French invaded Flanders and overran Franche-Comté. The regent was compelled to purchase the restoration of the latter province by ceding part of Flanders to France in the treaty of Aix-la-Chapelle (1668). At the same time the independence of Portugal was finally acknowledged. These disasters increased the jealousy with which the Spanish nobles regarded the rule of a Jesuit and a foreigner. A strong opposition party was formed under the leadership of Don John of Austria, and in 1669 Nithard was compelled to resign. But among the nobles themselves there was little unity, and a difference arose as to the policy to be pursued when Louis XIV. attacked Holland in 1672. The queen-mother was naturally on the side of Austria, and her influence was sufficient to secure the adhesion of Spain to the first European coalition against France. This success she followed up by obtaining the post of chief minister for another favorite, Fernando de Valenzuela, who was appointed marquis of Villafierra and raised to the rank of a grandee of Spain. This revived the jealousy of the nobles, who again formed a league for the maintenance of their privileges under Don John of Austria. This time they were completely successful. Not only was Valenzuela banished, but Maria Anna herself was compelled to retire from the court and to take up her residence in Toledo. Don John was now all-powerful. A natural antipathy to the policy of the regent led him to draw aloof from the Austrian alliance and to attach himself to France. A marriage was concluded between Charles II. and Maria Louisa of Orleans. It was hoped that by this means better terms would be obtained from Louis XIV., but in the treaty of Nimeguen Spain had to surrender Franche-Comté and fourteen fortresses in Flanders. This treaty marks the complete loss by Spain of its position as a first-rate power. Henceforth it could only exist by the support of those states which resented the aggrandizement of France. Don John was no more successful in his domestic than in his foreign policy. His industry was as unwearying as that of Philip II. himself, and he determined to rule independently of all interested advisers. The reform from which he hoped most was a revocation of the crown domains which had passed into private hands. But the scheme met with natural opposition from the nobles, and he died in 1679 without having accomplished anything. For a year Charles II. endeavored to rule in person with the help of the ordinary council, but the attempt only showed how the strength of the monarchy was bound up with the personal character of the ruler. "Charles V.," says Mignet, "had been both general and king; Philip II. was merely king, Philip III. and Philip IV. had not been kings; Charles II. was not even a man." From infancy Charles's health had been so defective that his death had appeared an imminent contingency, and his intellect was as feeble as his body. It was impossible for him to exercise any effective control over the government, and he was little more than a tool in the hands of the nobles, who, under Don Luis de Haro, had recovered much of the political influence from which Olivares had excluded them. In 1680 the office of first minister was given to the greatest of Spanish magnates, the duke of Medina-Celi. It was at this time that Louis XIV. was conducting his famous *réunions*, and the weakness of Spain enabled him to annex without opposition Courtrai, Dixmude, and the great fortress of Luxemburg. Medina-Celi, disgusted with his thankless task, resigned in 1685, and his place was taken by Count Oropesa. The new minister revived the alliance with Austria, and Spain became a member of the league of Augsburg in 1686. The success of the league seemed to be almost assured by the Revolution which gave the crown of England to William III., the leader of the opposition to Louis XIV. But in spite of apparently overwhelming odds France more than held her own, and Spain was humiliated by the capture of Urgel and Barcelona. Ministers held office only at the will of court factions, and the first disaster was fatal to Oropesa. Spain continued to play a secondary part in the war, which was concluded in 1697 by the treaty of Ryswick, the first for many years in which France did not obtain any addition of territory. The chief motive for Louis XIV.'s moderation was the desire to devote his attention to the approaching question of the Spanish succession.

Decline of Spain in the 17th century.

The decline of Spain in the 17th century is not to be measured by its territorial losses. Holland had extorted a tardy recognition of its independence; Portugal was once more a separate kingdom; Catalonia was reduced only to very doubtful submission; France had seized upon Roussillon and Cerdagne, Franche-Comté, and great part of the southern Netherlands; French influence had been established in Italy as a counterpoise to that of Spain. But the weakness of the extremities, to which these facts bear conclusive testimony, was the result of still greater weakness at the centre. The population of the peninsula, estimated at twenty millions under the Arabs and at twelve under Ferdinand and Isabella, had fallen to less than six millions in the reign of Charles II. This decrease of numbers was doubtless due in the first place to the religious bigotry which had condemned thousands of Jews and Moriscoes to death or exile, but it is partly traceable to a fatal decline in the economic prosperity of the country. Agriculture, for which many parts of Spain were peculiarly fitted, had suffered from the departure of the Moriscoes and from a number of other causes. The want of any law of mortmain had led to the accumulation of at least one-fourth of the land in the hands of the monasteries, the most charitable but the most careless and conservative of landlords. Thanks to their obstinate adherence to obsolete methods of cultivation, their estates produced little more than one per cent. on the outlay. The system of entail, which earlier monarchs had striven to restrict, made enormous strides in the 16th century, and most of the secular estates were inalienably concentrated in the hands of a few great nobles, who lived at Madrid and spent their revenues in lavish extravagance without any regard to the interests of their tenants. In the fertile provinces of Andalusia and Estremadura agriculture was entirely ruined by the system of sheep-farming. In the 12th century, when the country was exposed to the destructive forays of the Moors, the inhabitants had been forbidden to inclose their lands with either hedges or ditches, and successive kings had encouraged the rearing of huge flocks of sheep which could easily be driven over the open country into a place of safety. In the 16th and 17th centuries the condition of things had entirely changed, but the old regulations were jealously maintained by the company of *La Mesta*, one of the most powerful and independent corporations in Spain. This body, which derived large revenues from the sale of wool, was enabled to retain its privileges intact until the reign of Charles III. Every summer their flocks poured down the northern mountains, and the absence of enclosures made it impossible to defend the crops from their ravages. Besides making agriculture impossible, the exclusive attention to sheep-rearing led to the gradual disappearance of the old forests, and, as no one ventured to plant new trees, great parts of Castile became an arid desert. Every kind of industry suffered in the same way as agriculture. The true Spaniard despised all who earned a living by handicraft, and when the Moriscoes had been banished it was impossible to obtain skilled artisans except by importing them. The Spaniards could not even cut their own timber into ships or construct fortifications for their own towns. Madrid and other cities were crowded with foreigners, who hastened to make a fortune that they might carry it back to their native land. The Government was quite as much to blame as individuals. The gold from the New World would have enabled Spain to command the markets of Europe, but the mediæval restrictions on the exportation of the precious metals were strictly enforced. The high price of commodities was attributed, not to the superfluity of the medium of exchange, but to the competition of foreign and colonial markets. It was forbidden to export one article after another, and the colonies were expected to send gold without receiving anything in exchange. A more ruinous policy could hardly be conceived; but it was supported by the merchants themselves, who refused to fill their vessels with anything but gold and silver, and left the indigo, cotton, and other commodities to the English and the Dutch. Domestic production, crippled by these restrictions, was almost destroyed by the excessive taxation rendered necessary by the ambitious schemes of Philip II. and his descendants. It is notorious that Austria could never have carried on the Thirty Years' War so long but for the supplies received from Spain. Spain, in fact, was the great subsidizing power in the 17th century, as England was in the 18th. The enormous expenditure thus necessitated was wrung from the classes least able to pay it, as the Government was not strong enough to attack the exemption of the nobles and clergy. The *alcavala*, the tax on sales which Ximenes had abolished, was restored under Philip II., and in the 17th century reached the enormous amount of 14 per cent. The traders naturally sought to evade a tax which it was impossible to pay. But this only increased the vigilance of the revenue officers, who endeavored to collect the tax at every opportunity, on the raw material, on the manufactured product, and again every time that it changed hands. Taxation in Spain was a caricature of Alva's system in the Netherlands, and was even more ruinous than that had been. Foreign nations reaped all the advantages which the short-sighted policy of the Spaniards threw away. It has been calculated that five-sixths of the manufactured commodities consumed in Spain were provided by foreigners, and that they carried on nine-tenths of the commerce with the Spanish colonies. By law all foreign trade with the colonies was prohibited, but the decline of native industry made it impossible to enforce the laws, and the Spanish Government had to connive at a contraband trade of which other countries gained all the profit. The policy of the earlier kings had made the colonies dependent upon European products, and when Spain could no longer supply them they had to be obtained elsewhere. Circumstances in the latter half of the 17th century allied Spain with England and Holland against France, and the English and Dutch founded their commercial supremacy upon the trade which Spain threw into their hands. The country which had sent a hundred vessels to Lepanto, and which in 1588 had despatched the great Armada against England, was reduced under Charles II. to borrowing Genoese vessels to maintain its connection with the New World. The army which had once been the terror of Europe, had sunk at this time to an effective force of little more than 20,000 men. In literature and art the decadence of Spain was equally conspicuous and complete. The religious unity of the country was preserved, but all touch with the intellectual advance of Europe was deliberately sacrificed.

The Spanish succession question.

In spite of its loss of power and prestige, the crown of Spain was still regarded as a prize well worth winning. Ever since Charles II.'s accession the Spanish succession had been a prominent question for European diplomacy, and from 1697 it became the pivot on which international relations turned. Charles II.'s first wife, Maria Louisa, of Orleans, had died childless in 1689, and his second marriage to Maria Anna of Neuburg was equally unfruitful. The male line of the Spanish Hapsburgs was evidently on the verge of extinction, and by law and tradition the crown would pass to the nearest female or her heir. But the question was complicated in many ways. Of Charles II.'s two sisters, the elder, Maria Theresa, had married Louis XIV., and had renounced her claims, but her husband had always protested against the renunciation, and the non-payment of the stipulated dowry gave him an argument for its nullity. The younger, Margaret Theresa, had married the emperor Leopold I., and had made no renunciation; but she had since died, leaving an only daughter, Maria, who married the elector of Bavaria. Going a generation back, the two sisters of Philip IV. had also married into the houses of Bourbon and Hapsburg. Anne of Austria, whose renunciation of the Spanish crown was undisputed, was the mother of Louis XIV., while Maria Anna was the mother of Leopold I. Ever since the division of the house of Hapsburg into two branches it had been agreed by a family compact that if either became extinct the other should succeed to its territories. Leopold I. was extremely anxious to restore the unity of the family by securing the observance of this compact, and he had a great advantage in the fact that Charles II.'s mother was his own sister, and Charles's second wife was his sister-in-law. The will of Philip IV. had arranged that, after Charles II. and his descendants, the crown should pass, first to Margaret Theresa and her children, and secondly to Leopold and his children. It was a great disappointment to Leopold that his first wife left him only a daughter, but he tried to secure the claims of his family by extorting from her on her marriage a renunciation of her rights to the crown of Spain. This renunciation the Spanish Government had never recognized, and the queen-mother, whose adherence to the Hapsburg interests was overcome by her feelings for her own family, induced Charles II. to make a will in 1696 in which he named Joseph Ferdinand, the infant electoral prince of Bavaria, as his heir. But the queen-mother's death withdrew the dominant influence at the court of Madrid and enabled the Austrian envoy, Count Harrach, with the help of the queen, to procure the revocation of this will. The succession now became the subject of party quarrels and intrigues, in which the rival envoys of Austria and France took a prominent part. The aim of Leopold I. was to obtain the succession of his second son, the archduke Charles, while Louis XIV. hoped to procure the Spanish crown, if not for his son, at least for one of his grandsons. The office of first minister in Spain had not been filled up since the fall of Oropesa, and the most influential man in the kingdom was Cardinal Portocarrero, archbishop of Toledo. He was a bitter opponent of the queen, who was extremely unpopular, and all his efforts were directed to thwart the schemes of Austria. To depress the cardinal, Maria Anna induced Charles II. to recall Oropesa, but the latter declined to return to the Austrian alliance which he had previously championed, and espoused the cause of the electoral prince. There was no semblance at this time of a French party in Madrid, but Louis XIV. availed himself of the cessation of hostilities to send thither an able diplomatist, Count Harcourt, who speedily contrived to exercise considerable influence over the course of events.

Too many European interests were involved in the succession to allow it to be settled as a mere question of domestic politics. The idea of the balance of power dominated European diplomacy at this time, and William III. of England was its avowed and recognized champion. England and Holland, the two countries with which William was connected, were vitally interested in the Spanish trade. The accession of a French prince in Spain would almost inevitably transfer to France all the advantages which they at present enjoyed. It was obvious that William III. must have a voice in the settlement of this succession, and Louis XIV., who had no desire for a new European war, was willing to recognize this. The negotiations between England and France resulted in the first treaty of partition (October 11, 1698). The electoral prince was to receive the bulk of the Spanish empire, viz., Spain itself, the Netherlands, Sardinia, and the colonies; the dauphin was to have Naples, Sicily, Finale, and Guipuzcoa; while Lombardy was to go to the archduke Charles. This treaty had one fatal defect—that it was based solely on the interests of the contracting powers and took no account of the wishes of the Spaniards, who resented any proposal for the division of the empire. The first hint of the treaty irritated Charles II. into making a second will in November in favor of the electoral prince, and all parties in Spain agreed in its approval. But within three months both treaty and will were rendered null by the sudden death of the infant prince (February, 1699), and the question, thus reopened became more thorny than ever, as the choice now lay definitely between Austria and France. It seemed almost impossible to prevent the outbreak of a general war, but William III. patiently reunited the broken threads of his diplomacy, and arranged with France a second treaty of partition. The Spanish monarchy was to be divided into two parts. The larger, consisting of Spain, the Netherlands, Sardinia, and the colonies, was to go to the archduke Charles. The dauphin was to receive the share stipulated in the former treaty, with the material addition of Lorraine. The duke of Lorraine was to be compensated with the Milanese. This treaty, unlike the first, was communicated to Austria; but the emperor, who was now confident of securing the whole inheritance, refused to accept it.

Meanwhile the death of the electoral prince had destroyed the temporary unanimity at Madrid. Portocarrero and his partisans were gained over to the side of France by Harcourt. Oropesa fell back upon a scheme of his own for uniting the whole Peninsula under the king of Portugal. The queen returned to her old allegiance to her brother-in-law, and formed a close alliance with Harrach for the advancement of the interests of the archduke Charles. A popular rising overthrew Oropesa and enabled Portocarrero to regain his ascendency. At this juncture came the news of the second partition treaty, which again irritated the tender susceptibility of the Spaniards. The Austrian party hoped to utilize the popular feeling against Louis XIV. as a party to the hated treaty. But Harcourt adroitly contrived to suggest that the best way of annulling the partition project was to enlist Louis's own interests against it. The view steadily gained ground that the house of Bourbon was the only power strong enough to secure the unity of the Spanish empire. Portocarrero succeeded in inducing Pope Innocent XII. to support the French claim. Charles II., feeble to the last, succumbed to this combination of influences, and signed a testament bequeathing the succession to Philip of Anjou, the second grandson of Louis XIV., on condition that he would renounce all claims to the crown of France (October 3, 1700). Thus his last act was to disinherit his own family in favor of the enemy with whom he had been at war almost all his reign. He died on the 1st of November, 1700.

Everything now depended upon the decision of Louis XIV. The treaty of partition offered substantial advantages to France; Charles II.'s will would exalt the house of Bourbon above every other family in Europe. His hesitation, whether real or feigned, did not last long. On November 16, he introduced his grandson to the French court as Philip V. of Spain. The dynastic ambition of the king was also based upon sound policy. In the face of Spanish opinion and of the emperor's refusal it was impossible to carry out the partition treaty. And for the moment it appeared that the accession of a Bourbon prince would be secured without difficulty. Philip V. was proclaimed in all parts of the Spanish monarchy amid popular acclamations. Leopold I. protested and prepared to attack Lombardy, but he could not hope to obtain the whole succession for his son without the assistance of the maritime powers. William III., who saw the aims of his life threatened with ruin, was eager for war, but his subjects, both in England and Holland, were resolute to maintain peace. In these circumstances Louis XIV. played into the hands of his enemies. He expelled the Dutch garrisons from the fortresses of the Netherlands which they had occupied since the treaty of Ryswick, and replaced them by French troops. He showed a cynical intention to regard Spain as a province of France, and he took measures to secure for the French the commercial advantages hitherto enjoyed by England and Holland. William III. was thus enabled to conclude the Grand Alliance (September 7, 1701), by which the contracting powers undertook to obtain the Netherlands and the Italian provinces of Spain for the archduke Charles and to preserve the mercantile monopoly of the English and Dutch. A few days afterwards James II. died at St. Germains, and Louis XIV. was injudicious enough to acknowledge his son as king of England. This insult exasperated public opinion in that country; the Tory parliament was dissolved; and the last obstacle to William's warlike policy was swept

Philip V.

away. William himself died in March, 1702, but he left the continuance of his policy to the able hands of Marlborough and Heinsius. The war which the emperor had commenced single-handed in 1701 became general in the next year.

War of the Spanish Succession.

It is needless to follow the military operations of the War of the Spanish Succession, which have been rendered famous by the exploits of Eugene and Marlborough. The chief scenes of hostilities were the Netherlands, Germany, and Italy, in each of which the French suffered fatal and humiliating reverses. At first the peninsula of Spain was not directly concerned in the war. The Grand Alliance did not aim at excluding Philip from the Spanish monarchy as a whole, but only from those parts which the maritime powers wished to preserve from French influence. But in 1703 Pedro II. of Portugal deserted the cause of France and concluded the Methuen treaty with England. This opened the Peninsula to the allied forces. and necessitated a revision of the terms of the alliance. Pedro's support could only be purchased by the expulsion of the French from Spain, and the allies now determined to claim the whole Spanish inheritance for the archduke Charles. In 1704 the archduke appeared in Portugal, and the English fleet, under Sir George Rooke, captured Gibraltar. As the assistance of the Portuguese was only half-hearted, it was decided in 1705 to seek a new opening in the east. Catalonia, always inclined to revolt against its rulers, and recently irritated by the conduct of Philip V., offered a convenient base of operations. The brilliant but eccentric earl of Peterborough succeeded in capturing Barcelona, and by the end of the year the archduke was acknowledged as Charles III. in Catalonia, Valencia, and Aragon. A great effort on the part of Philip to recover the lost provinces was repulsed, and a simultaneous advance of the allies from the east and from Portugal compelled him to evacuate Madrid, where Charles III. was formally proclaimed. But the provincial disunion, which had so often hampered the Hapsburg kings, proved the salvation of their Bourbon successor. The Castilians refused to obey a king who was forced upon them from Aragon, and their religious instincts were offended by the alliance of Charles with the heretics of England and Holland. Disunion among the allies aided the revolt of Castile, and by the end of 1706 Charles III. found himself compelled to evacuate his recent conquests and to return to Barcelona. In 1707 the allies attempted another invasion of Castile, but they were routed by the duke of Berwick at Almanza, and Aragon and Valencia were forced to return to their allegiance to Philip V. For the next two years the war in the Peninsula languished. Charles III. received reinforcements from Austria under Starhemberg, but he was unable to do more than retain his hold upon Barcelona. In 1710 the cause of the allies received a new impulse from the arrival of Stanhope with supplies of men and money from England. Under the joint command of Stanhope and Starhemberg the army advanced westwards from Barcelona, defeated Philip V. at Almenara and Saragossa, and for the second time occupied Madrid. The disasters which the French had experienced in other parts of Europe had broken the pride of Louis XIV., and he was prepared to purchase peace by sacrificing his grandson. A treaty would have been concluded to this effect at Gertruydenburg, if the allies had not insisted that the French troops should be employed in forcing Philip V. to accept it. Louis XIV. refused to take arms against his own family, and a sudden change in the current of fortune saved him from the humiliation which his enemies wished to force upon him. Charles III. found it impossible to maintain Madrid in face of the enthusiasm of the Castilians for his rival. The capital of Spain was of no importance from a military point of view, and the allies determined on its evacuation. On their retreat they were followed by Vendôme, whom Louis XIV. had sent to his grandson's assistance. Stanhope, attacked at Brihuega, was compelled to capitulate with all his forces before Starhemberg could arrive to his assistance. The latter was defeated after an obstinate struggle at Villa Viciosa. Aragon and Valencia again submitted to Philip, and the archduke was once more confined to Catalonia.

At this juncture two events occurred which completely altered the balance of the contending powers. The fall of the Whig ministry through a court intrigue gave the control of English policy to the Tories, who had always been hostile to the war. The death of Joseph I. in April, 1711, left the Austrian territories to his brother, the archduke Charles, who was soon afterwards elected emperor as Charles VI. To allow him to obtain the Spanish succession would be to revive the empire of Charles V., and would be even more dangerous to the balance of power than the recognition of Philip V. with adequate securities against the union of France and Spain. The object for which the allies had been making such immense exertions was now a result to be averted at any cost.

Treaty of Utrecht.

In these altered circumstances, Bolingbroke, the English minister, hurried on the negotiations with France which resulted in the treaty of Utrecht between England, France, Spain, and Holland. Philip V. was acknowledged as king of Spain, on condition that he should formally renounce all eventual claims to the crown of France. But the partition of the Spanish monarchy was insisted upon by the allies. The Netherlands were to be handed over to Austria, on condition that the Dutch should garrison the barrier fortresses. Austria was also to receive the Italian provinces of Spain, with the exception of Sicily, which was given to the duke of Savoy with the title of king. England naturally obtained considerable advantages from a war in which she had borne so prominent a part. The acquisition of Gibraltar and Minorca gave her the control of the Mediterranean. The *asiento* conferred upon her the privilege of importing slaves into the Spanish colonies, and she also obtained the right of sending a single vessel into the South Seas. France had to recognize the Protestant succession, and to cede Newfoundland, Acadia (Nova Scotia), and Hudson's Bay. Charles VI. refused to accept the terms offered to him at Utrecht, but he found it impossible to carry on the war by himself, and in 1714 he made peace with France by the treaty of Rastatt. But he still retained the title of king of Spain, and showed no willingness to acknowledge Philip V.

The great blot on the conduct of the allies in arranging the treaty of Utrecht was the desertion of the Catalans, who had rendered such loyal services during the war. They were left to the tender mercies of Philip V., who sent Berwick to reduce the rebellious province. Barcelona resisted for many months with the heroism of despair, and was well-nigh reduced to ashes before it could be taken (September, 1714). With its fall all resistance came to an end. The three Aragonese provinces were deprived of the last remnants of their ancient privileges, and were henceforth ruled from Madrid under Castilian laws.

With the final accession of a Bourbon king Spain entered upon a new period of history, in which it once more played a considerable part in European politics. The death of Louis XIV. (1715), and the acquisition of the regency in France by the duke of Orleans, destroyed the close connection that had hitherto existed between France and Spain. Philip V. was hypochondriacal and bigoted, the slave of his wife and his confessor, but he had certain definite schemes to which he clung with the obstinacy of a weak character. In spite of his solemn renunciations and the guarantee of the European powers, he never relinquished the idea of ultimately succeeding to the French throne. In what was regarded as the probable event of Louis XV.'s death, he was determined to enforce his hereditary claim, even if he had to resign the crown of Spain. His interests were diametrically opposed to those of the duke of Orleans, who was after Philip's family, the natural heir to Louis XV. Philip V. had one other guiding passion, enmity to Charles VI., who had robbed the Spanish monarchy of its fairest provinces in Italy. These provinces he set his heart upon regaining, and in this project he was encouraged by the two people who had the most influence over him,—his wife and his minister.

Philip V.'s first wife, Maria Louisa of Savoy, had died in 1714, leaving him two sons, Louis and Ferdinand. A successor was speedily found for her in the person of Elizabeth Farnese, niece of the duke of Parma, who was suggested by Alberoni, at that time agent for Parma at Madrid. The new queen speedily obtained unlimited ascendency over her husband's mind, and she displayed an unbridled ambition and a capacity for intrigue astounding in one who had been brought up in complete retirement. As Philip's sons by his first wife would exclude her own children from the Spanish throne, she was anxious to obtain for the latter the reversion of the duchies of Parma and Tuscany, to which she had an eventual claim. With this end in view she encouraged her husband's designs in Italy, while personal ambition made her eager to see him on the French throne. Her favor gave the conduct of Spanish affairs for a short period to her countryman Alberoni, one of the strangest personages of the 18th century. The son of a gardener at Piacenza, he had sought a career in the church, and had come to Spain in the suite of Vendôme, whose favor he had won by combining the functions of a cook and a buffoon. After the death of his patron he remained in Spain, and conceived an ardent affection for the country of his adoption. Raised to power by the part he had played in effecting the king's marriage, he determined to exalt Spain from its long depression to the position it had once occupied in Europe. His domestic reforms showed that he had a real capacity for government. Commerce and industry revived under his patronage; the army was reorganized, and the revenue increased. But his chief attention was given to the navy, the real foundation of the former greatness of Spain. Foreigners who had known the country under Charles II. or during the Succession War were astounded at the strides which it had made under the new administration. Alberoni himself is said to have assured Philip that with five years of peace he would make him the most powerful sovereign of Europe. But these years of peace he was not destined to have. Alberoni cordially approved the Italian designs of Philip, and hoped to employ the restored might of Spain in freeing his native country from the hated rule of Austria. He had less sympathy with the king's hankering after the French crown and his enmity to the regent Orleans. But he held office only by the royal favor, and could not venture to set up his own will against that of his master. He was convinced, and not without reason, that everything would go well if he could secure the English alliance.

Administration of Alberoni.

But the attitude of Spain had already awakened suspicion in France, and the ready mind of Dubois had conceived a plan for thwarting Alberoni. He determined to desert the policy of Louis XIV. and to conclude a close alliance between France and England. This was to be based upon the common danger from rival pretenders, which urged the houses of Orleans and Hanover to maintain the provisions of the treaty of Utrecht. An agreement was arranged between the two states in 1716, and, being joined by Holland in January, 1717, was known as the Triple Alliance. This was a great blow to Alberoni, and made him anxious to postpone all hostilities until his preparations were complete. But his hand was forced by the indignation excited in Philip V.'s mind by an insult offered to him by the emperor. The grand inquisitor of Spain was arrested in Lombardy as a rebel against Charles III., his lawful king. Philip V. decided for an immediate rupture, and Alberoni against his will had to send an expedition to Sardinia, which overran the island in 1717. The enthusiasm excited in Spain by the unwonted news of a military success was increased in 1718 when another Spanish force occupied Sicily. But meanwhile Charles VI. had appealed to France and England for assistance against this rupture of the treaty of Utrecht. The Triple Alliance, reinforced by the junction of Austria, became the Quadruple Alliance (August, 1718). The resolution of the allies was convincingly displayed in a naval encounter in which Admiral Byng destroyed the Spanish fleet off Cape Passaro.

Hitherto the only fault to be found with Alberoni's schemes is that they were attempted prematurely, and this was the fault of the king rather than of the minister. But the Quadruple Alliance drove him in despair to form those far-reaching projects which are generally associated with his name, and which have given rise to the unjust impression that his whole policy was chimerical and unsound. To meet the hostility of England and France he must make use of internal divisions. He invited the Pretender to Spain, prepared an expedition in his behalf, and concerted with Count Görz, the minister of Charles XII., a grand scheme by which Sweden and Russia were to combine in supporting the Jacobites against George I. At the same time, through the Spanish envoy Cellamare, he organized a conspiracy among the numerous opponents of the regent. All these schemes broke down simultaneously. Charles XII. was killed at the siege of an obscure town in Norway; Görz was executed by his successor; the Spanish fleet which was to carry the Pretender to England was wrecked; the conspiracy of Cellamare was discovered and suppressed. France declared war, and sent an army under Berwick across the Pyrenees. An English fleet gratified the national love of a maritime monopoly by burning along the Spanish coast the vessels and docks which Alberoni had created. The emperor, who had just ended a war with Turkey by the treaty of Passarowitz, was able to send a force which succeeded in recovering Sicily. Alberoni was sacrificed to appease the enemies of Spain, and was exiled from the kingdom he had served so loyally in December, 1719. A month later Philip V. accepted the terms imposed upon him by the Quadruple Alliance. He had to confirm his renunciation of the French crown, and also to abandon all claims on the provinces of Spain which had been ceded to Austria by the treaties of Utrecht and Rastatt. He also allowed the emperor to retain Sicily, the duke of Savoy being compensated with Sardinia. On the other hand Charles VI.'s pretensions to the Spanish crown were definitely abandoned, and the allies recognized the eventual claims to Parma and Tuscany of Philip's children by his second marriage, on condition that those duchies should never be united with Spain.

In spite of the conclusion of peace, Philip continued to cherish his animosity against Charles VI., especially as the latter showed an inclination to evade the condition about Parma and Tuscany by encouraging other claimants to come forward. To gratify this passion, Philip went so far as to lay aside his old enmity against the duke of Orleans, and to authorize the negotiation of a close alliance with France. His eldest son, Don Luis, was married to a daughter of the regent, and Louis XV. was betrothed to the infanta Maria Anna. But the death of Orleans in 1723 gave a new direction to the king's policy. In 1724 Europe was astounded by the news that Philip had abdicated in favor of Don Luis, and had gone into retirement at San Ildefonso. This act was generally attributed to the indolence and superstition which formed the basis of his character, but the real motive was undoubtedly a desire to remove the chief obstacle to his accession in France. Louis XV., however, disappointed his expectations by continuing to live, and the queen soon wearied of her unwonted seclusion. Luis only survived his accession eight months, and to the surprise of the world Philip V. emerged from his retreat to resume the crown which he had laid down of his own accord.

Ripperda.

The queen returned to power more determined than ever to carry out her favorite scheme of obtaining an Italian principality for her eldest son Don Carlos. As France and England had shown themselves lukewarm in the matter, she resolved to turn to her husband's enemy, Charles VI. This scheme was suggested by a Dutch adventurer, Ripperda, who inspired Elizabeth with a belief that the Austrian alliance would enable her not only to effect her object in Italy, but also to regain Gibraltar and Minorca for Spain. This was rendered the more probable by the fact that Charles VI. had quarrelled with England about the foundation of the Ostend Company. The conduct of the affair was entrusted to Ripperda himself, and while he was at Vienna a great impulse was given to the negotiation by a complete rupture between Spain and France. The duke of Bourbon, who had become chief minister in France after the death of Orleans, had set himself to reverse the policy of his predecessor. To complete this he sent the infanta back to Spain and married Louis XV. to Maria Leczinska, daughter of the ex-king of Poland. This insult removed the last scruples of Philip V. about the Austrian alliance, and in April, 1725, Ripperda concluded the treaty of Vienna. The mutual renunciations arranged by the Quadruple Alliance were confirmed: Spain recognized the settlement of the Austrian succession by the Pragmatic Sanction and promised great commercial privileges to the Ostend Company, while Charles VI. pledged himself to secure the succession of Don Carlos in Parma and Tuscany and to use his influence with England to obtain the restitution of Gibraltar and Minorca. By a secret treaty Charles further undertook, in the case of England's refusal, to assist Spain with arms and also to send aid to the Jacobites. These terms were soon divulged by the indiscreet vanity of Ripperda himself, and England and France formed the counter-league of Hanover (September, 1725), which was also joined by Frederick William I. of Prussia, though only for a short time.

Ripperda returned to Spain, to be rewarded with the office of chief minister. But his success seems to have turned his head; his boasts about the grand results to be expected from the Austrian alliance proved to be ill-founded, and his fall was as sudden as his rise had been. After a brief period of exile in England, he sought a new home in Morocco, where he became a convert to Islam and died in 1737. But his policy was continued by his successor, Don Joseph Patiño, who sent a fleet to lay siege to Gibraltar. Europe was now divided into two hostile leagues, but the outbreak of a general war was averted, partly by the pacific inclinations of Walpole in England and Fleury in France, and partly by the growing coolness between Austria and Spain. Charles VI. had been led into the treaty of Vienna by a momentary pique against England, but he soon realized that he had more to lose than to gain by favoring the Spanish designs upon Italy. Accordingly, in May, 1727, while the siege of Gibraltar was proceeding, he threw over his obligations to Spain and signed the preliminaries of a peace with England and France. The Ostend Company was suspended, and the questions about Parma, Tuscany, and Gibraltar were referred to a European congress at Soissons. The Spanish Government found it impossible to hold out in isolation, and accepted these terms by the convention of the Pardo (March, 1728).

The congress of Soissons was a complete failure, and the irrepressible energy of the Spanish queen discovered a new method of obtaining her ends. The birth of a son to Louis XV. removed into the background all idea of the succession in France, and the attitude of Charles VI. proved that he would do nothing for Don Carlos. Under these circumstances there was no alternative but to sacrifice the prospect of recovering Gibraltar and Minorca and to seek the alliance of England and France. By the treaty of Seville (November, 1729), these powers, with Holland, concluded an offensive and defensive alliance with Spain. The privileges which the latter country had conferred upon the Ostend Company were revoked. Don Carlos was recognized as the heir to Parma and Tuscany, and to enforce his claims these provinces were to be occupied by 6000 Spanish troops. Charles VI., astounded at this sudden change in the aspect of affairs, took active steps to oppose this occupation of the duchies. He collected 30,000 troops in Italy, and when the old duke of Parma died in January, 1731, he seized his territories as an imperial fief. Elizabeth called upon her allies to carry out the treaty of Seville, but Walpole and Fleury were unwilling to resort to hostilities. Luckily Charles VI. thought more of securing his daughter's succession in Austria than of anything else. By promising that England would guarantee the Pragmatic Sanction, Walpole induced the emperor to conclude the second treaty of Vienna (March, 1731), which dissolved the Ostend Company and confirmed the provisions of the treaty of Seville. In 1732 English ships conveyed Don Carlos and the Spanish troops to Italy. Parma and Piacenza were immediately occupied, and the grand-duke of Tuscany acknowledged Don Carlos as his heir.

In the long and intricate series of negotiations of which we have given a brief summary the guiding thread is the grasping ambition of the queen of Spain. That ambition was by no means satisfied by the results obtained in the treaty of Vienna. Austria still held the Italian provinces of Spain and was looking out for an opportunity to expel Don Carlos from central Italy. England retained her hold upon Gibraltar and Minorca, and claimed a maritime and colonial supremacy which threatened to thwart all schemes for the revival of Spanish commerce. Elizabeth never relinquished for a moment the hope of humiliating England and expelling the Hapsburgs from Italy. Circumstances at this time were more favorable than they had ever been before. The able administration of Patiño, "the Colbert of Spain," had restored order in the Spanish finances, and had already made considerable strides towards the creation of a formidable fleet. But the great advantage lay in the fact that the death of Orleans and the birth of children to Louis XV. had removed all obstacles in the way of an alliance between Spain and France. The close union between the two branches of the house of Bourbon, which the Grand Alliance had endeavored to avert, and which circumstances had postponed for twenty years, was now to become an accomplished fact. In 1733 "an eternal and irrevocable family compact" was signed by the Count Rottembourg and Don Joseph Patiño. France and Spain pledged themselves to pursue a common policy in regard both to Austria and England, the object of which was to destroy the Italian ascendency of the one and the commercial monopoly of the other. This treaty, which constituted a danger to Europe hardly less than the aggressions of Louis XIV., was kept a profound secret, and, though its existence was more than suspected at the time, its full importance has not been apprehended until recent times.

War of the Polish succession.

The first opportunity for carrying out this common policy was offered by the dispute about the Polish succession which broke out in 1733 between Stanislaus Leczinski and Augustus III. of Saxony. Austria and Russia supported the latter prince, while Louis XV. espoused the cause of his father-in-law. But the war in Poland itself was of very secondary importance compared with the hostilities to which it gave rise in southern Europe. France, Spain, and Sardinia concluded the league of Turin (October, 1733) for the partition of Charles VI.'s Italian provinces. The chief events of the war, from the Spanish point of view, were the occupation of Naples and Sicily by Don Carlos. It was intended that he should keep these kingdoms, and that Parma and Tuscany should be transferred to his younger brother Don Philip. But Fleury, seeing an opportunity of securing his own ends, refused to continue the war for the aggrandizement of Spain. In 1735 he concluded the preliminaries of a peace with Austria by which Don Carlos was to be recognized as king of the Two Sicilies, Charles VI. was to be compensated with Parma, and his son-in-law was to receive Tuscany in exchange for Lorraine, which was eventually to pass to France. The Spanish queen was bitterly indignant at the desertion of her ally, at the cession of her native Parma to Austria, and at the failure to provide anything for her second son. She struggled hard to prolong the war, but the only result of her manœuvres was to postpone the conclusion of the definitive treaty until 1739, when the preliminaries were confirmed.

War of Jenkins's ear.

Meanwhile Spain had become involved in a maritime quarrel with England. The restrictions imposed by the treaty of Utrecht upon English trade with the Spanish colonies had been systematically evaded by the development of a system of organized smuggling on the part of the British traders. The Spaniards, encouraged by the secret compact with France, refused to tolerate an abuse which their weakness had compelled them to connive at in the previous century. To put a stop to it they rigidly enforced their right of search, often seizing British vessels on the high seas and treating the crews with gross brutality. This gave rise to great ill-feeling between the two nations, which was increased by other colonial disputes about the right of gathering logwood in Campeachy Bay and on the frontiers of Honduras. The popular indignation in England, which Walpole's opponents fanned for their own purposes, was raised to fever-heat by the story of Jenkins, an English captain, who maintained that he had been tortured and his ears cut off by a Spanish *guarda costa*. Walpole, who had refused to believe in the Family Compact, and had steadily adhered to a policy of peace, was compelled by the popular clamor to declare war in October, 1739. The maritime operations which followed were insignificent. Admiral Vernon took Porto Bello, and Anson plundered Payta; but England was distracted by party jealousies and her naval organization had fallen into disorder during the long peace. Luckily for her, Patiño had died in 1736, and the impulse which he had given to the Spanish navy ended with him. But before long the quarrel was absorbed in the great European war which arose about the Austrian succession.

War of the Austrian succession.

Charles VI. had persuaded almost every European power to guarantee the Pragmatic Sanction, but the succession of Maria Theresa to his territories was not in the least facilitated by the paper promises to support her. England was almost the only power that adhered to its engagements. Frederick of Prussia advanced an obsolete claim to Silesia, and France seized the opportunity to humiliate the house of Hapsburgs. Spain hastened to join the coalition against the unfortunate heiress. Philip V. claimed to represent the Spanish branch of the Hapsburgs, and pleaded the old family agreement by which they were to succeed on the extinction of the Austrian line. There was no possibility of so absurd a claim being recognized, but it opened the prospect of recovering the lost provinces in Italy. Sardinia was gained over by the promise of part of Lombardy. Naples and Sicily were already in the hands of Don Carlos. It seemed hardly possible that Maria Theresa, pressed by enemies on every side, could successfully defend her Italian territories. A Spanish army under Montemar was embarked in French vessels, and, after evading the English fleet, landed in the Gulf of Genoa in 1741. The first news was discouraging, as Charles Emmanuel of Sardinia, ready like his predecessors to sell his alliance to the highest bidder, had been bought off by Maria Theresa. It was not till 1742 that the campaign began with an advance upon Modena, where the duke had promised his support to Spain. But the Austrians and Sardinians were the first in the field. They expelled the duke of Modena from his territories, and drove Montemar to retreat towards Naples. At the same time the English fleet appeared before Naples, and a threat of an immediate bombardment compelled Don Carlos to promise a strict neutrality during the rest of the war. Count Gages, who was sent to supersede the unsuccessful Montemar, was unable to recover the lost ground, and the first campaign ended without any serious advantage to either side beyond the Austrian occupation of Modena. In 1743 Gages again attempted the invasion of Lombardy, but was defeated at Campo Santo and repulsed. Austria and Sardinia concluded a close alliance in the treaty of Worms (September, 1743), which was negotiated by England. France and Spain sought to meet this coalition by renewing the Family Compact at Fontainebleau (October, 1743). France undertook to aid in conquering the Milanese for Don Philip, to declare war against England, and not to make peace until Gibraltar, and if possible Minorca too, had been restored to Spain. Don Philip himself was sent with a Spanish army through southern France but he failed to force a passage through the Alps. The campaign of 1744 was indecisive, but in the next year the great efforts made by Maria Theresa to recover Silesia gave her opponents in Italy an opportunity of which they were not slow to avail themselves. Gages effected a junction at Genoa with the combined French and Spanish troops under Maillebois and Don Philip. Advancing into Piedmont the allies took Tortona, and after occupying Parma and Piacenza they invaded Lombardy. This move effected the desired object of separating the Austrians and Sardinians. Schulenburg hurried off to the defence of his mistress's territories, and the allies at once turned upon Charles Emmanuel and defeated him at Bassignano. The French wished to complete the conquest of Piedmont, but the Spaniards insisted upon renewing the invasion of Lombardy. That province was now entirely undefended, as the Austrians had returned to the assistance of Charles Emmanuel, who detained them by the threat that if he were deserted he would make terms with the allies. One town after another surrendered or was taken, and in December Don Philip entered Milan in triumph. But meanwhile Maria Theresa had ended the Silesian War by the treaty of Dresden, and was thus enabled to send reinforcements into Italy. The tide of success turned with marvellous rapidity. The Spaniards evacuated Lombardy, and were soon driven from all their conquests in Piedmont except Tortona. At Piacenza, to which the Bourbon army had retreated, it was completely defeated by the Austrians.

Ferdinand VI.

At this juncture the news arrived from Spain that Philip V. had died on July 9, and had been succeeded by Ferdinand VI., the only surviving son of his first marriage. Elizabeth Farnese, "the termagant," as Carlyle calls her, whose ambition had kept Europe embroiled for thirty years, went into retirement at San Ildefonso. This event naturally influenced the war in Italy. It was not likely that the new king, who had never been on good terms with his stepmother, would expend more of his country's blood and treasure to obtain a principality for his half-brother. His first act was to supersede Gages by the marquis of Las Minas, who found the Spanish army at Tortona and hastened to withdraw it from Italy into Savoy, which Don Philip had occupied since 1742. The Austrians at once besieged and captured Genoa, thus cutting off the possibility of a renewed invasion of Italy, except through the well-guarded passes of the Alps. From this time the military operations ceased to have any direct importance for Spain, and all interest centred in the negotiations which were carried on at Breda in 1747 and transferred to Aix-la-Chapelle in the next year. The chief obstacle to peace was the demand of a principality for Don Philip, which Ferdinand VI. persisted in as necessary for the honor of Spain. Maria Theresa had already made sacrifices to Prussia and to Sardinia, and resented the idea of ceding any more of her territories. But the persistence of England carried the day, and in the treaty of Aix-la-Chapelle (October, 1748) Don Philip obtained Parma, Piacenza, and Guastalla as an hereditary principality, on condition that they should revert to Austria on extinction of his male descendants. This was the sole advantage gained by Spain. Austria retained Lombardy, shorn of the portion promised to Charles Emmanuel; and the commercial and naval ascendency of England remained unshaken. The recovery of Gibraltar, which at one time Philip V. had confidently expected, was now further off than ever.

Ferdinand VI. was as feeble in health and as averse to business as his father had been, but he was equally obstinate on certain points. He would have nothing to do with the aggressive policy of his stepmother or with the Bourbon schemes for the humiliation of England. His accession broke off the Family Compact, and gave to Spain the unaccustomed boon of thirteen years' peace. His aim was to hold the balance between the rival powers of western Europe, and in this he was aided by the discord between his two ministers, Ensenada and Carvalho, of whom the former favored France and the latter England. When Kaunitz, the Austrian envoy at Versailles, was endeavoring to negotiate an alliance between the Hapsburgs and Bourbons, Ferdinand seized the opportunity to conclude the treaty of Aranjuez, which guaranteed the neutrality of the Italian provinces of the two families. On the outbreak of the Seven Years' War in 1756 great efforts were made to draw Spain into the struggle. France offered Minorca, which had been lost by Byng at the first outbreak of hostilities, and England hastened to make the counter-proposition of a cession of Gibraltar. Ferdinand, however, refused both bribes, and maintained his policy of peace till his death in 1759.

Charles III.

This event gave the Spanish crown to Charles III., who had ruled the Two Sicilies since 1735. His accession threatened a speedy reversal of Spanish policy. The new king was a true Bourbon, and naturally inclined to the French alliance. He had an old grudge against England for the treatment he had received in the War of the Austrian Succession. He also owed a debt of gratitude to Maria Theresa for enabling him to transfer the crown of Naples to his third son, whereas by the treaty of Aix-la-Chapelle it ought to have passed to his brother, Philip of Parma. In spite of these motives, he hesitated for two years to take a decisive step. Spain was not prepared for war, and Charles had never cordially approved the change of policy at Versailles which had united France with its old rival Austria. But the rapid successes of England under Pitt's administration, and the danger of a vast extension of the maritime and colonial ascendency of that country, soon overcame his scruples. In 1761 the third Family Compact was concluded, and Spain undertook to give active assistance to France unless peace were concluded within a year. Pitt, suspecting the existence of this agreement, proposed an immediate declaration of war against Spain, but he failed to convince his cabinet and resigned. His successors, however, were driven to adopt his policy, and in January, 1762, hostilities commenced between the two countries. But Spain only entered the war to share the disasters which France had already begun to suffer. An invasion of Portugal, which had been regarded as a defenceless prey, was foiled by English assistance, and the English fleet captured Martinique and Havana. The Bourbon powers found it necessary to implore peace, and it was fortunate for them that the English government had passed into the hands of Bute, who was eager to diminish the influence of Pitt by terminating the war. By the treaty of Paris (February, 1763) England recovered Minorca, extending its colonies in every direction at the expense of France, and rejected all the demands which Charles III. had advanced on behalf of Spain.

In spite of the treaty Charles III.'s foreign policy continued to be guided by jealousy of England, and he clung to the French alliance as the only means by which he could avenge his recent humiliation. In this he was encouraged by his foreign minister, Grimaldi, who was so devoted to France that Choiseul declared himself to be more powerful at Madrid than at Versailles. In 1770 a dispute about the Falkland Islands, from which the English settlers had been expelled by a Spanish force, would probably have led to a renewal of war if a domestic intrigue had not succeeded at this juncture in overthrowing Choiseul. For the next few years a marked coolness grew up between France and Spain, which was increased when Louis XVI. disappointed the hopes that had been formed of his accession and left Choiseul in retirement. Grimaldi, chagrined at the failure of an alliance on which all his schemes were based, resigned office in 1777 and was succeeded by Count Florida Blanca, one of the most distinguished of the able ministers who ruled Spain during this period. The change of ministers made no difference to the policy of Charles III., whose obstinacy was in no way inferior to that of his predecessors. For many years Spain and Portugal had been engaged in disputes about the frontiers of their territories in South America, disputes which were rendered more bitter by the arrogance of Pombal, the Portuguese minister. The death of Joseph I. in 1777 and the consequent dismissal of Pombal enabled Florida Blanca to negotiate the treaty of San Ildefonso, by which Sacramento and the navigation of the Rio de la Plata were ceded to Spain, and a definite boundary was drawn between Brazil and Paraguay on the one side and Peru on the other. This was followed in March, 1778, by the conclusion of a perpetual alliance at the Pardo, by which Portugal was attached to the interests of the Bourbon states. These treaties, which Florida Blanca regarded as among the most signal successes of his ministry, came very opportunely to enable Charles III. to resume the schemes that had lain in abeyance since 1763. England was involved in a desperate struggle with the revolted colonies of North America, and this offered the Bourbons the long-desired opportunity for revenge. In 1778 France entered into close alliance with the colonists, and in the next year Spain followed her example. Everything seemed to favor the allies. The Northern powers, irritated by the high-handed way in which England had asserted and exercised her maritime supremacy, formed the "armed neutrality," under the lead of Catherine II. of Russia. Even Holland, the oldest and most constant ally of England, was involved in the general coalition. England, which had failed single-handed to coerce its own subjects, was now face to face with the whole maritime power of Europe, and was also hampered by domestic and Irish troubles. Spain succeeded in capturing Minorca and laid close siege to Gibraltar. Many of the West-Indian islands were captured from the English, and the surrender of Cornwallis at Yorktown destroyed the last hope of restoring American dependence. The most confident hopes were entertained of stripping England of the great bulk of its colonial possessions. But in 1782 the tide of success turned. Rodney, by the novel manœuvre of breaking the line, destroyed the French fleet in the West Indies, while the heroic defence of General Elliott and the opportune arrival of supplies under the convoy of Lord Howe saved Gibraltar from overwhelming odds. The want of unanimity among the allies, each of whom thought only of its own interests, hastened the conclusion of peace in 1783. The treaty of Versailles, by which Spain kept Minorca and obtained the Floridas, was the most honorable which that country had concluded since Cateau Cambrésis. But the failure to recover Gibraltar was a bitter disappointment to Charles III., who continued till his death (December 14, 1788) to cherish the scheme of renewing the war, though the growing disorders in France made it more and more certain that he could no longer rely upon the assistance of that country.

Revival of Spain in the 18th century.

The reigns of the first three Bourbon kings form a period of great importance in Spanish history. At the end of the 17th century Spain appeared to be a lifeless corpse, over which the other powers of Europe could contend at will. In the 18th century men were astounded to see that country rise with renewed vigor to play once more an independent part on the international stage. This revival was due in the first place to the change of dynasty. Another Hapsburg would probably have continued the obsolete policy of his predecessors. The accession of the Bourbons introduced into Spain the methods and ideas of government which had raised France to greatness under Richelieu, Mazarin, and Colbert. The two great problems to be grappled with were the profound depression of trade and agriculture and the fatal wealth and ascendency of the church. Philip V., feeble as he was personally, began the movement in advance even during the Succession War. The abolition of the old provincial independence rendered possible a more regular and centralized government, an increase of the revenue, and the removal of the old impediments to trade between the various provinces. The French officers who accompanied the king gave a new organization and new tactics to the Spanish army. Under the influence of the princess Orsini Philip seemed inclined to attack even the prescriptive privileges of the clergy. His marriage with Elizabeth Farnese saved the hierarchy and diverted his attention to wars of aggrandizement. But these wars were directed by purely political motives; the old Hapsburg idea of a religious propaganda was forever abandoned. And even during the war the task of internal reform was hindered rather than neglected. The efforts of Alberoni and Patiño gave Spain a navy more powerful than that of Philip II. The conquest of the Two Sicilies and the acquisition of Parma, though they brought little direct advantage to Spain, yet gave conclusive evidence that the old lethargy had been shaken off and that the country was capable of exertions and sacrifices which had long appeared impossible. The period of peace under Ferdinand VI. was an inestimable boon to Spain. Taxation was lightened, production was facilitated by the removal of the most crushing burdens, yet at the same time the revenue improved and the chronic deficit of previous reigns was replaced by a surplus. And this prince took a step which no one would have expected from him. The concordat of 1753 was the first vindication of the political interests of Spain against the pretensions of Rome. The crown asserted its right to appoint to all important benefices, and the number of papal presentations was reduced from twelve thousand to fifty-two. The revenue derived by the curia from Spain was proportionately diminished, and the clergy were compelled to recognize their obligations as members of the body politic. This measure was followed by an edict that henceforth papal bulls should not be obeyed until they had received the royal sanction.

The work of reform, thus tentatively commenced under Philip V. and Ferdinand VI., was carried still further by Charles III., whose reign is regarded with more pride by the Spaniards than any other since that of Philip II. Charles had served an apprenticeship in the art of government in Naples, where, with the help of his minister Tanucci, he had successfully grappled with evils similar to those from which Spain was suffering. He would have been a prince quite after the heart of the 18th century if he had not retained too large a share of the superstition of his family. He shared to the full that conception of the rights and duties of monarchy which inspired the reforms of Frederick the Great and Joseph II., and his allegiance to the church was fortunately counterbalanced by his desire for absolutism. His greatest work, the expulsion of the Jesuits, would never have been carried out if he had not been persuaded of its political necessity. The order had already been driven by Pombal from Portugal and by Choiseul from France, when Charles III. was convinced that a riot in Madrid, provoked by the financial measures of Squillaci, had been promoted by the Jesuits. This conviction overpowered all scruples; the fathers were promptly removed from the country, and Spain joined the other Bourbon courts in demanding that suppression of the order which was finally decreed by Clement XIV. in 1773. The Rubicon once crossed, Charles's ministers urged him on in the path of ecclesiastical reform. The increase of lands in mortmain was restricted; the number of monasteries was diminished; and the Inquisition was compelled to moderate its procedure and to subordinate its independence to the royal will. For the papal jurisdiction was substituted a national court, the *Rota*, established at Madrid.

These measures, of which the importance in a country like Spain can hardly be over-estimated, were accompanied by others no less notable for the development of trade and agriculture. The colonial trade was freed from the old restriction which compelled it to pass through Cadiz, and other ports were opened for its reception. Native manufactures were encouraged in every way, and a famous ordinance in 1773 endeavored to remove the old prejudice against trade by declaring that the engaging in industrial occupations should not involve any loss of rank or its privileges. Internal communication was facilitated by the construction of canals. Agriculture was revived by the removal of the old prohibition against enclosures,—so long maintained by the selfish influence of the *Mesta*,—by the planting of trees in the arid deserts of central Spain, and by the rapid growth of population, which rose in the course of the century from 5,700,000 to 10,541,000. These measures, which are only selected from a large number tending in the same direction, are to be credited to three ministers, whose names reflect its chief lustre upon Charles III.'s reign. D'Aranda, who succeeded the Italian Squillaci as finance minister, was an Aragonese noble who had imbibed the spirit of philosophical speculation from France. He was the first layman who presided in the council of Castile, and he introduced into the Spanish administration a liberal tendency quite opposed to the traditions of the country. His views, however, were not congenial to the king, and, after completing his work with regard to the Jesuits and the Inquisition, he retired to the embassy in Paris and was succeeded by Campomanes. The latter was not only a distinguished statesman but also one of the foremost representatives of Spanish literature. He was one of the earliest students of political economy, and many of the most enlightened measures for the relief and encouragement of trade are to be assigned to him. But his administration, which aimed at educating the people to a share in political life, was almost as alien to the wishes of Charles III. as the liberal and anti-clerical schemes of D'Aranda. A far more congenial minister was found in Florida Blanca, whose aim was to promote the material interests of Spain by the supervision of an internal despotism, who stopped the attack on the church when its subordination was secured, who supported the economic reforms of Campomanes, but would only carry them out by a rigid bureaucracy, and who conciliated the king by falling in with his foreign policy even when it conflicted with the national welfare.

Meritorious as Charles III.'s reforms were, it would give a false impression to represent them as completely successful. The regeneration of Spain was by no means accomplished, and many of the abuses which had been growing for centuries survived the attempt to effect their annihilation. One of the chief causes of this failure was the corruption and ignorance of the lower officials. The reforming impulse was confined to the educated classes, and made little impression upon the bulk of the people. It was of little use to devise the most enlightened measures when there was no efficient machinery to carry them out. Many of the most promising reforms remained mere paper schemes. The methods employed, too, were not always the best calculated to obtain their end. The state took too much upon itself, and attempted to discharge functions which would have been better left to local enterprise. Roads were constructed on a magnificent scale, but only too often in directions where they were not wanted, and they remained almost unused. Thus the debt was increased without any improvement of the revenue. The return of Charles III. to a military policy imposed serious burdens upon the country, and it would have been better to have prolonged the peace of Ferdinand VI.'s reign, inglorious as it appeared to an ambitious king. Undoubtedly a great advance was made, but equal exertions would have produced a greater result in any other country. The population of Spain remained to a great extent sunk in sloth and superstition. Much might be hoped from a steady persistence in ameliorative measures, but unfortunately the work of reform was interrupted just at the moment when success appeared to be within reach.

Charles IV.

The death of Charles III, and the accession of Charles IV. were contemporary with the outbreak of the French Revolution, which was destined to exercise a decisive influence over the fortunes of the adjacent peninsula. Florida Blanca, who continued to hold office during the first three years of the new reign, found it impossible to continue his policy. The revival of Spain could only be effected by the restoration of its naval and colonial ascendency at the expense of England, and for the carrying out of this scheme the support of France was imperatively necessary. But the French alliance rested upon the relationship between the two branches of the house of Bourbon, and the Family Compact ceased to exist when Louis XVI. was deprived of power by his subjects. Of this conclusive evidence was given in 1791. Some English merchants founded a settlement at Nootka Sound on the west coast of America, which provoked an indignant protest from Spain. But the French national assembly refused to send any assistance, and Florida Blanca was compelled to conclude a humiliating treaty and to give up all hope of opposing the progress of England. This failure was attributed by the minister to the Revolution, of which he became the uncompromising opponent. The reforms of Charles III.'s reign were abandoned; all liberal tendencies in Spain were suppressed; and the Government set itself to restore the old lethargy under absolute rule from which the country had been gradually awakened. The movement of reform had made so little progress among the mass of the people that reaction was really easier than progress. But Florida Blanca was not content with suppressing liberalism in Spain; he was eager to avenge his disappointment by crushing the Revolution in France. He opened negotiations with the emigrants, urged the European powers to a crusade on behalf of legitimacy, and paraded the devotion of Charles IV. to the head of his family. This bellicose policy, however, brought him into collision with the queen. Maria Louisa of Parma, a woman whose real abilities were perverted to the gratification of sensual lusts, was unwilling to allow the minister to share her ascendency over the feeble mind of her husband, and she feared that the outbreak of war would diminish the revenues which she squandered in self-indulgence. She had already removed from the ministry Campomanes and other supporters of Florida Blanca, and had compelled the latter to restrict himself to the single department of foreign affairs. Early in 1792 she completed her task by inducing Charles IV. to banish Florida Blanca to Murcia, and his place was intrusted to the veteran D'Aranda. But the new minister found that he held office only at the favor of the queen, and that this had to be purchased by a disgraceful servility to her paramour, Emanuel Godoy. Spain withdrew from the projected coalition against France, and sought to maintain an attitude of neutrality, which alienated the other powers, while it failed to conciliate the republic. The repressive measures of Florida Blanca were withdrawn; society and the press regained their freedom; and no opposition was offered to the propaganda of French ideas. D'Aranda's policy might have been successful if it had been adopted earlier, but the time for temporizing was now past, and it was necessary for Spain to choose one side or the other. But the decision was not allowed to rest with the man who had always shown a sympathy with the revolutionary principles. In November, 1792, the queen felt herself strong enough to carry out the scheme which she had been long maturing. D'Aranda was dismissed, and the office of first minister was intrusted to Godoy, who had recently received the title of duke of Alcudia. Godoy, who was at once the queen's lover and the personal favorite of the king, had had no education for the part which he was called upon to play. Though endowed with a natural quickness of parts and a capacity for intrigue, he had no habits of application, no experience of the routine of office, and above all no settled policy. His appointment was regarded with jealousy by the grandees of Spain, while his undisguised relations with the queen outraged the moral feelings of the best part of the nation. Luckily for Godoy, the course to be pursued was decided for him. The execution of Louis XVI. (January 21, 1793) made a profound impression in a country where loyalty was a superstition. Charles IV. was roused to demand vengeance for the insult to his family, and from one end of Spain to the other a cry resounded for immediate war with the impious rebels who had shed the blood of an anointed king. Godoy had nothing to do but to follow the national impulse, and Spain became a member of the first coalition against France. Everything seemed to promise a rapid and complete success. The number of volunteers who offered their services rendered conscription unnecessary; and the southern provinces of France were so preponderatingly royalist that they were ready to welcome the Spaniards as deliverers. These advantages, however, were nullified by the shameful incompetence and carelessness of the Government. The troops were left without supplies; no plan of combined action was imposed upon the commanders; and each regiment was left to act of its own will. The military action of Spain provoked the contempt of Europe. The two campaigns of 1793 and 1794 were one long catalogue of failures. The bravery of the soldiers was rendered useless by the incapacity of their officers, and the maladministration of the central Government excited such disgust that an outbreak of revolutionary disturbance in Spain itself seemed more than possible. Instead of reducing the southern provinces of France, the Spaniards were driven from the strong fortresses that guarded the Pyrenees, and the French advanced almost to the Ebro. And at the same time the English, the hated rivals of Spain, were utilizing the war to extend their colonial power and were establishing more firmly that maritime supremacy which the Spanish

Government had been struggling for almost a century to overthrow. Under the circumstances it is no wonder that the queen and Godoy hastened to follow the example set by Prussia, and concluded the treaty of Basel with France. The terms were unexpectedly favorable. Spain purchased the evacuation of her territories and fortresses by the cession of her share of St. Domingo, which had little but a sentimental value as the first discovery of Columbus, and which had already been occupied by the English. So great was the joy excited in Madrid that popular acclamation greeted the bestowal upon Godoy of the title of "Prince of the Peace." But the moderation of the treaty was only a flimsy disguise of the disgrace that it involved. Spain found herself tied hand and foot to the French republic. Godoy had to satisfy his allies by the encouragement of reforms which both he and his mistress loathed, and in 1796, the veil was removed by the conclusion of the treaty of San Ildefonso. This was a virtual renewal of the Family Compact of 1761, but with far more disadvantageous terms to Spain. Each power was pledged to assist the other in case of war with twenty-five ships, 18,000 infantry, and 6000 cavalry. The real object of the treaty, which was to involve Spain in the war against England, was cynically avowed in the eighteenth article, by which, during the present war, the Spanish obligations were only to apply to the quarrel between England and France. A scheme was prepared for a joint attack on the English coast, but it was foiled by the battle of Cape St. Vincent, in which Jervis and Nelson forced the Spanish fleet to retire to Cadiz. This defeat was the more disastrous because it cut off the connection with the colonies and thus deprived Spain of the revenues derived from that quarter. The finances, already exhausted by extravagance and maladministration, were in no condition to meet the expenses of a naval war. England seized the opportunity to punish Spain for its conduct in the American War by encouraging discontent in the Spanish colonies, and in the Peninsula itself both nobles and people were bitterly hostile to the queen and her favorite. It was in vain that Godoy sought to secure the friendship of the reforming party by giving office to two of its most prominent members, Jovellanos and Saavedra. Spanish pride and bigotry were offended by the French occupation of Rome and the erection of a republic in the place of the papal government. The treatment of the duke of Parma by the Directory was keenly resented by the queen. Godoy found himself between two parties, the liberals and the ultramontanes, who agreed only in hatred of himself. At the same time the Directory, whose mistrust was excited by his attitude in the question of Parma, insisted upon his dismissal. Charles IV. could not venture to refuse a demand from France; the queen was alienated by Godoy's notorious infidelities; and in March, 1798, he was compelled to resign his office. But he did not forfeit his hold on the king's favor, and he only waited for a favorable opportunity to emerge from his retirement.

Godoy's office was entrusted to Saavedra, but the reformers did not obtain the advantages which they expected from the change. Jovellanos was compelled in August to retire on account of ill-health,—the result, it was rumored, of attempts on the part of his opponents to poison him. His place was taken by Caballero, an ardent opponent of reform, who restored all the abuses of the old bureaucratic administration and pandered to the most bigoted prejudices of the clergy and the court. The ministry was hopelessly divided, and the policy of the country was directed by the basest and most paltry intrigues. The only advantage which Spain enjoyed at this period was comparative independence of France. The military plans of the Directory were unsuccessful during the absence of their greatest general in Egypt, and the second coalition gained successes in 1799 which had seemed impossible since 1793. But the return of Bonaparte, followed as it was by the fall of the Directory and the establishment of the Consulate, commenced a new epoch for Spain. As soon as the First Consul had time to turn his attention to the Peninsula, he determined to restore Godoy, who had already regained the affection of the queen, and to make him the tool of his policy. Maria Louisa was easily gained over by playing on her devotion to the house of Parma, and on October 1, 1800, a secret treaty was concluded at San Ildefonso. Spain undertook to cede Louisiana and to aid France in all her wars, while Bonaparte promised to raise the duke of Parma to the rank of king and to increase his territories by the addition either of Tuscany or of the Roman Legations. This was followed by Godoy's return to power, though he left the department of foreign affairs to a subordinate. Spain was now more servile to France than ever, and in 1801 was compelled to attack Portugal in the French interests. Bonaparte was indignant against Portugal, partly because its fleet had aided his enemies in Egypt, and partly because its harbors offered great naval advantages to the English. The Spanish invasion, which was commanded by Godoy in person, met with no resistance, and the prince ventured to conclude a peace on his own authority by which Portugal promised to observe a strict neutrality on condition that its territories were left undiminished. But Bonaparte resented this show of independence, and compelled Charles IV. to refuse his ratification of the treaty. Portugal had to submit to far harsher terms, and could only purchase peace by the cession of territory in Guiana, by a disadvantageous treaty of commerce, and by a payment of twenty-five millions of francs [$4,825,000]. This insult to his ally Bonaparte followed up by others. In the preliminary treaty with England he ceded the Spanish colony of Trinidad without even consulting the court of Madrid, while he sold Louisiana to the United States in spite of his promise not to alienate it except to Spain. For these humiliations Spain had to console itself with the empty honor of being the first signatory of the treaty of Amiens.

For nearly three years Spain was allowed to remain at peace. Its finances were partially revived by the restoration of free intercourse with the colonies and by the payment of the supplies which had been withheld for the last six years. But the administration was as incompetent and misdirected as ever. Godoy, since his return to office, had abandoned all connection with the reforming party and had thrown himself into the reactionary policy of Caballero. The Spanish church was once more placed in strict subjection to the Roman see, from which for a short time it had been freed. But the worst evil lay in the undisguised domination of France, which the Government was wholly incapable of shaking off. As soon as Bonaparte saw himself involved in a new war with England, he turned to Spain for assistance and extorted a new treaty (October 9, 1803), which was still more burdensome than that of 1796. Spain had to pay a monthly subsidy of six million francs [$1,158,000], and to pledge itself to enforce a strict neutrality upon Portugal. Thus the country was involved in a new and still more disastrous war with England. The last remnants of its maritime power were shattered in the battles of Cape Finisterre and Trafalgar, and the English seized Buenos Ayres. The popular hatred of Godoy was roused to passion by these disasters,[1] and many competent observers believed that Spain stood on the brink of revolution. At the head of the opposition was the crown prince Ferdinand, as insignificant as his rival, but endowed with all good qualities by the credulous favor of the people. To maintain himself against his domestic enemies Godoy turned to France, where Bonaparte, now the emperor Napoleon I., was irritated by the crown prince's marriage with a daughter of the king of Naples. The court quarrels at Madrid were fomented from Paris in order to complete the subordination of Spain. Napoleon was at this time eager to humble England by excluding it from all trade with Europe. The only country which had not accepted his "continental system" was Portugal, and he determined to reduce that kingdom by force. It was not difficult to bribe Godoy, who was conscious that his position could not be maintained after the death of Charles IV. In October, 1807, Spain accepted the treaty of Fontainebleau, which arranged a partition of Portugal into three parts. The northern provinces were to be given to the young king of Etruria, who was to purchase them by the cession of Tuscany. In the south a principality was to be carved out for Godoy himself. The central district was to be kept in pledge by France until the conclusion of a general peace. The treaty was hardly concluded when a French army under Junot marched through Spain to Portugal, and the royal family of that country fled to Brazil. But Spain was destined to share the same fate as its neighbor. The crown prince, whose wife had died in 1806, determined to imitate his rival by bidding for French support. He entered into secret relations with Beauharnais, Napoleon's envoy at Madrid, and went so far as to demand the hand of a Bonaparte princess. Godoy, who discovered the intrigue, induced Charles IV. to order his son's arrest. Napoleon at once seized the opportunity to make himself absolute master of Spain, and ordered French troops to cross the Pyrenees in support of the prince. This act terrified Godoy into a reconciliation with his opponents, but the French invasion was not delayed by the removal of its pretext. Charles IV. and his minister, conscious that they could expect no support from the people, determined on flight. The news of this intention, however, excited a popular rising in Madrid, and the king was compelled to abdicate in favor of his son. Murat, however, who commanded the French, refused to be turned aside by this change of circumstances. He obtained from Charles IV. a declaration that his abdication had been involuntary, and occupied Madrid (March 23, 1808). Meanwhile Napoleon advanced to the frontier, and Ferdinand was lured by French agents to an interview with the emperor at Bayonne. There he was confronted with his parents and Godoy, and was intimidated into restoring the crown to his father, who at once made a second abdication. Napoleon now divulged the real intention of his actions, and the crown of Spain was formally conferred upon his brother Joseph Bonaparte, who two years before had been made king of Naples.

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[1] [For the disasters at Buenos Ayres to the British arms, see ARGENTINE REPUBLIC, vol. ii. p. 431.—AM. ED.]

Joseph Bonaparte.

But Spanish loyalty was too profound to be daunted even by the awe-inspiring power of the French emperor. For the first time Napoleon found himself confronted, not by terrified and selfish rulers but by an infuriated people. The rising in Spain commenced the popular movement which ultimately proved fatal to his power. At first he treated the novel phenomenon with contempt, and thought it sufficient to send his less prominent generals against the rebels. Madrid was taken without difficulty, but the capital was absolutely devoid of military importance, and the Spaniards showed great capacity for the guerilla warfare in the provinces. The French were repulsed from Valencia; and Dupont, who had advanced into the heart of Andalusia, was compelled to retreat and ultimately to capitulate with all his forces at Baylen (July 10). The Spaniards now advanced upon Madrid and drove Joseph from the capital, which he had just entered. Unfortunately the insurgents displayed less political ability than military courage. The government was entrusted in Ferdinand's name to a central junta of thirty-four members, a number which was far too large for the conduct of executive business. Napoleon's arrival in Spain was enough to restore victory to the French. In less than a week the Spanish army was broken through and scattered, and Napoleon restored his brother in Madrid. Sir John Moore, who had advanced with an English army to the relief of the capital, retired when he found he was too late, and an obstinate battle, in which the gallant general lost his life, had to be fought before the troops could secure their embarkation at Coruña. Napoleon, thinking the work accomplished, had quitted the Peninsula, and Soult and Victor were left to complete the reduction of the provinces. The capture of Seville resulted in the dissolution of the central junta, and the Peninsula was only saved from final submission by the obstinate resistance of Wellington in Portugal and by dissensions among the French. The marshals were jealous of each other, and Napoleon's plans were not approved by his brother. Joseph wished to restore peace and order among his subjects in the hope of ruling an independent nation, while Napoleon was determined to annex Spain to his own overgrown empire. So far did these disputes go that Joseph resigned his crown, and was with difficulty induced to resume it. Meanwhile Cadiz became the capital of what was left of independent Spain, and there the cortes met in 1810 for the purpose of drawing up a new constitution. The fall of the old monarchy and the exigencies of self-defence had given to the reforming party an ascendency which they had never before possessed. In the constitution which was promulgated early in 1812 the principles of the French constituent assembly were closely followed. The Inquisition had already perished, and the last relics of the old autocratic government shared its fate. Supreme legislative power was placed in the hands of a single national assembly, and effective checks were devised to restrict the power of the monarchy whenever it should be revived. The freedom of the press was established, and the property of the clergy was confiscated to defray the expenses of the war. The great defect of the constitution was that it was the work of one party, to which circumstances had given a temporary supremacy, and it failed to command the support of the united nation. The nobles and priests were bitterly hostile, and the latter had more influence in Spain than in any European country except Ireland.

The restoration of Spanish independence could hardly have been accomplished without the assistance of England. Wellington had already made two attempts to advance from Portugal into the adjacent kingdom, but had been foiled by superior forces. In 1812 he determined on a great effort. He secured his base of operations by the capture of Ciudad Rodrigo and Badajoz, and at Salamanca he completely routed the opposing army of Marmont. This victory enabled the English general to enter Madrid (August 12), and Joseph retreated to Valencia. But further advance was prevented by the concentration of the French forces in the east, and Wellington found it advisable to retire for the third time to winter-quarters on the Portuguese frontier. It was during this winter that Napoleon suffered his first and greatest reverse in the retreat from Moscow and the destruction of his grand army. This was the signal for the outbreak of the "war of liberation" in Germany, and French troops had to be withdrawn from Spain to central Europe. For the first time Wellington found himself opposed by fairly equal forces. In the spring of 1813 he advanced from Ciudad Rodrigo and defeated Jourdan at Vittoria, the battle which finally decided the Peninsular War. Joseph retired altogether from his kingdom, and Wellington, eager to take his part in the great European contest, fought his way through the Pyrenees into France. Napoleon, who had suffered a crushing defeat at Leipsic, hastened to recognize the impossibility of retaining Spain by releasing Ferdinand VII., who returned to Madrid in March, 1814.

After the convulsions it had endured Spain required a period of firm but concilitatory government, but the ill-fate of the country gave the throne at this crisis to

Ferdinand VII.

the worst of her Bourbon kings. Ferdinand VII. had never possessed the good qualities which popular credulity had assigned to him, and he had learnt nothing in his four years' captivity except an aptitude for lying and intrigue. He had no conception of the duties of a ruler; his public conduct was regulated by pride and superstition, and his private life was stained by the grossest sensual indulgence. Spain was still governed under the constitution of 1812, but the king's first act was to dissolve the cortes and to abrogate the constitution, promising, however, to grant a new one in its place. But no sooner was he established on the throne, and conscious of the strong reaction in favor of the monarchy, than he threw his promises to the wind and set himself to restore the old absolutism with all its worst abuses. The nobles recovered their privileges and their exemption from taxes; the monasteries were restored; the Inquisition resumed its activity; and the Jesuits returned to Spain. The liberals were ruthlessly persecuted, together with all who had acknowledged Joseph Bonaparte. A *camarilla* of worthless courtiers and priests conducted the government, and urged the king to fresh acts of revolutionary violence. For six years Spain groaned under a royalist "reign of terror," and isolated revolts only served as the occasion for fresh cruelties. The finances were squandered in futile expeditions to recover the South American colonies, which had taken advantage of Napoleon's conquest of Spain to establish their independence. In his straits for money Ferdinand ventured to outrage national sentiment by selling Florida to the United States in 1819.[1] Discontent found expression in the formation of secret societies, which were especially powerful among the neglected and ill-paid soldiers. At last, in 1820, Riego and Quiroga, two officers of an expedition which had been prepared for South America, raised the standard of revolt in Cadiz. Ferdinand and his advisers proved as incapable as they were tyrannical, and their feeble irresolution enabled the movement to spread over the whole country. In March the king gave way and accepted the constitution of 1812. The royalists or *serviles*, as they were called, were dismissed from office and their places taken by liberals. The cortes met in July, and at once proceeded to dissolve the monasteries and the Inquisition, to confiscate the clerical tithes, to abolish entails, and to secure the freedom of the press and of popular meetings. Great results might have been achieved if the moderate party, under Martinez de la Rosa, had been able to grapple with the task of suppressing disorder and establishing a permanent constitution. But this was the last thing which the king desired, and the moderates were defeated by a factious combination of the *serviles* and the radicals. Risings took place among the loyal and bigoted peasants of the provinces, and their suppression contributed to the victory of the extreme party, which seemed to be secured in 1822 by the election of Riego as president of the cortes.

But Spain was not allowed to work out its own salvation. Europe was dominated at this time by the Holy Alliance, which disguised a resolution to repress popular liberties and to maintain despotism under a pretended zeal for piety, justice, and brotherly love. At the congress of Verona (October, 1822) France, Austria, Russia, and Prussia agreed upon armed intervention in Spain, in spite of the protest of Canning on the part of England. Spain was to be called upon to alter her constitution and to grant greater liberty to the king, and if an unsatisfactory answer were received France was authorized to take active measures. The demand was unhesitatingly refused, and a French army, 100,000 strong, at once entered Spain under the duke of Angoulême (April, 1823). No effective resistance was made, and Madrid was entered by the invaders (May 23). The cortes, however, had carried off the king to Seville, whence they again retreated to Cadiz. The bombardment of that city terminated the revolution and Ferdinand was released (October 1). His first act was to revoke everything that had been done since 1819. The Inquisition was not restored, but the secular tribunals took a terrible revenge upon the leaders of the rebellion. The protest of the duke of Angoulême against these cruelties was unheeded. Even the fear of revolt, the last check upon despotism, was removed by the presence of the French army, which remained in Spain till 1827. But Spain had to pay for the restoration of the royal absolutism, as Canning backed up his protest against the intervention of France by acknowledging the independence of the Spanish colonies.

Isabella II.

Ferdinand VII. was enabled to finish his worthless and disastrous reign in comparative peace. In 1829 he married a fourth wife, Maria Christina of Naples, and at the same time he issued a "Pragmatic Sanction" abolishing the Salic law in Spain. No one expected any practical results from this edict, but a formal protest was made against it by the king's brothers, Carlos and Francisco, and also by the French and Neapolitan Bourbons. In the next year, however, the queen gave birth to a daughter, Isabella, who was proclaimed as queen on her father's death in 1833, while her mother undertook the office of regent. Don Carlos at once asserted his intention of maintaining the Salic law, and rallied round him all the supporters of absolutism, especially the inhabitants of the Basque Provinces. Christina was compelled to rely upon the liberals, and to conciliate them by the grant of a constitution, the *estatuto real*, which established two chambers chosen by indirect election. But this constitution, drawn up under the influence of Louis Philippe of France, failed to satisfy the advanced liberals, and the Christinos split into two parties, the *moderados* and *progresistas*. In 1836 the latter party extorted from the regent the revival of the constitution of 1812. All this time the Government was involved in a desperate struggle with the Carlists, who at first gained considerable successes under Zumalacarregui and Cabrera. But the death of Zumalacarregui in 1835 and the support of France and England ultimately gave the regent the upper hand, and in 1839 her general, Espartero,[2] forced the Basque Provinces to submit to Isabella. Don Carlos renounced his claims in favor of his eldest son, another Carlos, and retired to Trieste, where he died in 1855. Christina now tried to sever herself from the *progresistas*, and to govern with the help of the moderate party who enjoyed the patronage of Louis Philippe. But England, jealous of French influence at Madrid, threw the weight of her influence on to the side of the radicals, who found a powerful leader in Espartero. In 1840 Christina had to retire to France, and Espartero was recognized as regent by the cortes. But his elevation was resented by the other officers, while his subservience to England made him unpopular, and in 1843 he also had to go into exile. Isabella was now declared of age. Christina returned to Madrid, and the *moderados* under Narvaez obtained complete control over the government. This was a great victory for France, and Louis Philippe abused his success by negotiating the famous "Spanish marriages." A husband was found for Isabella in her cousin, Francis of Assis, whose recommendation in French eyes was the improbability of his begetting children. On the same day the queen's sister, Maria Louisa, was married to Louis Philippe's son, the duke of Montpensier. By this means it was hoped to secure the reversion of the Spanish throne for the house of Orleans. The scheme recoiled on the heads of those who framed it. The alienation of England gave a fatal impulse to the fall of Louis Philippe, while the subsequent birth of children to Isabella deprived the Montpensier marriage of all importance.

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[1] [Of this treaty, negotiated by John Quincy Adams in 1819–21. Lorin Blodget writes the Editor: "This cession of Florida was forced on Spain by the United States to obtain indemnity for spoliation and other claims on Spain, but the treaty provided for paying $5,000,000. In fact the U. S. never paid anything to the claimants, all of whom were Americans." The claims in 1821 were 142 for $7,429,580, which exorbitancy, with the biennial changes of Congress, has hindered any settlement under the treaty.—AM. ED.]

[2] [Don Baldomero Espartero (*c.* 1793–1879), son of a mechanic, fought against Bolivar in Colombia, exiled from Spain by Narvaez, prime minister (1854), adhered to provisional government (1868) and to Alfonso XII.—AM. ED.]

Spanish history during the reign of Isabella II. presents a dismal picture of faction and intrigue. The queen herself sought compensation for her unhappy marriage in sensual indulgence, and tried to cover the dissoluteness of her private life by a superstitious devotion to religion and by throwing her influence on to the side of the clerical and reactionary party. Every now and then the *progresistas* and *moderados* forced themselves into office, but their mutual jealousy prevented them from acquiring any permanent hold upon the government. In 1866 Isabella was induced to take vigorous measures against the liberal opposition. Narvaez was appointed chief minister; and the most prominent liberals, Serrano, Prim, and O'Donnell, had to seek safety in exile. The cortes were dissolved, and many of the deputies were transported to the Canary Islands. The ascendency of the court party was maintained by a rigorous persecution, which was continued after Narvaez's death (April, 1868) by Gonzales Bravo. Common dangers succeeded at last in combining the various sections of the liberals for mutual defence, and the people, disgusted by the scandals of the court and the contemptible *camarilla* which surrounded the queen, rallied to their side. In September, 1868, Serrano and Prim returned to Spain, where they raised the standard of revolt and offered the people the bribe of universal suffrage. The revolution was speedily accomplished, and Isabella fled to France, but the successful rebels were at once confronted with the difficulty of finding a successor for her. During the interregnum Serrano undertook the regency, and the cortes drew up a new constitution, by which an hereditary king was to rule in conjunction with a senate and a popular chamber. As no one of the Bourbon candidates for the throne was acceptable, it became necessary to look round for some foreign prince. The offer of the crown to Leopold of Hohenzollern-Sigmaringen excited the jealousy of France, and gave Napoleon III. the opportunity of picking a quarrel, which proved fatal to himself, with the rising state of Prussia. At last a king was found (1870) in Amadeus of Aosta, the second son of Victor Emmanuel, who made an honest effort to discharge the difficult office of a constitutional king in a country which was hardly fitted for constitutional government. But he found the task too hard and too distasteful, and resigned in 1873. A provisional republic was now formed, of which Castelar was the guiding spirit. But the Spaniards, trained to regard monarchy with superstitious reverence, had no sympathy with republican institutions. Don Carlos seized the opportunity to revive the claim of inalienable male succession, and raised the standard of revolt in the Basque Provinces, where his name was still a power. The disorders of the democrats and the approach of civil war threw the resposibility of government upon the army. The cortes were dissolved by a military *coup d'état*; Castelar threw up his office in disgust; and the administration was undertaken by a committee of officers. Anarchy was suppressed with a strong hand, but it was obvious that order could only be restored by reviving the monarchy. Foreign princes were no longer thought of, and the crown was offered to and accepted by Alfonso XII., the young son of the exiled Isabella (1874). His first task was to terminate the Carlist War, which still continued in the north, and this was successfully accomplished in 1876. Time was required to restore the prosperity of Spain under a peaceful and orderly government and to consolidate by prescription the authority of the restored dynasty. Unfortunately a premature death carried off Alfonso XII. in 1885, before he could complete the work which circumstances laid upon him. The regency was entrusted to his widow, Christina of Austria, and the birth of a posthumous son (May 17, 1886), who is now the titular king of Spain, has excited a feeling of pitying loyalty which may help to secure the Bourbon dynasty in the last kingdem which is left to it.

Amadeus.

Alfonso XII.

Literature.—Lafuente, *Historia General de España*; Ortiz, *Compendio General de la Historia de España*; Mariana, *Historia General de España* (cont. from 1516 to 1600 by Miñana); Desormeaux, *Abrégé Chronologique de l'Histoire d'Espagne*. For shorter periods see Prescott, *Ferdinand and Isabella*; Baumgarten, *Geschichte Karls V.* (the first volume, the only one which has appeared, contains the best account of the rising of the communes); Prescott, *History of Philip II.*; Forneron, *Histoire de Philippe II.*; Weiss, *L'Espagne depuis Philippe II.*; Ranke, *Die Osmanen und die Spanische Monarchie*; Mignet, *Negotiations relatives à la Succession d'Espagne sous Louis XIV.*; Hippeau, *Avènement des Bourbons au trône d'Espagne*; Coxe, *Memoirs of the Kings of Spain of the House of Bourbon*; Baumgarten, *Geschichte Spaniens vom Ausbruch der französ. Revolution*; Lauser, *Geschichte Spaniens von dem Sturz Isabellas.*

(R. L.)

PART III.—LANGUAGE.

The Iberian Peninsula is not a linguistic unity. Not to speak of the Basque, which still forms an island of some importance in the north, three Romance languages share this extensive territory: (1) Portuguese-Galician, spoken in Portugal, Galicia, and a small portion of the province of Leon; (2) Castilian, covering about two-thirds of the Peninsula in the north, centre, and south; (3) Catalan, occupying a long strip of territory to the east and southeast.

These three varieties of the *Romana Rustica* are marked off from one another much more distinctly than is the case with, say, the Romance dialects of Italy; they do not interpenetrate one another, but where the one ends the other begins. It has only been possible to establish at the points of junction of two linguistic regions the existence of certain mixed jargons in which certain forms of each language are intermingled; but these jargons, called into existence for the necessities of social relations by bilinguists, have an essentially individualistic and artificial character. The special development of the vulgar Latin tongue in Spain, and the formation of the three linguistic types just enumerated, were promoted by the peculiar political circumstances. From the 9th century onwards Spain was slowly recaptured from the Mohammedans, and the Latin spoken by the Christians who had taken refuge on the slopes of the Pyrenees was slowly carried back to the centre and ultimately to the south of the Peninsula, whence it had been driven by the Arab invasion. Mediæval Spain divides itself into three *conquistas*—that of Castile (much the most considerable), that of Portugal, and that of Aragon; and to these three political conquests correspond an equal number of linguistic varieties. If a given province now speaks Catalan rather than Castilian, the explanation is to be sought simply and solely in the fact that it was conquered by a king of Aragon and peopled by his Catalan subjects.

I. CATALAN.—This domain now embraces, on the mainland, the Spanish provinces of Gerona, Barcelona, Tarragona, and Lerida (the old principality of Catalonia), and of Castellon de la Plana, Valencia, and Alicante (the old kingdom of Valencia), and in the Mediterranean, that of the Balearic Islands (the old kingdom of Majorca). Catalan, by its most characteristic features, belongs to the Romance of southern France and not to that of Spain; it is legitimate, therefore, to regard it as imported into Spain by those *Hispani* whom the Arab conquest had driven back beyond the mountains into Languedoc, and who in the 9th century regained the country of their origin; this conclusion is confirmed by the fact that the dialect is also that of two French provinces on the north of the Pyrenees—Roussillon and Cerdagne. From the 9th to the 12th century Catalan spread further and further within the limits of Catalonia, properly so called; in 1229 it was brought to Majorca by Jaime el Conquistador, and in 1238 the same sovereign carried it to Valencia also. Even Murcia was peopled by Catalans in 1266, but this province really is part of the Castilian conquest, and accordingly the Castilian element took the upper hand and absorbed the dialect of the earlier colonists. The river Segura, which falls into the Mediterranean in the neighborhood of Orihuela, a little to the north of Murcia, is as nearly as possible the southern boundary of the Catalan domain; westward the boundary coincides pretty exactly with the political frontier, the provinces of New Castile and Aragon not being at all encroached on. Catalan, which by the reunion of Aragon and the countship of Barcelona in 1137 became the official language of the Aragonese monarchy,—although the kingdom of Aragon, consisting of the present provinces of Saragossa, Huesca, and Teruel, has always been Castilian in speech,—established a footing in Italy also, in all parts where the domination of the kings of Aragon extended, viz., in Sicily, Naples, Corsica, and Sardinia, but it has not maintained itself there in modern times except in a single district of the last named island (Alghero); everywhere else in Italy, where it was not spoken except by the conquerors, nor written except in the royal chancery, it has disappeared without leaving a trace.

From the 13th century, the name given to the vulgar tongue of eastern Spain has been *Catalanesch* (*Catalaniscus*) or *Catalá* (*Catalanus*),—the idiom of the Catalans.[1] By Catalanesch or Catalá was understood, essentially, the spoken language and the language of prose, while that of poetry, with a large admixture of Provençal forms, was early called *Lemosi*, *Limosi*, or language of Limousin,—Catalan grammarians, and particularly the most celebrated of them, Ramon Vidal de Besalú, having adopted *Lemosi* as the generic name of the language of the troubadours. These grammarians carefully distinguish the vulgar speech, or *pla Catalá*, from the refined *trobar* idiom, which originally is simply a more or less modified form of Provençal. Afterwards, and especially in these parts of the Catalan domain outside of Catalonia which did not care to acknowledge that they derived their language from that province, *Lemosi* received a more extensive signification, so as to mean the literary language in general, whether of verse or of prose. To this hour, particularly in Valencia and the Balearics, *Lemosi* is employed to designate on the one hand the old Catalan and on the other, the very artificial and somewhat archaizing idiom which is current in the "jochs florals"; while the spoken dialect is called, according to the localities, *Valenciá* (in Valencia), *Majorquí* and *Menorquí* (in Majorca and Minorca), or *Catalá* (in Catalonia); the form *Catalanesch* is obsolete.

The principal features which connect Catalan with the Romance of France and separate it from that of Spain are the following: (1) To take first its treatment of the final vowels,—Catalan, like French and Provençal, having only oxytones and paroxytones, does not tolerate more than one syllable after the tonic accent: thus *anima* gives *arma*, *cámera* gives *cambra*. All the proparoxytones of modern Catalan are of recent introduction and due to Castilian influence. Further, the only post-tonic Latin vowel preserved by the Catalan is, as in Gallo-Roman, *a: mare* gives *mar*, *gratu*(*s*) gives *grat*, but *anima* gives *arma;* and; when the word terminates in a group of consonants requiring a supporting vowel, that vowel is represented by an *e: arb*(*o*)*rem*, Cat. *abre* (Prov. and Fr. *arbre*, but Cast. *árbol*); *pop*(*u*)*l*(*us*), Cat. *poble* (Prov. *poble*, Fr. *peuple*, but Cast. *pueblo*); sometimes, when it is inserted between the two consonants instead of being made to follow them, the supporting vowel is represented by an *o: escándol* (scándalum), *frévol* (frivolus), *círcol* (circulus). In some cases a post-tonic vowel other than *a* is preserved in Catalan, as, for example, when that vowel forms a diphthong with the tonic (*Deu*, Deus; *Ebriu*, Hebreus); or, again, it sometimes happens, when the tonic is followed by an *i* in hiatus, that the *i* persists (*dilúvi*, dilúvium; *servici*, servicium; *lábi*, lábium; *ciri*, cereus); but in many cases these ought to be regarded as learned forms, as is shown by the existence of parallel ones, such as *servey*, where the atonic *i* has been attracted by the tonic and forms a diphthong with it (*servíci*, *servii*, *servey*). What has just been said as to the treatment of the final vowels in Catalan must be understood as applying only to pure Catalan, unaltered by the predominance of the Castilian, for the actual language is no longer faithful to the principle we have laid down; it allows the final *o* atonic in a number of substantives and adjectives, and in the verb it now conjugates *canto*, *temo*, *sento*,—a thing unknown in the ancient language. (2) As regards conjugation, only two points need be taken up here: (*a*) it employs the form known as the inchoative, that is to say, the lengthening of the radical of the present in verbs of the third conjugation by means of the syllable *ex* or *ix*, a proceeding common to Italian, Walachian, Provençal, and French, but altogether unknown in Hispanic Romance; (*b*) the formation of a great number of past participles in which the termination is added, as in Provençal, not to the radical of the verb, but to that of the perfect: *tingut* formed from *tinch*, *pogut* from *poch*, *conegut* from *conech*, while Castilian says *tenido* (formerly also *tenudo*,) *podido conocido*, that is to say, it forms those participles from the infinitive.

As for features common alike to Catalan and Hispanic (Castilian and Portuguese) Romance, on the other hand, and which are unknown to French Romance, there is only one which possesses any importance, the conservation, namely, of the Latin *u* with its original sound, while the same vowel has assumed in French and Provençal, from a very early period,—earlier doubtless than the oldest existing monuments of those languages,—a labio-palatal pronunciation (*ü*). It is not to be supposed that the separation of Catalan from the Gallo-Roman family should have occurred before the transformation had taken place; there is good reason to believe that Catalan possessed the *ü* at one time, but afterwards lost it in its contact with the Spanish dialects. The question, however, is one for further examination.

Catalan being a variety of the *langue d'oc*, it will be convenient to note the peculiarities of its phonetic and inflection as compared with ordinary Provençal.

Tonic Vowels.—With regard to *a*, which is pronounced alike in open and close syllables (*amar*, amare; *abre*, arbor), there is nothing to remark. The Latin ē, which is treated like ĭ, gives *e*, sometimes close, sometimes open. On this point Catalan is more hesitating than Provençal; it does not distinguish so clearly the pronunciation of *e* according to its origin; while ē (ĭ) is capable of yielding an open *e*, the ĕ is often pronounced close, and the poets have no difficulty in making words in *e* close and in *e* open rhyme together, which is not the case in Provençal. The Latin ĕ never yields *ie* in Catalan as it does in French and occasionally in Provençal; sedet become *seu* (where *u* represents the final *d*), pedem makes *peu*, and ego *eu;* in some words where the tonic ĕ is followed by a syllable in which an *i* occurs, it may become *i* (*ir*, hĕri; *mig*, mĕdius; *mils*, mĕlius); and the same holds good for ē in a similar situation (*ciri*, cērius, cēreus; *fira*, fēria), and for *e* in a close syllable before a nasal (*eximpli*, exemplum; *mintré* for *mentiré*, *gint* for *gent*); *I* tonic long and *i* short, when in hiatus with another vowel, produce *i* (*amich*, amicus; *via*, vĭa). *O* tonic long and *o* short are represented by *o* close and *o* open (*amor*, amorem; *poble*, populus). *O* short is never diphthongized into *uo* or *ue;* such a treatment is as foreign to Catalan as the diphthongization of ĕ into *ie*. Just as *e* before a syllable in which an *i* occurs is changed into *i*, so in the same circumstances *o* becomes *u* (*full*, folium; *vull*, volio for voleo) and also when the accented vowel precedes a group of consonants like *cl*, *pl*, and the like (*ull*, oc'lus; *escull*, scop'lus). Latin *u* persists with the Latin pronunciation, and, as already said, does not take the Franco-Provençal pronunciation *ü*. Latin *au* becomes *o* (*cosa*, causa; *or*, aurum); Old Catalan has kept the diphthong better, but possibly we should attribute the examples of *au* which are met with in texts of the 13th and 14th centuries to the literary influence of Provence. Latin *ua* tends to become *o* (*cor*, quare).

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[1] The origin of the name *Catalanus* is unknown.

Atonic Vowels.—As for the Latin post-tonic vowels already spoken of, it remains to be noted that *a* is often represented in writing by *e*, especially before *s;* in old Catalan, the substantives, adjectives, and participles readily form their singular in *a* and their plural in *es: arma*, *armes* (anima, animas); *bona*, *bones* (bona, bonas); *amada*, *amades* (amata, amatas). This *e* is neither open nor close, but a surd *e* the pronunciation of which comes very near *a*. In the same way the supporting vowel, which is regularly an *e* in Catalan, is often written *a*, especially after *r* (*abra*, arborem; *astra*, astrum; *para*, patrem); one may say that in the actual state of the language post-tonic *e* and *a* become indistinguishable in a surd sound intermediate between the French *a* and mute *e*. Before the tonic the same change between *a* and *e* constantly takes place; one finds in manuscripts *enar*, *emor* for *anar*, *amor* (the same manner of writing extends even to the case of the tonic syllable, *ten* and *sent* from tantum and sanctum being far from rare), and, on the other hand, *antre*, *arrar*, for *entre*, *errar*. *I* atonic is often represented by *e* even when it is long (*vehi*, vicinus). *O* atonic close which in genuine Catalan exists only before the tonic has become *u;* at the present day *truvar*, *cuntradir* is the real pronunciation of the words spelt *trovar*, *contradir*, and in the final syllables verbal or other, where under Castilian influence an *o* has come to be added to the normal Catalan form, this *o* has the value of a *u; trovo* (genuine Catalan, *trop*) is pronounced *trovu; bravo* (genuine Catalan, *brau*) is pronounced *bravu*. *U* atonic keeps its ground.

The only strong diphthongs of the spoken language are *ái*, *áu* (rather rare), *éi*, *éu*, *íu*, *ói*, *óu*, *úi*, *uu*. *Ai* produced by *a* + *i* or by *a* + a palatal consonant has for the greater part of the time become an *e* in the modern language; *factum* has yielded *fait*, *feit*, and then *fet*, the last being the actual form; *arius* has given *er* alongside of *aire*, *ari*, which are learned or semi-learned forms. Of the two weak diphthongs *ió* and *uá*, the latter, as has been seen, tends to become *o* close in the atonic syllable, and is pronounced *u: quaranta* has become *coranta*, then *curanta*. After the tonic *ua* often becomes *a* in the Catalan of the mainland (*ayga*, aqua, *llenga*, lingua), while in Majorca it becomes *o* (*aygo*, *llengo*).

Consonants.—Final *t* readily disappears after *n* or *l* (*tan*. tantum; *aman*, *venin*, *partin*, for *amant*, *venint*, etc.; *mol*, multum; *ocul*, ocultum); the *t* reappears in composition before a vowel (*fon*, fontem, but *Font-alba*). On the other hand, a *t* without etymological origin is frequently added to words ending in *r* (*cart* for *car*, *quare; mart* for *mar*, *mare; amart*, *ohirt*, infinitive for *amar*, *ohir*) and even to some words terminating in a vowel (*genit*, ingenium; *premit*, premium) or the addition of the *t* has taken place by assimilation to past participles in *it*. The phenomenon occurs also in Provençal (see *Romania*, vii. 107, viii. 110). Median intervocal *d*, represented by *s* (*z*) in the first stage of the language has disappeared: fidelis gave *fesel*, then *feel*, and finally *fel;* videtis became *vezets*, then *veets*, *vets*, and *vèu*. Final *d* after a vowel has produced *u* (*peu*, pedem; *niu*, nidum; *mou*, modum); but, when the *d*, in consequence of the disappearance of the preceding vowel, rests upon a consonant, it remains and passes into the corresponding surd: frigidus gives *fred* (pronounced *fret*). The group *dr*, when produced by the disappearance of the intermediate vowel, becomes *ur* (*creure*, credere; *ocïure*, occidere; *veure*, vidĕre; *seure*, sedĕre). Final *n*, if originally it stood between two vowels, falls away (*bo*, bonum; *vi*, vinum); but not when it answers to *mn* (thus donum makes *do*, but domnum *don;* sonum makes *so*, but somnum *son*). *Nd* is reduced to *n* (*demanar*, *comanar* for *demandar*, *comandar*). Assibilated *c* before *e*, *i* is treated like *d;* within a word it disappears after having been represented for a while by *s* (lucere gives *llusir*, *lluhir;* recipere gives *resebre*, *reebre*, *rebre*); at the end of a word it is replaced by *u* (*veu*, vicem; *feu*, fecit). The group *c'r* gives *ur*, just like *d'r* (*jaure*, jacĕre; *naure*, nocĕre; *plaure*, placĕre); but facere, dicere, ducere, make *far* (*fer*), *dir*, *dur*. Initial *l* has been preserved only in certain monosyllables (the article *lo*, *los*); everywhere else it has been replaced by *l* mouillée (Prov. *lh*), which in the present orthography is written *ll* as in Castilian, but formerly used to be represented by *ly* or *yl* (*lletra*, litera; *llengua*, lingua). *P* readily disappears after *m*, like *t* after *n* (*cam*, campum; *tems*, tempus). *B* is replaced by the surd *p* at the end of a word (*trobar* in the infinitive, but *trop* in the present tense); so also in the interior of a word when it precedes a consonant (*supvenir*, subvenire, *sopte*, sub'to). Median intervocalic *f* gives *v* (*Estéve*, Stephanus); it has disappeared from profundus, which yielded the form *preon*, then *pregon* (*g* being introduced to obviate the hiatus). *V*, wherever it has been preserved, has the same pronunciation as *b;* at the end of a word and between vowels it becomes vocalized into *u* (*suau*, suavis; *viure*, vivere). *C* guttural, written *qu* before *e* and *i*, keeps its ground as a central and as a final letter; in the latter position it is generally written *ch* (*amich*, amicum; *joch*, jocum). *G* guttural is replaced as a final letter by surd *c* (*longa*, but *lonc; trigar*, but *trich*). *Tj* after a consonant gives *ss* (*cassar*, captiare); between vowels, after having been represented by soft *s*, it has disappeared (rationem gave *rasó*, *raysó*, then *rahó*); at the end of every word it behaves like *ts*, that is to say, changes into *u* (*preu*, pretium); instead of *ts* the second person plural of the verb—at(i)s, et(i)s, it(i)s—now has *au*, *eu*, *iu* after having had *ats*, *ets*, *its*. *Dj* gives *ǵ* between vowels (*verger*, viridiarum), and *ć* as a terminal (written either *ig* or *tx: goig*, gaudium, *mig*, *mitx*, medium). *Stj* and *sc* before *e* and *i*, as well as *x* and *ps*, yield the sound *sh*, represented in Catalan by *x* (*angoxa*, angustia; *coneixer*, cognoscere; *dix*, dixit; *mateix*, metipse). *J* almost everywhere has taken the sound of the French *j* (*jutge*, etc.). *Lj* and *ll* give *l* mouillée (*ll* in the present orthography: *fill*, filium; *consell*, consilium; *null*, nullum). In the larger portion of the Catalan domain this *l* mouillée has become *y;* almost everywhere *fiy* is pronounced for *fill*, *consey* for *consell*. *Nj* and *nn* give *n* mouillée (*ny* in both old and modern spelling: *senyor*, seniorem; *any*, annum). Sometimes the *ny* becomes reduced to *y;* one occasionally meets in manuscripts with *seyor*, *ay*, for *senyor*, *any*, but this pronunciation has not become general, as has been the case with the *y* having its origin in *ll*. Lingual *r* at the end of a word has a tendency to disappear when preceded by a vowel: thus the infinitives amare, temere, *legire are pronounced *amá*, *temé*, *llegí*. It is never preserved except when protected by the non-etymological *t* already spoken of (*llegirt* or *llegí*, but never *llegír*); the *r* reappears, nevertheless, whenever the infinitive is followed by a pronoun *donarme*, *dirho*). *Rs* is reduced to *s* (*cos* for *cors*, corpus). *H* is merely an orthographic sign; it is used to indicate that two consecutive vowels do not form a diphthong (*vehi*, *raho*), and, added to *c*, it denotes the pronunciation of the guttural *c* at the end of a word (*amich*).

Inflection.—Catalan, unlike Old Provençal and Old French, has never had declensions. It is true that in certain texts (especially metrical texts) certain traces of case-endings are to be met with, as for example, *Deus* and *Deu*, *amors* and *amor*, *clars* and *clar*, *forts* and *fort*, *tuyt* and *tots*, *abduy* and *abdos*, *senyer* and *senyor*, *emperaire* and *emperador;* but, since these forms are used convertibly, the nominative form when the word is in the objective, and the accusative form when the word is the subject, we can only recognize in these cases a confused recollection of the Provençal rules known only to the literate but of which the transcribers of manuscripts took no account. Catalan, then, makes no distinctions save in the gender and the number of its nouns. As regards the formation of the plural only two observations are necessary. (1) Words which have their radical termination in *n* but which in the singular drop that *n*, resume it in the plural before *s; homin-em* makes *ome* in the singular and *omens* in the plural; *asin-um* makes *ase* and *asens*. (2) Words terminating in *s* surd or sonant and in *x* anciently formed their plural by adding to the singular the syllable *es* (*bras*, *brasses; pres*, *preses; mateix*, *mateixes*), but subsequently, from about the 15th century, the Castilian influence substituted *os*, so that one now hears *brassos*, *presos*, *mateixos*. The words in *tx*, *sc*, *st* have been assimilated to words in *s* (*x*); from *bosch* we originally had the plural *bosches*, but now *boscos;* from *trist*, *tristes*, but now *tristos*. For these last in *st* there exists a plural formation which is more in accordance with the genius of the language, and consists in the suppression of the *s* before the *t;* from *aquest*, for example, we have now side by side the two plurals, *aquestos* in the Castilian manner, and *aquets*. The article is *lo*, *los* (pronounced *lu*, *lus* in a portion of the domain), fem. *la*, *les* (*las*). Some instances of *li* occur in the ancient tongue, applying indifferently to the nominative and the objective case; *el* applying to the singular is also not wholly unknown. On the northwestern border of Catalonia, and in the island of Majorca, the article is not a derivative from *ille* but from *ipse* (sing. masc. *es* or *so*, fem. *sa;* pl. masc. *es*, and also *ets*, which appears to come from *istos*,—*ets* for *ests*, like *aquets* for *aquests*,—fem. *sas*). Compare the corresponding Sardinian forms *su*, *sa*, pl. *sos*, *sas*. On the pronouns it has only to be remarked that the modern language has borrowed from Castilian the composite forms *nosaltres* and *vosaltres* (pronounced also *nosaltros* and *nosatrus*) as also the form *vosté*, *vusté* (Castilian *usted* for *vuestra merced*).

Conjugation.—Catalan, and especially modern Catalan, has greatly narrowed the domain of the 2d conjugation in ēre; a large number of verbs of this conjugation have been treated as if they belonged to the 3d in ĕre; debere makes *deure*, videre, *veure*, and alongside of *haber*, which answers to habēre, there is a form *heure* which points to habĕre. A curious fact, and one which has arisen since the 15th century, is the addition of a paragogic *r* to those infinitives which are accented on the radical; in a portion of the Catalan domain one hears *creurer*, *veurer*. Some verbs originally belonging to the conjugation in ēre have passed over into that in *ir*; for example tenēre gives *tenir* alongside of *tindre*, remanēre *romanir* and *romandre*. In the gerundive and in the present participle Catalan differs from Provençal in still distinguishing the conjugation in *ir* from that in *er*, *re*,—saying, for example, *sentint*. As in Provençal, the past participle of a large number of verbs of the 2d and 3d conjugations is formed, not from the infinitive, but from the perfect (*pogut*, *volgut*, *tingut* suggest the perfects *poch*, *volch*, *tinch*, and not the infinitives *poder*, *voler*, *tenir*). In the present indicative and subjunctive many verbs in *ir* take the inchoative form already described, by lengthening the radical in the three persons of the singular and in the third person of the plural by means of the syllable *esc* (*isc*); *agrahir* has the present indicative *agraesch*, *agraheixes*, *agraheix*, *agraheixen*, the present subjunctive *agraesca*, *-as*, *-a*, *-an* (or more usually now *agraesqui*, *-is*, *-i*, *-in*). The old perfect of the conjugation in *ar* had *é* (also *i*) in the first pers. sing. and *-á* in the third; alongside of the *-á*, which is proper to Catalan exclusively, we also find, in the first period of the language, *-et* as in Provençal. Subsequently the perfect of the three conjugations has admitted forms in *-r* (*amáres*, *amárem*, *amáreu*, *amaren*), derived from the ancient pluperfect *amara*, etc., which has held its ground down to the present day, with the meaning of a conditional in some verbs (one still hears *fora*, *haguera*). But the simple perfect is no longer employed in the spoken language, which has substituted for it a periphrastic perfect, composed of the infinitive of the verb and the present of the auxiliary *anar*: *vaig pendre*, for example, does not mean "I am going to take," but "I have taken." The earliest example of this periphrastic perfect carries us back to the 15th century. The most usual form of the subj. pres. in spoken Catalan is that in *-i* for all the three conjugations (*ami*, *-is*, *-i*, *-em*, *-eu*, *-in*; *temi*, *-is*, etc.; *senti*, *-is*, etc.); it appears to be an abbreviation from *-ia*, and in effect certain subjunctives, such as *cántia*, *témia*, *tínguia*, *vinguia* (for *cante*, *tema*, *tinga*, *vingia*), evidently formed upon *sia* (subj. of *esser*), have been and still are used. The same *i* of the present subjunctive, whatever may be its origin, is still found in the imperfect: *amés*, *-essis*, *-es*, *-essim*, etc.

Catalan Dialect of Alghero (*Sardinia*).—As compared with that of the mainland, the Catalan of Alghero, introduced into this portion of Sardinia by the Aragonese conquerors and colonists, does not present any very important differences; some of them, such as they are, are explicable by the influence of the indigenous dialects of Sassari and Logudoro. In phonetics one observes—(1) the change of *lj* into *y* as an initial before *i* (*yitx*, *yigis*; *lego*, *legis*), a change which does not take place in the Catalan of the mainland except in the interior, or at the end of the word; (2) the frequent change of *l* between vowels and of *l* after *c*, *g*, *f*, *p* or *b* into *r* (*taura*, *tabula*; *candera*, *candela*; *sangrot*, *singultum*; *frama*, *flama*). In conjugation there are some notable peculiarities. The 1st pers. sing. does not take the *o* which continental Catalan has borrowed from Castilian (*cant*, not *canto*, etc.); the imp. ind. of verbs of the 2d and 3d conjugations has *eva*, *iva* instead of *ia*, a form which also occurs in the conditional (*cantariva*, *drumiriva*); the simple perfect, of which some types are still preserved in the actual language (*e. g.*, *anighé*, *aghé*), has likewise served for the formation not only of the past participle but also of the infinitive (*agher*, *habere*, can only be explained by *ach*, 3d person of the perfect); the infinitives with *r* paragogic (*viurer*, *seurer*, *plourer*) are not used (*viure*, *seure*, *ploure* instead); in the conjugation of the present of the verb *essar* or *esser*, the 2d pers. sing. *ses* formed upon the persons of the plural, while continental Catalan says *ets* (anciently *est*), as also, in the plural, *sem*, *seu*, instead of *som*, *sou*, are to be noted; *tenere* has passed over to the conjugation in *re* (*trenda* = *tendre*), but it is at the same time true that in ordinary Catalan also we have *tindrer* alongside of *tenir* the habitual form; *dicere* gives not *dir* but *diure*, which is more regular.

II. CASTILIAN.—This name (derived from the kingdom of Castile, the most powerful element in the Spanish monarchy) is the most convenient designation to apply to the linguistic domain which comprises the whole of central Spain and the vast regions of America and Asia colonized from the 16th century onwards by the Spaniards. We might also indeed call it the *Spanish* domain, narrowing the essentially geographical meaning of the word *Español* (derived, like the other old form *Españon*, from *Hispania*), and using it in a purely political sense. But the first expression is to be preferred, all the more because it has been long in use, and even the inhabitants of the domain outside the two Castiles fully accept it and are indeed the first to call their idiom *Castellano*. It is agreed on all hands that Castilian is one of the two branches of the vulgar Latin of Spain, Portuguese-Galician being the other; both idioms, now separated by very marked differences, can be traced back directly to one common source—the Hispanic Romance. One and the same vulgar tongue, diversely modified in the lapse of time, has produced Castilian and Portuguese as two varieties, while Catalan, the third language of the Peninsula, connects itself, as has already been pointed out, with the Gallo-Roman.

Within the Castilian domain, thus embracing all in Spain that is neither Portuguese nor Catalan, there exist linguistic varieties which it would perhaps be an exaggeration to call dialects, considering the meaning ordinarily attached to that word, but which are none the less worthy of attention. Generally speaking, from various circumstances, and especially that of the reconquest, by which the already-formed idiom of the Christian conquerors and colonists was gradually conveyed from north to south, Castilian has maintained a uniformity of which the Romance languages afford no other example. We shall proceed in the first instance to examine the most salient features of the *normal Castilian*, spoken in the provinces more or less closely corresponding to the old limits of Old and New Castile, so as to be able afterwards to note the peculiarities of what, for want of a better expression, we must call the Castilian dialects.

In some respects Castilian is hardly further removed from classical Latin than is Italian; in others it has approximately reached the same stage as Provençal. As regards the tonic accent and the treatment of the vowels which come after it, Castilian may be said to be essentially a paroxytonic language, though it does not altogether refuse proparoxytonic accentuation and it would be a mistake to regard vocables like *lámpara*, *lágrima*, *rápido*, etc., as learned words. In this feature, and in its almost universal conservation of the final vowels *e*, *i*, *u* (*o*), Castilian comes very near Italian, while it separates from it and approaches the Gallo-Roman by its modification of the consonants.

Vowels.—Normal Castilian faithfully preserves the vowels *ē*, *ī*, *ō*, *ū*; the comparatively infrequent instances in which *ē* and *ō* are treated like *ĕ* and *ŏ* must be attributed to the working of analogy. It diphthongizes *ĕ* in *ie*, *ŏ* in *ue*, which may be regarded as a weakening of *uo* (see *Romania*, iv. 30). Sometimes *ie* and *ue* in the modern language are changed into *i* and *e*: *silla* from sĕlla (Old Cast. *siella*), *víspera* from vĕspera (Old Cast. *viespera*), *castillo* from castĕllum (Old Cast. *castiello*), *frente* from frontem (Old Cast. *fruente*), *fleco* from flŏccus (Old Cast. *flueco*). The words in which *ĕ* and *ŏ* have kept their ground are either learned words like *médico*, *mérito*, or have been borrowed from dialects which do not suffer dipthongization. In many cases the old language is more rigorous; thus, while modern Castilian has given the preference to *mente*, *como*, *modo*, we find in old texts *miente*, *cuemo*, *muedo*. Lat. au makes *o* in all words of popular origin (*cosa*, *oro*, etc.).

Consonants.—On the liquids *l*, *m*, *n*, *r*, there is little to be remarked, except that the last-named letter has two pronunciations—one soft (voiced), as in *amor*, *burla*, the other hard (voiceless), as in *rendir*, *tierra* (Old Cast. in this case goes so far as to double the initial consonant: *rrendir*)—and that *n* is often inserted before *s* and *d*: *ensayo*, *mensage*, *rendir* (reddere). *L* mouillée (written *ll*) represents not only the Latin *l*, *ll*, *lj*, but also, at the beginning of words, the combinations *cl*, *gl*, *pl*, *bl*, *fl*: *llama* (flamma), *llave* (clavis), *llorar* (plorare); the tendency of the modern language is, as in Catalan, to reduce *ll* to *y*; thus one readily hears *yeno* (plenum). *N* mouillée (*ñ*) corresponds to the Latin *nn*, *mn*, *nj*, and sometimes to initial *n*: *año* (annum), *daño* (damnum), *ñudo* (nodum). Passing to the dentals, except as an initial, *t* in words that are popularly current and belong to the old stock of the language, can only be derived from Lat. *tt*, *pt*, and sometimes *ct*, as in *meter* (mittere), *catar* (captare), *punto* (punctum); but it is to be observed that the habitual mode of representing *ct* in normal Castilian is by *ch* (pron. *tch*), as in *derecho* (directum), *pecho* (pectus), so that we may take those words in which *t* alone represents *ct* as secondary forms of learned words; thus we have *bendito, otubre, santo* as secondary forms of the learned words *bendicto, octubre, sancto*, alongside of the old popular forms *bendicho, ochubre, sancho*. *D* corresponds in Castilian to Latin *t* between vowels, or *t* before *r: amado* (amatus), *padre* (patrem). At the present day the *d* of the suffixes *ado, ido*, is no longer pronounced throughout the whole extent of the domain, and the same holds good also of the final *d: salú, poné*, for *salud, poned* (from salutem, ponite). Sometimes *d* takes the interdental sound of *z* (English *th*), or is changed into *l;* witness the two pronunciations of the name of the capital —*Madriz* and *Madril* (adj. *Madrileño*). The study of the spirants, *c, z, s; g, j* is made a very delicate one by the circumstance that the interdental pronunciation of *c, z* on the one hand, and the guttural pronunciation of *g, j* on the other, are of comparatively recent date, and convey no notion of the value of these letters before the 17th century. It is admitted, not without reason, that the spirants *c, z*, which at present represent but one interdental sound (a lisped *s*, or a sound between *s* and Eng. *th* in thing), had down till about the middle of the 16th century the voiceless sound *ts* and the voiced sound *dz* respectively, and that in like manner the palatal spirants *g, j, x*, before assuming the uniform pronunciation of the guttural spirant (= Germ. *ch* in *Buch*), had previously represented the voiced sound of ǯ (Fr. *j*) and the voiceless sound of š (Fr. *ch*), which are still found in Portuguese and in the Castilian dialects of the northwest. The substitution of these interdental and guttural sounds for the surd and sonant spirants respectively did certainly not take place simultaneously, but the vacillations of the old orthography, and afterwards the decision of the Spanish Academy, which suppressed *x* (= š; *x* was retained for *cs*) and allows only *c* and *g* before *e* and *i, z* and *j* before *a, o, u*, make it impossible for us to follow, with the help of the written texts, the course of the transformation. *S* now has the voiceless sound even between vowels: *casa* (pronounced *cassa*); final *s* readily falls away, especially before liquids: *todo los* for *todos los*, *vamono* for *vamos nos*. The principal sources of *j* (*g*) are—Lat. *j* and *g* before *e* and *i* (*juego*, jocum; *gente*, gentem); Lat. initial *s* (*jabon*, saponem); Lat. *x* (*cojo*, coxum); *lj, cl* (*consejo*, consilium; *ojo*, oc'lum). The sources of *z* (*c*) are Lat. *ce, cj, tj, s* (*cielo*, caelum; *calza*, calcea; *razon*, rationem; *zampoña*, symphonia). As regards the spirants *f* and *v*, it is to be observed that at the beginning of a word *f* has in many instances been replaced by the aspirated *h* (afterwards silent), while in others no less current among the people the transformation has not taken place; thus we have *hijo* (filium) alongside of *fiesta* (festa). In some cases the *f* has been preserved in order to avoid confusion that might arise from identity of sound: the *f* in *fiel* (fidelis) has been kept for the sake of distinction from *hiel* (fel). As for *v*, it has a marked tendency to become confounded, especially as an initial letter, with the sonant explosive *b;* Joseph Scaliger's pun—*bibere est vivere*—is applicable to the Castilians as well as to the Gascons. *H* is now nothing more than a graphic sign, except in Andalusia, where the aspirate sound represented by it comes very near *j*. Words beginning in *hue*, where the *h*, not etymologically derived, marks the inseparable aspiration of the initial diphthong *ue*, are readily pronounced *güe* throughout almost the whole extent of the domain: *güele* for *huele* (olet); *güeso* for *hueso* (os). This *güe* extends also to words beginning with *bue: güeno* for *bueno* (bonum).

Inflection.—There is no trace of declension either in Castilian or in Portuguese. Some nominative forms—*Diós* (anciently *Díos*, and in the Castilian of the Jews *Dío*), *Cárlos, Márcos, sastre* (sártor)—have been adopted instead of forms derived from the accusative, but the vulgar Latin of the Peninsula in no instance presents two forms (subjective and objective case) of the same substantive. The article is derived from ille, as it is almost everywhere throughout the Romance regions: *el, la*, and a neuter *lo; los, las*. The plural of the first and second personal pronoun has in the modern language taken a composite form —*nosotros, vosotros*—which has been imitated in Catelan. *Quien*, the interrogative pronoun which has taken the place of the old *qui*, seems to come from quem.

Conjugation.—The conjugation of Castilian (and Portuguese) derives a peculiar interest from the archaic features which it retains. The vulgar Latin of Spain has kept the pluperfect indicative, still in current use as a secondary form of the conditional (*cantára, vendiéra, partiéra*), and what is more remarkable still, as not occurring anywhere else, the future perfect (*cantáre, vendiére, partiére*, formerly *cantáro, vendiéro, partiéro*). The Latin future has been replaced, as everywhere, by the periphrasis (cantare habeo), but it is worth noticing that in certain old texts of the 13th century, and in the popular songs of a comparatively ancient date which have been preserved in Asturias, the auxiliary can still *precede* the infinitive (habeo cantare), as with the Latin writers of the decadence: "Mucho de mayor preçio a seer el tu manto Que non será el nuestro" (Berceo, *S. Laur.*, str. 70), where *a seer* (habet sedere) corresponds exactly to *será* (sedere habet). The vulgar Latin of the Peninsula, moreover, has preserved the 2d pers. pl. of the imperative (*cantad, vended, partid*), which has disappeared from all the other Romance languages. Another special feature of Castilian-Portuguese is the complete absence of the form of conjugation known as inchoative (intercalation, in the present tense, of the syllable *isc* or *esc* between the radical and the inflection), although in all the other tenses, except the present, Spanish shows a tendency to lay the accent upon the same syllable in all the six persons, which was the object aimed at by the inchoative form. Castilian displaces the accent on the 1st and 2d pers. pl. of the imperfect (*cantábamos, cantábais*), of the pluperfect indicative (*cantáramos cantárais*), and of the imperfect subjunctive (*cantásemos, cantáseis*); possibly the impulse to this was given by the forms of future perfect *cantáremos, cantáreis* (*cantarĭmus, cantarĭtis*). The 2d persons plural were formerly (except in the perfect) *-ades, -edes, -ides;* it was only in the course of the 16th century that they got reduced, by the falling away of *d*, to *ais, eis*, and *is*. The verb essere has been mixed, not as in the other Romance languages with stare, but with sedere, as is proved by older forms *seer, siedes, sieden, seyendo*, obviously derived from sedere, and which have in the texts sometimes the meaning of "to be seated," sometimes that of "to be," and sometimes both. In old Latin charters also sedere is frequently met with in the sense of esse: *e.g.*, "*sedeat* istum meum donativum quietum et seçurum" (anno 1134), where *sedeat* = *sit*. The 2d pers. sing. of the present of *ser* is *eres*, which is best explained as borrowed from the imperfect (*eras*), this tense being often used in Old Spanish with the meaning of the present; alongside of *eres* one finds (but only in old documents or in dialects) *sos*, formed like *sois* (2d pers. pl.) upon *somos*. The accentuation in the inflection of perfects in the conjugation called strong, like *hubiéron, hiziéron*, which correspond to habuērunt, fecērunt (while in the other Romance languages the Latin type is ĕrunt: Fr. *eurent, firent*), may be regarded as truly etymological, or rather as a result of the assimilation of these perfects to the perfects known as weak (*amáron*), for there are dialectic forms having the accent on the radical, such as *díxon, híson*. The past participle of verbs in *er* was formerly *udo* (utus) in most cases; at present *ido* serves for all verbs in *er* and *ir*, except some ten or twelve in which the participle has retained the Latin form accentuated on the radical: *dicho, hecho, visto*, etc. It ought to be added that the past participle in normal Castilian derives its theme not from the perfect but from the infinitive: *habido, sabido*, from *haber, saber*, not from *hubo, supo*.

CASTILIAN DIALECTS.—To discover the features by which these are distinguished from normal Castilian we must turn to old charters and to certain modern compositions in which the provincial forms of speech have been reproduced more or less faithfully.

Asturian.—The Asturian idiom, called by the natives *bable*, is differentiated from the Castilian by the following characters. *Ie* occurs, as in Old Castilian, in words formed with the suffix *ellum* (*castiellu, portiellu*), while modern Castilian has reduced *ie* to *i*. *E, i, u*, post-tonic for *a, e, o: penes* (*penas*), *gracies* (*gracias*), *esti* (*este*), *frenti* (*frente*), *llechi* (*leche*), *nuechi* (*noche*), *unu* (*uno*), *primeru* (*primero*). There is no guttural spirant, *j*, but, according to circumstances, *y* or *x* (š); thus Lat. *cl, lj* gives *y: veyu* (*veclus), *espeyu* (spec'lum), *conseyu* (consilium); and after an *i* this *y* is hardly perceptible, to judge by the forms *fiu* (filium), *escoidos* (Cast. *escogidos*), *Castia* (*Castilla*); Lat. *g* before *e* and *i*, Lat. initial *j*, and Lat. *ss, x*, give *x* (š)—*xiente* (gentem), *xudiu* (Judaeus), *baxu* (bassus), *coxu* (coxus), *floxu* (fluxus). Lat. initial *f* has kept its ground, at least in part of the province: *fiu, fueya* (Cast. *hijo, hoja*). A very marked feature is the habitual "mouillure" of *l* and *n* as initial letters: *lleche, lleer, lluna, llutu; ñon, ñunca, ñueve, ñube*. With respect to inflection the following forms may be noted: personal pronouns: *i* (*illi*), *yos* (*illos*); possessive pronouns: *mió*, pl. *miós; to, tos; so, sos* for both masc. and fem.; verbs: 3d pers. pl. imp. of the 2d and 3d conjugations in *in* for *ien* (Cast. *ian*); *train, tenin, facin* (from *facer*), [illegible] (from *fer*), and even some instances of the 2d pers. sing. (*abis*; Cast. *habias*); instances of pres. subj. in *ia* for *a* (*sírvia*, *mélia*, *sépia*). The verb *ser* gives *yes* (sometimes *yeres*) in the 2d pers. sing., *ye* in the 3d. Facere appears under two forms—*facer* and *fer*,—and to the abridged form correspond *feis*, *fiendo*, *fiin*, etc. Ire often appears under the form *dir* (*antes de diros* = *antes de iros*) which it is not necessary to explain by *de-ire* (see Schuchardt, *Ztschr. f. rom. Philol.* v. 312).

Navarrese-Aragonese.—In its treatment of the post-tonic vowels this dialect parts company with normal Castilian and comes nearer Catalan, in so far as it drops the final *e*, especially after *nt*, *rt* (*mont*, *plazient*, *muert*, *fuert*, *parents*, *gents*); and, when the atonic *e* has dropped after a *v*, this *v* becomes a vowel—*breu* (brevem), *grieu* (*grevem), *nueu* (novem). Navarrese-Aragonese has the diphthongs *ie*, *ue* from tonic ĕ and ŏ, and adheres more strictly to them than normal Castilian does,—*cuende* (cŏmitem), *huey* (hŏdie), *pueyo*, (pŏdium), *yes* (ĕst), *yeran* (ĕrant), while Castilian says *conde*, *hoy*, *poyo*, *es*, *eran*. The initial combinations *cl*, *pl*, *fl*, have withstood the transformation into *ll* better than in Castilian; *plano*, *pleno*, *plega*, *clamado*, *flama* are current in old documents; and at the present day, although the *l* has come to be "mouillée," the first consonant has not disappeared (*plluma*, *plloró*, *pllano*—pronounced *pljuma*, etc.). Lat. *ct* gives *it*, not *ch* as in Castilian; *nueyt* (noctem), *destruito* (destructum), *proveito* (provectum), *dito* for *diito* (dictum). *D* between vowels kept its ground longer than in Castilian: documents of the 14th century supply such forms as *vidieron*, *vido*, *hudio*, *provedir*, *redemir*, *prodeza*, *Benedit*, *vidiendo*, etc.; but afterwards *y* came to be substituted for *d* or *dj*: *veyere* (videre), *seyer* (sedere), *seya* (sedeat), *goyo* (gaudium), *enueyo* (inodium). Initial *f* does not change into *h*: *fillo*, *feito*. Navarrese-Aragonese does not possess the guttural spirant (*j*) of Castilian, which is here rendered according to circumstances either by *g* (Fr. *j*) or by *ll* (*l* mouillée), but never by the Asturian *x*. Certain forms of the conjugation of the verb differ from the Castilian: *dar*, *estar*, *haver*, *saber*, *poner* readily form their imperfects and imperfect subjunctives like the regular verbs in *ar* and *er*,—*havieron* (Cast. *hubieron*), *estaron* (Cast. *estubieron*), *sabió* (Cast. *supo*), *dasen* (Cast. *diesen*), *poniese* (Cast. *pusiese*); on the other hand, past participles and gerundives formed from the perfect are to be met with,—*fisiendo* for *faciendo* (perf. *fiso*), *tuviendo* and *tuvido* for *teniendo*, *tenido* (perf. *tuvo*). In the region bordering on Catalonia the simple perfect has given way before the periphrastic form proper to Catalan; *voy cayer* (I fell), *va fé* (he has done), *vamos ir* (we went), etc.; the imperfects of verbs in *er*, *ir*, moreover, are found in *eba*, *iba* (*comeba*, *subiba*, for *comia*, *subia*), and some presents also occur where the Catalan influence makes itself felt: *estigo* (Cat. *estich*), *vaigo* (Cat. *vaig*), *veigo* (Cat. *veig*). Navarrese-Aragonese makes use of the adverb *en* as a pronoun: *no les en daren pas*, *no'n hi ha*.

Andalusian.—The word "dialect" is still more appropriately applied to Andalusian than either to Asturian or Navarrese-Aragonese. Many peculiarities of pronunciation, however, are commonly called Andalusian which are far from being confined to Andalusia proper, but are met with in the vulgar speech of many parts of the Castilian domain, both in Europe and in America. Of these but a few occur only there, or at least have not yet been observed elsewhere than in that great province of southern Spain. They are the following: *L*, *n*, *r*, *d* between vowels or at the end of a word disappear: *sá* (*sal*), *só* (*sol*), *viee* (*viene*), *tiee* (*tiene*), *paa* and *pa* (*para*), *mia* (*mira*), *naa* and *na* (*nada*), *too* and *to* (*todo*). *D* is dropped even from the beginning of a word: *e* (*de*), *inero* (*dinero*), *on* (*don*). Before an explosive, *l*, *r*, *d* are often represented by *i*: *saiga* (*salga*), *vaiga* (*valga*), *laigo* (*largo*), *maire* (*madre*), *paire* (*padre*). Lat. *f* is more rigorously represented by *h* than in normal Castilian, and this *h* here preserves the aspirate sound which it has lost elsewhere; *hablá*, *horma* (*forma*), *hoder*, are pronounced with a very strong aspiration, almost identical with that of *j*. The Andalusians also very readily write these words *jablá*, *jorma*, *joder*. This aspirate, expressed by *j*, often has no etymological origin; for example, *Jándalo*, a nickname applied to Andalusians, is simply the word *Andaluz* pronounced with the strong aspiration characteristic of the inhabitants of the province. *C*, *z* are seldom pronounced like *s*; but a feature more peculiar to the Andalusians is the inverse process, the softened and interdental pronunciation of the *s* (the so-called *ceceo*): *zeñor* (*señor*), etc. Before a consonant and at the end of a word *s* becomes a simple aspiration: *mihmo* (*mismo*), *Dioh* (*Dios*), *do reales* (*dos reales*). In the inflection of the verb there is nothing special to note, except some instances of 2d pers. sing. of the perfect in *tes* for *te*: *estuvistes*, *estuvites*, for *estuviste*,—evidently a formation by analogy from the 2d pers. of the other tenses, which all have *s*.

It is with the Andalusian dialect that we can most readily associate the varieties of Castilian which are spoken in South America. Here some of the most characteristic features of the language of the extreme south of Spain are reproduced,—either because the Castilian of America has spontaneously passed through the same phonetic transformations or because the Andalusian element, very strongly represented in colonization, succeeded in transporting its local habits of speech to the New World.

Leonese.—Proceeding on inadequate indications, the existence of a Leonese dialect has been imprudently admitted in some quarters; but the old kingdom of Leon cannot in any way be considered as constituting a linguistic domain with an individuality of its own. The fact that a poem of the 13th century (the *Alexandro*), and certain redactions of the oldest Spanish code, the *Fuero Juzgo*, have a Leonese origin has been made too much of, and has led to a tendency to localize excessively certain features common to the whole western zone where the transition takes place from Castilian to Galician-Portuguese.

III. PORTUGUESE.—Portuguese-Galician constitutes the second branch of the Latin of Spain. In it we must distinguish—(1) Portuguese (*Portuguez*, perhaps a contraction from the old *Portugalez* = Portugalensis), the language of the kingdom of Portugal and its colonies in Africa, Asia, and America (Brazil); (2) Galician (*Gallego*), or the language of the old kingdom of Galicia (the modern provinces of Pontevedra, La Coruña, Orense, and Lugo) and of a portion of the old kingdom of Leon (the territory of Vierzo in the province of Leon). Portuguese, like Castilian, is a literary language, which for ages has served as the vehicle of the literature of the Portuguese nation constituted in the beginning of the 12th century. Galician, on the other hand, which began early in the Middle Ages a literary life,—for it was employed by Alfonso the Wise in his *cantigas* in honor of the Virgin,—decayed in proportion as the monarchy of Castile and Leon, to which Galicia had been annexed, gathered force and unity in its southward conquest. At the present day Gallego, which is simply Portuguese variously modified and with a development in some respects arrested, is far from having as a dialect the same importance as Catalan, not only because the Spaniards who speak it (1,800,000) number much less than the Catalans (3,500,000), but also because, its literary culture having been early abandoned in favor of Castilian, it inevitably fell into the vegetative condition of a provincial patois. Speaking generally, Portuguese is further removed than Castilian from Latin; its development has gone further, and its actual forms are more worn out than those of the sister language, and hence it has, not without reason, been compared to French, with which it has some very notable analogies. But, on the other hand, Portuguese has remained more exclusively Latin in its vocabulary, and, particularly in its conjugation, it has managed to preserve several features which give it, as compared with Castilian, a highly archaic air. Old Portuguese, and more especially the poetic language of the 13th century, received from the language of the troubadours, in whose poetry the earlier Portuguese poets found much of their inspiration, certain words and certain turns of expression which have left upon it indelible traces.

Vowels.—Lat. ĕ, ŏ with the accent have not been diphthongized into *ie*, *uo*, *ue*: *pé* (pedem), *dez* (decem), *bom* (bonus), *pode* (potet). On the other hand, Portuguese has a large number of strong diphthongs produced by the attraction of an *i* in hiatus or the resolution of an explosive into *i*: *ràiba* (rabia), *feira* (feria), *feito* (factum), *seixo* (saxum), *oito* (octo). A quite peculiar feature of the language occurs in the "nasal vowels," which are formed by the Latin accented vowels followed by *m*, *n*, or *nt*, *nd*: *bẽ* (bene), *grã* (grandem), *bõ* (bonum). These nasal vowels enter into combination with a final atonic vowel: *irmão* (germanus); also *amão* (amant), *sermão* (sermonem), where the *o* is a degenerated representative of the Latin final vowel. In Old Portuguese the nasal vowel or diphthong was not as now marked by the *til* (˜), but was expressed indifferently and without regard to the etymology by *m* or *n*: *bem* (bene), *tan* (tantum), *disserom* (dixerunt), *sermom* (sermonem). The Latin diphthong *au* is rendered in Portuguese by *ou* (*ouro*, aurum; *pouco*, paucum), also pronounced *oi*. With regard to the atonic vowels, there is a tendency to reduce *a* into a vowel resembling the Fr. *e* "muet," to pronounce *o* as *u*, and to drop *e* after a group of consonants (*dent* for *dente*).

Consonants.—Here the most remarkable feature, and that which most distinctly marks the wear and tear through which the language has passed, is the disappearance of the median consonants *l* and *n*: *corõa* (corona), *lua* (luna), *pôr* formerly *poer* (ponere), *conego* (canonicus), *vir* (venire), *dôr*, formerly *door* (dolorem), *paço* (palatium), *saude* (salutem), *pego* (pelagus). Latin *b* passes regularly into *v*: *cavallo* (caballus), *fava* (faba), *arvore* (arborem); but, on the other hand, Latin initial *v* readily tends to become *b*: *bexiga* (vesica), *bodo* (votum). Latin initial *f* never becomes *h*: *fazer* (facere), *filo* (filum). Latin *c* before *e* and *i* is represented either by the hard sibilant *s* or by the soft *z*. Latin *g* between vowels is dropped before *e* and *i*: *ler* for *leer* (legere), *dedo* (digitum); the same is the case with *d*, of course in similar circumstances: *remir* (redimere), *rir* (ridere). Latin *j* has assumed the sound of the French *j*. The Latin combinations *cl*, *fl*, *pl* at the beginning of words are transformed in two ways in words of popular origin. Either the initial consonant is retained while the *l* is changed into *r*: *cravo* (clavum), *prazer* (placere), *fror* (florem); or the group is changed in *ch* (= Fr. *ch*, Catal. *x*) through the intermediate sounds *kj*, *fj*, *pj*: *chamar* (clamare), *chao* (planus), *chamma* (flamma). Within the word the same group and other groups also in which the second consonant is an *l* produce *l* mouillée (written *lh*, just as *n* mouillée is written *nh*, as in Provençal): *ovelha* (ovic'la), *velho* (*veclus); and sometimes *ch*: *facho* (fac'lum), *ancho* (amplum). Lat. *ss* or *sc* before *e* and *i* gives *x* (Fr. *ch*): *baixo* (bassus), *faxa* (fascia). The group *ct* is reduced to *it*: *leito* (lectum), *peito* (pectus), *noite* (noctem); sometimes to *ut*: *douto* (doctus). Such words as *fruto*, *reto*, *dileto* are modern derivatives from the learned forms *fructo*, *recto*, *dilecto*. Latin *cs* becomes *is*: *seis* (sex); or *isc*, *x* (= Fr. *ich*, *ch*): *seixo* (saxum), *luxo* (luxum); or even *ss*: *disse* (dixi).

Inflection.—The Portuguese article, now reduced to the vocalic form *o*, *a*, *os*, *as*, was *lo* (exceptionally also *el*, which still survives in the expression *El-Rei*), *la*, *los*, *las* in the old language. Words ending in *l* in the singular lose the *l* in the plural (because it then becomes median, and so is dropped): *sol* (solem), but *soes* (soles); those having *ão* in the sing. form the plural either in *ães* or in *ões* according to the etymology: thus *cão* (canem) makes *cães*, but *ração* makes *rações*. As regards the pronoun, mention must be made of the non-etymological forms of the personal *mim* and of the feminine possessive *minha*, where the second *n* has been brought in by the initial nasal. Portuguese conjugation has more that is interesting. In the personal suffixes the forms of the 2d pers. pl. in *adès*, *edes*, *ides* lost the *d* in the 15th century, and have now become *ais*, *eis*, *is* through the intermediate forms *aes*, *ees*, *eis*. The form in *des* has persisted only in those verbs where it was protected by the consonants *n* or *r* preceding it: *pondes*, *tendes*, *vindes*, *amardes*, and also no doubt in some forms of the present of the imperative, where the theme has been reduced to an extraordinary degree by the disappearance of a consonant and the contraction of vowels: *ides*, *credes*, *ledes*, etc. Portuguese is the only Romance language which possesses a personal or conjugated infinitive: *amar*, *amar-es*, *amar*, *amar-mos*, *amar-des*, *amar-em*; *e.g.*, *antes de sair-mos*, "before we go out." Again, Portuguese alone has preserved the pluperfect in its original meaning, so that, for example, *amara* (amaveram) signifies not merely as elsewhere "I would love," but also "I had loved." The future perfect, retained as in Castilian, has lost its vowel of inflection in the 1st and 3d pers. sing. and consequently becomes liable to be confounded with the infinitive (*amar*, *render*, *partir*). Portuguese, though less frequently than Castilian, employs *ter* (tenere) as an auxiliary, alongside of *aver*; and it also supplements the use of essere with sedere, which furnished the subj. *seja*, the imperative *se*, *sede*, the gerundive *sendo*, the participle *sido*, and some other tenses in the old language. Among the peculiarities of Portuguese conjugation may be mentioned—(1) the assimilation of the 3d pers. sing. to the 1st in strong perfects (*houve*, *pude*, *quiz*, *fez*), while Castilian has *hube* and *hubo*; (2) the imperfects *punha*, *tinha*, *vinha* (from *por*, *ter*, and *vir*), which are accented on the radical in order to avoid the loss of the *n* (*ponía* would have made *poía*), and which substitute *u* and *i* for *o* and *e* in order to distinguish from the present subjunctive (*ponha*, *tenha*, *venha*).

Galician.—Almost all the phonetic features which distinguish Portuguese from Castilian are possessed by Gallego also. Portuguese and Galician even now are practically one language, and still more was this the case formerly: the identity of the two idioms would become still more obvious if the orthography employed by the Galicians were more strictly phonetic, and if certain transcriptions of sounds borrowed from the grammar of the official language (Castilian) did not veil the true pronunciation of the dialect. It is stated, for example, that Gallego does not possess nasal diphthongs; still it may be conceded once for all that such a word as planus, which in Galician is written sometimes *chau* and sometimes *chan*, cannot be very remote from the Portuguese nasal pronunciation *chao*. One of the most notable differences between normal Portuguese and Galician is the substitution of the surd spirant in place of the sonant spirant for the Lat. *j* before all vowels and *g* before *e* and *i*: *xues* (judicem), Port. *juis*; *xunto* (junctum), Port. *junto*; *xente* (gentem) Port. *gente*. In conjugation the peculiarities of Gallego are more marked; some find their explanation within the dialect itself, others seem to be due to Castilian influence. The 2d persons plural have still their old form *ades*, *edes*, *ides*, so that in this instance it would seem as if Gallego had been arrested in its progress while Portuguese had gone on progressing; but it is to be observed that with these full forms the grammarians admit contracted forms as well: *ás* (Port. *ais*), *és* (Port. *eis*) *ís* (Port. *is*). The 1st pers. sing. of the perfect of conjugations in *er* and *ir* has come to be complicated by a nasal resonance similar to that which we find in the Portuguese *mim*; we have *vendin*, *partin*, instead of *vendi*, *parti*, and by analogy this form in *in* has extended itself also to the perfect of the conjugation in *ar*, and *falin*, *gardin*, for *falei*, *gardei* are found. The second persons of the same tense take the endings *che*, *ches* in the singular and *chedes* in the plural; *falache* or *falaches* (fabulasti), *falachedes* as well as *falástedes* (fabulastis), *bateche* or *batiche*, pl. *batestes* or *batechedes*, etc. *Ti* (tibi) having given *che* in Galician, we see that *falasti* has become *falache* by a phonetic process. The 3d pers. sing. of strong perfect is not in *e* as in Portuguese (*houve*, *pode*), but in *o* (*houbo*, *puido*, *soubo*, *coubo*, etc.); Castilian influence may be traceable here. If a contemporary grammarian, Saco Arce, is to be trusted, Gallego would form an absolute exception to the law of Spanish accentuation in the imperfect and pluperfect indicative: *falabámos*, *falabádes*; *batiámos*, *batiádes*; *pidiámos*, *pidiádes*; and *falarámos*, *falarádes*; *baterámos*, *baterádes*; *pidirámos*, *pidirádes*. The future perfect indicative and the imperfect subjunctive, on the other hand, would seem to be accented regularly: *faláremos*, *falásemos*. The important question is worth further study in detail.

Bibliography.—On the general subject the only books to be mentioned are the *Grammatik der romanischen Sprachen* and the *Etymologisches Wörterbuch* of Diez. 1. CATALAN. On the old language see Manuel Milá y Fontanals, *De los Trovadores en España*, Barcelona, 1861, and several essays by the same author in the *Revue des Langues Romanes*, the *Jahrb. f. roman. u. engl. Literatur*, vol. v., and the *Revista Histórica* of Barcelona; P. Meyer in *Romania*; A. Mussafia in the introduction to *Die Catalanische metrische Version der sieben weisen Meister*, Vienna, 1876; and Morel-Fatio in *Romania*. For modern Catalan, see Ballot y Torres, *Gramatica y Apologia de la Llengua Cathalana*, Barcelona, 1814; A. de Bofarull, *Estudios, Sistema Gramatical y Crestomatia de la Lengua Catalana*, Barcelona, 1864; and, before all, Manuel Milá y Fontanals, *Estudios de Lengua Catalana*, Barcelona, 1875. The dialectic varieties of Valencia and the Balearics have not yet been sufficiently investigated. On the Catalan of Alghero (Sardinia) there is a memoir by G. Morosi in the *Miscellanea di Filologia dedicata alla Memoria dei Prof. Caix e Canello*, Florence, 1885. 2. CASTILIAN. Since Diez's time no general work upon Castilian has been published, with the exception of a treatise on Spanish "doublets" by Mme. Carolina Michaelis, *Studien zur romanischen Wortschöpfung*, Leipsic, 1876, and a *Spanische Sprachlehre*, by Paul Förster, Berlin, 1880, which leaves much to be desired. On the grammar of Old Castilian the remarkable articles of Cornu in *Romania* must be consulted. Hitherto the dialects have received but little attention. For Asturian there is a *Coleccion de Poesias en Dialecto Asturiano*, published at Oviedo in 1839, and some lexicographical notes ("Apuntes Lexicograficos sobre una Rama del Dialecto Asturiano") by G. Laverde, in the *Revista de Asturias* for 1879. Navarrese-Aragonese has been worked at by Jerónimo Borao, *Diccionario de Voces Aragonesas*, 2d ed., Saragossa, 1885, and Andalusian has been very searchingly investigated by H. Schuchardt in *Ztschr. f. rom. Philol.*, vol. v. On American-Spanish there is an excellent work by R. J. Cuervo, *Apuntaciones Criticas sobre el Lenguaje Bogotano*, 4th ed., Chartres, 1885. 3. PORTUGUESE. The researches of Diez have been followed up by F. Adolpho Coelho in two works, *Theoria da Conjugação em Latim e Portuguez*, Lisbon, 1871, and *Questões da Lingua Portugueza*, 1st pt., Oporto, 1874. MM. Cornu and Coelho have contributed several very important articles in Portuguese to the pages of *Romania*. For Galician Saco Arce's *Gramatica Gallega*, Lugo, 1868, and A. Fernandez y Morales's *Ensayos Poéticos en Dialecto Berciano*, with introduction and glossary by Mariano Cubi y Soler, Leon, 1861, ought to be consulted. (A. M.-F.)

PART IV.—LITERATURE.

The name Spanish is now generally restricted to the literature of the Castilian tongue. In the present article it is taken in the wider sense as embracing the literature of the whole Iberian Peninsula, with the exceptions of PORTUGAL (*q.v.*) and of Galicia, the latter of which, as regards language and literature belongs to the Portuguese domain. Spanish literature thus considered falls into two divisions—Castilian and Catalan.

I. CASTILIAN LITERATURE.—Of the Castilian texts now extant none are of earlier date than the 12th century, and very probably none go farther back than 1150. That accepted as the oldest—*The Mystery of the Magian Kings*, as it is rather inappropriately designated—is a fragment of a short semi-liturgical play meant to be acted in the church of Toledo at the feast of Epiphany. Manifestly an imitation of the Latin *ludi* represented in France in the 12th century, the Spanish piece cannot have been composed much before 1150.

Heroic poetry.

The great national hero Rodrigo Diaz de Bivar (died 1099), better known in history by the Arabic surname of the CID (*q.v.*), was celebrated in the vulgar tongue less than a century after his death in two poems, neither of which, however, has come down to us in its entirety. The first *cantar*, usually entitled *Poema del Cid* since the first edition by Tomas Antonio Sanchez, relates in its first part the valiant deeds (*la gesta*) of the Cid subsequent to his quarrel with King Alfonso VI.; in the second the capture of Valencia, the reconciliation of the hero with the king, and the marriage of his daughters with the "infantes" of Carrion;[1] and then in the third the treason of the infantes, the vengeance of the Cid, and the second marriage of his daughters with the infantes of Navarre and Aragon. The narrative of the last years of the Cid, which closes this third part, is very much curtailed. Whilst in the *Poema* the Cid appears as the loyal vassal, faithful to his king and deploring the necessity of separating from him, the Cid of the second poem, *Crónica rimada del Cid*, is almost a rebel and at least a refractory vassal who dares treat his sovereign as an equal. The portion of the *Crónica* which has been preserved deals in the main with the youth (*mocedades*) of Rodrigo; it contains the primitive version of his quarrel with the Count Gomez de Gormaz, and the marriage of the slayer of the count with Ximena, his daughter, and also a series of fabulous episodes, such as the Cid's journey to France to fight with the twelve peers of Charlemagne, etc. If the *Poema* really belongs to the 12th century, some doubt attaches to the date of the *Crónica;* it would seem that the form under which this latter text has reached us is more recent than that of the *Poema*, but, on the other hand, several traditions collected by the author bear an incontestable stamp of antiquity. The versification of both poems is very barbarous, the metre very irregular. Normally this great epic measure ought to be divided into two hemistichs of seven or eight syllables each; but here the lines sometimes fall short of this number and sometimes exceed it. Instead of rhyme, assonance steadily prevails throughout; the strophes follow the model of the *laisses* of the French *chansons de geste*,—that is, they have a single assonance and vary greatly in extent.

The other heroes of Spanish history, such as the last Gothic king Roderick, Bernardo del Carpio, the infantes of Lara, have not given rise to long poems; at least we are acquainted with none of which they are the subject. Still some may have existed; and in fact the frequent allusions in the chronicle of Alfonso the Wise (13th century) to the narratives of the *juglares* suggest that Castilian heroic poetry was richer than the scarcity of the monuments still extant would lead us to believe. Fernan Gonzalez, first independent count of Castile (10th century), has alone been celebrated in a poem of the 13th century, composed in single-rhyme quatrains.

Poems of 13th century.

With the heroic poetry which takes its themes from the national history and legends, there grew up in the 13th century a religious and didactic poetry, the most eminent representative of which is Gonzalo de Berceo (1198–1268). This poet, born at Berceo in the province of Logroño, composed several lives of Spanish saints (St. Domingo de Silos, St. Millan de la Cogulla, St. Oria), and also devotional poems, such as the *Miracles* and the *Praises of the Virgin*, and some religious hymns. Berceo names his poems *prosa*, *decir*, *dictado*, indicating thereby that he intended them to be read and recited, not sung like the *cantares*. They are written in single-rhyme quatrains and in verses of twelve to fourteen syllables, according as the ending of each hemistich is masculine or feminine. In the same kind of versification were composed, also in the 13th century, two long poems,—one on Alexander the Great, the other on Apollonius of Tyre,—after Latin and French sources. The author of the first of these poems contrasts his system of versification, which he calls *mester de clerecia*, with the *mester de joglaria*, the one of the heroic poetry, intended to be sung, and declares that this single-rhyme quatrain (*curso rimado por la quaderna via*) consists of counted syllables. The composer of *Appolonio* calls this same versification *nueva maestria*. The single-rhyme quatrain, introduced in imitation of the French poetry of the 12th century into Castilian literature, became from the time of Berceo and the *Alexandro* and *Appolonio* the regular form in Castilian narrative and didactic poetry, and prevailed down to the close of the 14th century.

To the 13th century seem also to belong a *Life of St. Mary the Egyptian*, translated from the French, perhaps through a Provençal version, and an *Adoration of the Three Kings*, in verses of eight or nine syllables rhyming in pairs (*aa*, *bb*, *cc*, etc.), as well as a fragment of a *Debate between Soul and Body*, in verses of six or seven syllables, evidently an imitation of one of those mediæval Latin poems entitled *Rixa Animi et Corporis*. Mention may here also be made of the *cantigas* ("songs") of Alfonso the Wise in honor of the Virgin, although, being in the Galician dialect, these properly belong to the history of Portuguese literature.

Poetry of 14th century.

The 14th century saw the birth of the most original mediæval Spanish poet. Juan Ruiz (1300–1350), archpriest of Hita (near Guadalajara), has left us a poem of rather irregular composition, in which, while reproducing apologues translated from the Latin or French fabulists, and extracts from Ovid's *Art of Love*, or from a poem entitled *Pamphilus de Amore*, or, lastly, from *fabliaux* and *dits*, such as the *Bataille de Karesme et de Charnage*, the author frequently gives way to his own inspiration. Ruiz celebrates love and woman; his book is of *buen amor*, that is, he shows by his own experience and the example of the authors whom he follows how a man ought to set to work to be a successful lover. The character of the female go-between, named "Trota-Conventos," here plays an important part; it was suggested to Ruiz by the *Pamphilus*, but he has greatly strengthened the characteristics and thus prepared the way for the Celestina of the close of the 15th century. By way of precaution, the author represents himself as one who has survived his illusions, and maintains that carnal love (*loco amor*) must in the long run give place to divine love; but this stratum of devotion is a thin one and ought not to disguise the real character of the work. His form of versification is the single-rhyme quatrain in the narrative portions; as to the "songs" (*cantigas*) which sometimes interrupt the narrative, and of which the most successful are a "song of scholars" and a "song of the blind," their rhythm is different and much more varied. The *Rimado de Palacio* of the grand chancellor of Castile, Pedro Lopez de Ayala (1332–1407), does not exclusively refer to court life; the author takes up all classes of laymen and churchmen, whose vices he depicts in jocular style. Amid the tirades of this long moral poem there occur occasionally some *cantares* or even *decires* in strophes of eight lines of twelve syllables. Akin to this *Rimado de Palacio* are the *Proverbios Morales* of the Jew Santob (Shemtob) of Carrion, dedicated to King Pedro the Cruel, who reigned from 1350 to 1369, as well as the *General Dance of Death* and a new version of the *Debate between Soul and Body*, both in eight-line strophes of *arte mayor* (verses of twelve syllables), and both imitations of French originals. The 14th century also produced a long historical composition in verse, the *Rhymed Chronicle of Alfonso XI.* (died 1350), by Rodrigo Yanez, important fragments of which have come down to us; the versification of this chronicle is similar to that of Santob's *Proverbs* (strophes of four octosyllabic verses rhyming *abab*).

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[1] Carrion de los Condes is a district in the province of Valencia.

Romances.

The word romance not only signifies in Spain, as in other Romanic countries, the vulgar tongue, but also bears the special meaning of a short epic narrative poem (historic ballad) or, at a later date, a short lyric poem. As regards the form, the "romance" (Spanish *el romance*, in contrast to French, etc., *la romance*) is a composition in long verses of fourteen syllables ending with one rhyme, or assonance, which have been generally, but wrongly, divided into two short lines, the first of which, naturally, is rhymeless. This being the form of the romance verse, the *Crónica rimada del Cid*, and even the *Poema* (though in this case the influence of the French alexandrines is perceptible), might be considered as a series of romances tagged on one after the other; and in fact several of the old romances of the Cid, which form each an independent whole and have been printed as separate poems in the 16th century, are partly to be found in the *Crónica*. Other romances, notably those dealing with the heroes of the Carlovingian epic, so popular in Spain, or with the heroes which Spanish patriotism opposed at a certain period to the French paladins, —as, for example, Bernardo del Carpio, the rival and the conqueror of Roland in Castilian tradition,—seem to be portions severed from those *cantares de gesta* composed by *juglares* of which Alfonso X. makes mention. It is only at the close of the 15th century, and especially during the 16th, that the romances, which had previously passed from mouth to mouth by song and recitation, began to be written down and afterwards to be printed, at first on broadsheets (*pliegos sueltos*) and subsequently in collections (*romanceros*), either general, in which romances of very different date, character, and subject are mixed up, or restricted to a single historical or legendary episode or to a single personage (for example, the *Romancero del Cid*). In those collections the epic verse is always regarded as octosyllabic and printed as such; occasionally certain editions divide the romance into strophes of four verses (*cuartetas*).

Prose chronicles, 13th–14th centuries.

King Alfonso X. (died 1284), under whose patronage were published the memorable code entitled *Las Siete Partidas* and great scientific compilations, such as the *Libros de Astronomia* and the *Lapidario*, was also the founder of Spanish historiography in the vulgar tongue. The *Crónica General*, composed under his direction, consists of two distinct parts: the one treats of universal history from the creation of the world to the first centuries of the Christian era (*La General é Grant Historia*), the other exclusively of the national history (*La Crónica ó Historia de España*) down to the death of Ferdinand III. (1252), father of Alfonso. The main sources of the *Crónica General* are two Spanish chroniclers of the 13th century,—Lucas of Tuy and Rodriguez of Toledo,—who wrote in Latin, but whose works were early translated into the vernacular. In the *Historia de España* of Alfonso X., which has collected many legends and which occasionally refers to the songs of the *juglares* (for the purpose, however, of refuting them), the narrative relating to the Cid is partly based on an Arabic text. This portion has frequently been printed by itself, under the title of *Crónica del Cid*. Alfonso's example bore fruit. In the 14th century we find another *Crónica General de España* or *de Castilla*, constructed on the model of the first and embracing the years 1030–1312; next, the *Grant Crónica de España* and the *Grant Crónica de los Conqueridores*, compiled by command of the grand-master of the order of St. John of Jerusalem, Juan Fernandez de Heredia, about 1390. Special chronicles of each king of Castile were soon written. Our information is at fault in regard to the authorship of the chronicles of Alfonso X., Sancho IV., Ferdinand IV., and Alfonso XI.; but the four following reigns—those of Pedro I., Henry II., John I., and Henry III.—were dealt with by Pedro Lopez de Ayala, and here we can recognize the man of literary culture, who had acquired some knowledge of ancient history, for the form of the narrative becomes freer and more personal and the style rises with the thought. Several authors had a hand in the chronicle of John II., but the final redaction was by Fernan Perez de Guzman. The sad reign of Henry IV. was related by Diego Enriquez del Castillo and Alfonso de Palencia, the glorious reign of the Catholic sovereigns Ferdinand and Isabella by Fernando del Pulgar and Andrès Bernaldes. Along with those royal chronicles must be mentioned some biographies of important persons. Thus, in the 15th century the chronicle of Pedro Niño, count of Buelna (1379–1452), by Gutierre Diez de Gamez; that of Alvaro de Luna, constable of Castile (died 1453); also a very curious book of travels, the narrative of the embassy sent by Henry III. of Castile to Timor in 1403, written by the head of the mission, Ruy Gonzalez de CLAVIJO (*q.v.*).

Biographies.

Other prose works of 13th and 14th centuries.

The other productions of Castilian prose in the 13th and 14th centuries are for the most part didactic and sententious compositions, which, however, contain illustrations or tales of Eastern origin. The Spanish translation of *Kalila and Dimna*, made direct from an Arabic text, dates from the middle of the 13th century, and the romance of the *Seven Sages* (*Sindibad*), published under the title of *Engaños é Assayamientos de las Mugeres*, must be referred to almost the same period. From the second half of the 13th century the collections of sentences, *dits*, apologues, and moral tales become very numerous: first of all, versions of the *Secretum Secretorum*, attributed in the Middle Ages to Aristotle, one of which is entitled *Poridat de las Poridades*, next the *Proverbios Buenos*, the *Bocados de Oro* or *Libro de Bonium, Rey de Persia*, the *Libro de los Gatos*, which is derived from the *Narrationes* of Eudes of Cheriton. But the most celebrated is the *Libro de los Castigos y Documentos* of King Sancho IV. (died 1295), who also composed a *Lucidario*, a kind of encyclopædia of theology, morals, and natural history. It was during the first half of the 14th century that the nephew of Alfonso X., the infant Juan Manuel (1282–1349), wrote those various works which place him in the first rank of mediæval Spanish prose writers. The best known is the collection of tales, many of them borrowed from Oriental sources, entitled *El Conde Lucanor*; but besides this contribution to light literature he wrote graver and more specially instructive works, notably the *Libro de los Estados* or *Libro del Infante*, a kind of manual of education, domestic economy, and politics; the *Libro del Caballero é del Escudero*, a practical treatise on chivalry somewhat resembling a work of Raymond Lully on the same subject. Unfortunately Juan Manuel's poems, which he had collected in a *Libro de las Cantigas* or *de los Cantares*, have been lost. The knowledge of antiquity, previously so poor and vague, made remarkable progress in the 14th century. It was thought desirable to learn more about certain episodes of ancient history, such as the War of Troy, and therefore the poem on that subject by the Frenchman Benoît de Sainte-More and the Latin narrative of Guido de Columna were both translated. Pedro Lopez de Ayala translated or caused to be translated Pierre Bersuire's French version of Livy, Boetius, and various writings of Isidore of Seville and Boccaccio.

Books of chivalry.

While the Carlovingian cycle is mainly represented in Spain by romances, of which the oldest seem to be fragments of lost poems of the *juglares*, the British cycle (Lancelot, Tristram, Merlin, etc.) is represented almost exclusively by works in prose (compare **Romance**). Those narratives are known, it is true, only by 15th and 16th century editions, in which they have been more or less modified to suit the taste of the time, but it is impossible not to recognize that books such as *El Baladro del Sabio Merlin* and *La Demanda del Sancto Grial* (1515) presuppose a considerable antecedent literature of which they are only the afterglow. The principal French romances of the Round Table were translated and imitated in Spain and in Portugal as early as the first half of the 14th century at least; of that there is no doubt. And, even if there was not on this point satisfactory testimony, the prodigious development in Spanish literature of the *caballerias* or "book of chivalry," incontrovertibly derived from fictions of British origin, is proof enough that the Spaniards have at an early date been familiarized with this romance from France. The first book which begins the series of strictly Spanish *caballerias* is the *Amadis de Gaula* (*i.e.*, of Wales, not France). We know the *Amadis* only by the version made about 1480 in four books by Garci Ordoñez de Montalvo (the oldest edition extant is dated 1508), but the work in its original form (three books), already widely distributed and celebrated by various Castilian poets from about 1350, must have been composed at the latest in the second third of the 14th century. A few rather vague hints and certain sentimental considerations lead one to seek for the unknown author of the first *Amadis* in Portugal, where the romances of the Round Table were even more highly appreciated than in Spain, and where they have exercised a deeper influence on the national literature. To Montalvo, however, falls the honor of having preserved the book by republishing it; he only made the mistake of diluting the original text too much, and of adding a poor continuation, *Las Sergas de Esplandian*. Allied to Montalvo's *Amadis* with its Esplandian appendage are the *Don Florisando* and the *Lisuarte de Grecia*, the *Amadis de Grecia*, the *Don Florisel de Niquea*, etc., which form what Cervantes called the "Amadis sect." Along with the Amadises range the Palmerines, the most celebrated of which are the *Palmerin de Oliva*, the *Primaleon*, and the *Palmerin de Inglaterra*. None of those *caballerias* inspired by the *Amadis* were printed or even written before the 16th century; and they bear in language and style the stamp of that period; but they cannot be separated from their mediæval model, the spirit of which they have preserved intact. Among the *caballerias* we may also class some narratives belonging to the Carlovingian epic,—the *Historia del Emperador Carlomagno y de los Doce Pares*, a very popular version still reprinted of the French romance of *Fierabras*, the *Espejo de Caballerias*, into which has passed a large part of the *Orlando Innamorato* of Boiardo, the *Historia de la Reina Sibilla*, etc.

Poetry of 15th century.

The first half of the 15th century, or, what comes almost to the same thing, the reign of John II. of Castile (1407–1454), is, as regards its literature, characterized by three facts—(1) by the development of a court poetry, artificial and pretentious; (2) by the influence of Italian literature on Castilian prose and poetry, the imitation of Boccaccio and Dante, especially of the latter, which introduced into Spain a liking for allegory; and (3) by more assiduous intercourse with antiquity —a fuller understanding of the Latin writers who had been brought to the front by the Italian renaissance. After the example of the Provençals, whose literary doctrines had made their way into Castile through Portugal and Catalonia, poetry is now styled the *arte de trobar*. The *arte de trobar* is strictly "court" poetry, which consists in short pieces of rather complicated versification,—love plaints, debates, questions, and repartees, *motes* with their *glosas*, burlesque and satirical songs,—a poetry wholly "occasional," and which, when separated from its natural environment, loses great part of its charm. In order to understand and appreciate those pieces they must be read in the collections made by the poets of the time, and the one must be brought to throw light on the other. The most celebrated *cancionero* of the 15th century is that compiled for the amusement of his sovereign by Alfonso de Baena (who has not designated himself a Jew, as has been supposed, the word *judino* attached to his name in the preface being nothing but *indiño*); it is, so to say, the official collection of the poetic court of John II., although it also contains some pieces by poets of earlier date. After Baena's collection may be mentioned the *Cancionero de Stuñiga*, which contains the Castilian poems of the trobadores who followed Alfonso V. of Aragon to Naples. Those *cancioneros*, consisting of the productions of a society, a group, were succeeded by collections of a more general character, in which versifiers of very different periods and localities are jumbled together, the pieces being classed simply according to their type. The earliest *Cancionero General* is that compiled by Juan Fernandez de Constantina, which appears to have issued from the Valencia press in the very beginning of the 16th century; the second, much better known, was published for the first time at Valencia in 1511; its editor was called Fernando del Castillo. The other poetic school of the 15th century, which claims to be specially related to the Italians, had as its leaders Juan de Mena (1411–1456), author of the *Coronacion* and the *Labirinto* or *Las Trecientas* (a long poem so called because of the number of stanzas which, according to the scheme, were to compose it), and the marquis of Santillana, D. Iñigo Lopez de Mendoza (1398–1458), who in his sonnets was the first to imitate the structure of the Italian *endecasillabo*. Along with those two, who may be designated *poetas*, in distinction from the *decidores* and the *trobadores* of the *cancioneros*, must be ranked Francisco Imperial, a Genoese by descent, who also helped to acclimatize in Spain the forms of Italian poetry. The marquis of Santillana occupies a considerable place in the literature of the 15th century, not only by reason of his poems, but quite as much if not more through the support he afforded to all the writers of his time, and the impulse he gave to the study of antiquity and to the labors of translators who at his request turned Virgil, Ovid, Seneca, etc., into Castilian. He himself was not acquainted with Latin; but the generous efforts he made to stir up his fellow-countrymen to learn it have justly procured him the title of father of Spanish humanism. That he had an extensive knowledge of the national literature, and of the literatures of France and Italy, he has shown in the preface to his works, which is a sort of *ars poetica* as well as an historical exposition of the kinds of poetry cultivated in the Middle Ages by the Spaniards and the neighboring nations.

With the exception of the chronicles, and some *caballerias*, the prose of the 15th century contains

Prose of 15th century.

nothing very striking. The translation of Virgil by Enrique de Villena (died 1434) is very clumsy, and shows no advance on the versions of Latin authors made in the previous century; better worth reading is the *Trabajos de Hercules*, a whimsical production but with some savor in its style. A curious and amusing book, full of details about Spanish manners, is the *Corbacho* of the archpriest of Talavera, Alonso Martinez de Toledo, chaplain to King John II.; the *Corbacho* belongs to the numerous family of satires against women, and its title ("The Lash" or "Whip") borrowed from a work of Boccaccio's with which it has otherwise nothing akin, correctly indicates that he has not spared them.

Dramatic literature.

The ancient liturgical Spanish theatre is known to us only by fragments of the play of the *Magian Kings*, of which mention has already been made; but certain regulations of the code of the *Siete Partidas* (compiled between 1252 and 1257) prove that this theatre existed, and that at the great festivals, such as Christmas, Epiphany, and Easter, dramatic representations were given in church. These representations, originally a mere commentary on the liturgy, grew more complicated in course of time; they were gradually adulterated with buffoonery, which frequently brought down the censure of the clergy. Alfonso the Wise even thought it necessary formally to forbid the "clerks" playing *juegos de escarnios*, and permitted in the sanctuary only dramas destined to commemorate the principal episodes of the life of Christ. Of all the church festivals, the most popular in Spain was that of Corpus Christi, instituted by Urban IV. in 1264. At an early date was introduced the custom of accompanying the celebration of this festival with dramatic representations intended to explain to the faithful the Eucharistic mystery. Those dramas, called *autos sacramentales*, acquired more and more importance; in the 17th century, with Calderon, they become grand allegorical pieces, regular theological dissertations in the form of dramas. To the *auto sacramental* corresponds the *auto al nacimiento* or drama of the Nativity. The secular theatre is in Spain as elsewhere a product of the religious theatre. Expelled from the church, the *juegos de escarnios* took possession of the public squares and there obtained a free development; they cease to be a mere travesty of dogma to become a separate type, a drama whose movement is no longer determined by the liturgy, and whose actors are borrowed from real life in Spanish society. This new theatre starts about the close of the 15th century with the little pastoral pieces of Juan del Encina (died 1534), which, after Virgil's example, he calls *eglogas*. Genuine shepherds, clumsy, rude, and long-haired (*melenudos*), are the interlocutors of those bucolics, into which are also sometimes introduced students, and even, by Lucas Fernandez, a contemporary and pupil of Encina's, gentlemen (*caballeros*) and soldiers. A book which, strictly speaking, does not belong to the theatre, the *Tragicomedia de Calixto y Melibea*, by Fernando de Rojas, much better known as *La Celestina*, and dating from about 1492, caused the new theatre, still so childish in the attempts of the school of Encina, to make a gigantic step onwards. The history of two lovers, who are brought together by a go-between (Celestina), and who after various vicissitudes ultimately commit suicide,—this astonishing novel taught the Spaniards the art of dialogue, and for the first time exhibited persons of all classes of society (particularly the lowest) speaking in harmony with their natural surroundings, thinking and acting in accordance with their condition of life. The progress caused by the *Celestina* may be estimated by means of the *Propaladia* of Bartolomé Torres Naharro (Naples, 1517), a collection of pieces represented at Rome in presence of Leo X. and distributed by their author into two groups—*comedias a noticia*, those treating of things really known and seen, and *comedias a fantasia*, those bringing fictions on the stage, though it may be with the appearance of reality. The most interesting, if not the best composed, are the *comedia soldadesca*, depicting to the life the Spanish man-at-arms of the time, and the *comedia tinelaria*, a picture of the manners of the menials of the pontifical court. Torres Naharro is the first Spaniard who borrowed from France the division of the play into "days" (*jornadas*); shortly after Naharro we find the comedy of manners in Lope de Rueda, goldbeater of Seville (died about 1566), whose dramatic work is composed of regular comedies constructed on the model of Naharro and Italian authors of the beginning of the 16th century, and also of little pieces intended for performance in the intervals between the larger plays (*entremeses* and *pasos*), some of which, such as *El Convidado*, *El Rufian Cobarde*, *Las Aceitunas*, are storehouses of sprightliness and wit. Some of Naharro's and especially of Rueda's pieces have already the character of the comedy of intrigue, which is emphatically the type of the classic stage. But to reach Lope de Vega the Spanish stage had to be enlarged in relation to national history. A poet of Seville, Juan de la Cueva (born about 1550), first brought on the boards subjects such as the exploits of the Cid, Bernardo del Carpio, and others, which had previously been treated of only in the "romances." To a poet called Berrio, of whose work nothing has been preserved, are attributed the *comedias* of Moors and Christians, in which were represented famous episodes of the age-long struggle against the infidel. And it is at this period that Cervantes (1585) experimented in the dramatic line; in his *Tratos de Argel* he gives us a picture of galley-life, painful recollections of his long captivity in Algiers. There is no need to linger over certain attempts at tragedy of the ancient type by Geronimo Bermudez (born 1530), Cristóbal de Virues (born about 1550), Lupercio Leonardo Argensola (1562–1613), etc., the only successful specimen of which is the *Numancia* of Cervantes; these works in fact, cold and manneristic, mere exercises in style and versification, remained without influence on the development of the Spanish stage. The pre-classic period of this stage is, as regards dramatic form, one of indecision. Some write in prose, like Rueda; others, like Naharro, show a preference for the *redondillas* of popular poetry; and there are those again who, to elevate the style of the stage, versify in hendecasyllabics. Hesitation is also evident as to the mode of dividing the drama. At first a division into five acts, after the manner of the ancients, is adopted, and this is still followed by Cervantes in his first pieces; then Juan de la Cueva reduced the five acts to four, and in this he is imitated by most of the poets to the close of the 16th century (Lope de Vega himself in his youth composed pieces in four acts). It was only at this time that the custom which is still maintained of dividing all dramatic works into three acts or days was introduced,—exception, of course, being made of short pieces like the *loa* (prologue), the *entremes*, the *paso*, the *baile* (different kinds of *entr'acte*).

Classic age—16th and 17th centuries.

The golden age of Spanish literature, as it is called, belongs to the 16th and the 17th centuries, extending approximately from 1550 to 1650. Previous to the reign of the Catholic sovereigns there exists, strictly speaking, only a Castilian literature, not very self-reliant and largely influenced by imitation first of France and then of Italy; the union of the two crowns of Aragon and Castile, and afterwards the advent of the house of Austria and the king of Spain's election as emperor, proved the creation at once of the political unity of Spain and of Spanish literature. After the death of Philip IV. (1665) this fair-shining light went out; the nation, exhausted by distant expeditions, the colonization of America, Continental wars, and bad administration, produced nothing; its literary genius sank in the general decline, and Spain is destined ere long to be subjected again to the influence of France, to which she had submitted during all the first period of the Middle Ages. In the 16th and 17th centuries the literature is eminently national. Of course all is not equally original, and in certain kinds of literature the Spaniards continue to seek models abroad.

Lyric poetry.

Lyric poetry, especially that of the highest order, is always inspired by the Italian masters. An irresistible tendency leads the Spanish poets to rhyme in hendecasyllabics—as the marquis of Santillana had formerly done, though his attempts had fallen into oblivion—and to group their verses in tercets, octaves, sonnets, and *canciones* (*canzoni*). Garcilaso de la Vega (1503–1536), Juan Boscan (1493–*c.* 1550), and Diego de Mendoza (1503–1575) are the recognised chiefs of the school *al italico modo*, and to them belongs the honor of having successfully transplanted to Spain those different forms of verse, and of having enriched and improved the poetic language of their country. The few uncouthnesses of which Mendoza and Boscan more especially are guilty (such as certain faults of rhythmic accentuation) were corrected by their disciples Gutierre de Cetina, Gregorio Silvestre, Hernando de Acuña, by the poets of the so-called school of Seville, headed by Fernando de Herrera (died 1597), and also by those of the rival school of Salamanca, rendered famous mainly by the inspired poetry of Fr. Luis de Leon (1528–1591). Against those innovators the poets faithful to the old Castilian manner, the rhymers of *redondillas* and romances, hold their own; under the direction of Cristóbal de Castillejo (1556) they carry on a fierce war of the pen against the "Petrarchists." But by the last third of the 16th century the triumph of the new Italian school is assured, and no one any longer thinks of reproaching it for its foreign flavor. Only a sort of schism is effected from that period between the higher poetry and the other varieties; the former employs only the hendecasyllabic and the heptasyllabic (*quebrado*), while the popular poets, or those who affect a more familiar tone, preserve the national metres. Almost all the poets, however, of the 16th and 17th centuries have tried their powers in both kinds of versification, using them in turn according to the nature of their subjects. Thus Lope de Vega, first of all, who wrote *La Jerusalem Conquistada* (1609), *La Dragontea* (1602), *La Hermosura de Angélica* (1602), in Italian verses and in octaves, composed his long narrative poem on Isidore, the husbandman patron of Madrid (1599), in quintils of octosyllabic verse, not to mention a great number of "romances." As regards this last form, previously disdained or almost so by artistic poets, Lope de Vega gave it a prestige that brought it into favor with the literates of the court. A host of poets were pleased to recast the old "romances" or to compose new ones. The 17th century, it may be said, is characterized by a regular surfeit of lyric poetry, to which the establishment of various literary academies in the Italian style contributed not a little. Of this enormous mass of verses of all sorts and sizes very little still keeps afloat; the names of three-fourths of the versifiers must be forgotten, and in addition to those already cited it will be sufficient to mention Luis de Góngora (1561–1626) and Francisco de Quevedo Villegas (1580–1645). Góngora is especially famous as the founder of the "cultist" school, as the introducer into Castilian poetry of a flowery, bombastic, and periphrastic style, characterized by sonorous vocables and artificial arrangements of phrase. The Spaniards have given the name of *culto* to this pompous and manneristic style, with its system of inversions based on Latin syntax. The *Soledades* of Góngora are the monument *par excellence* of Spanish mannerism, which made numerous victims and inflicted on the poetry of the Peninsula irreparable injury. But Góngora, a poet of really great powers, had started better, and as often as he cares to forget about being sonorous and affected, and is contented to rhyme romances, he finds true poetic accents, ingenious ideas, and felicitous expressions. Quevedo, much greater, moreover, in his prose works than in his verse, displays real power only in satire, epigram, and parody. There are in some of his serious pieces the stuff of a Juvenal, and his satiric and burlesque romances, of which several are even written in slang (*germania*), are in their way little masterpieces. Another commonplace of Spanish poetry at this period was epic poetry after the style of Tasso's *Gerusalemme*. None of those interminable and prosaic compositions in *octavas reales* come near their model; none of them could even be compared in style, elevation of thought, and beauty of imagery to the *Lusiadas*. They are in reality only rhymed chronicles, and consequently, when the author happens to have taken part in the events he narrates, they have a genuine historical interest. Such is the case with the *Araucana* of Alonso de Ercilla (1533–1594), of which it may be said that it was written less with a pen than with a pike. In burlesque poetry the Spaniards have been rather more successful; *La Gatomaquia* of Lope de Vega and *La Mosquea* of Villaviciosa (died 1658) are somewhat agreeable pieces of fun.

Romances.

The departments of imaginative literature in which the genius of the new Spanish nation revealed itself with most vigor and originality are the *novela* and the drama. By *novela* must be understood the novel of manners, called *picaresca* (from *picaro*, a rogue or "picaroon") because of the social status of the heroes of those fictions; and this kind of novel is quite an invention of the Spaniards. Their pastoral romance, on the other hand—the best known examples of which are the *Diana Enamorada* of Jorge de Montemayor (died 1561), continued by Alonso Perez and Gaspar Gil Polo, the *Galatea* of Cervantes, and the *Arcadia* of Lope de Vega, as well as their novel of adventure, started by Cervantes in his *Novelas Ejemplares* (1613), and cultivated after him by a host of writers—is directly derived from Italy. The *Arcadia* of Sannazaro is the source of the *Diana* and of all its imitations, just as the Italian *novellieri* alone are the masters of the Spanish *novelistas* of the 17th century. The picaresque novel starts in the middle of the 16th century with the *Vida de Lazarillo de Tormes, sus Fortunas y Adversidades* (1554), the work of a very bold intellect whose personality unfortunately remains unknown, there being no satisfactory reason for assigning this little book, which is as remarkable for the vigor of its satire as for the sobriety and firmness of its style, to Diego Hurtado de Mendoza. A supplement to the adventures of Lazarillo appeared at Antwerp in 1555; it is probably, however, not the production of the author of the original romance. The impetus was given, and the success of *Lazarillo* was so great that imitators soon appeared. In 1599 Mateo Aleman published, under the title of *Atalaya de la Vida Humana*, the first part of the adventures of another picaroon, Guzman de Alfarache; and, as he was in no hurry to finish this narrative, another writer, jealous of his success, took possession of it and issued in 1603, under the pseudonym of Mateo Luxan, a continuation of the first Guzman. Aleman, not to be thwarted, resumed his pen, and published the second part of his romance in 1605. Quite unlike that of the *Lazarillo*, the style of Mateo Aleman of Seville is eloquent, full, with long and learned periods, sometimes diffuse. Nothing could be more extravagant and more obscure than the history of Justina the beggar woman (*La Picara Justina*) by Francisco Lopez de Ubeda (1605), an assumed name which concealed the person of the Dominican Andrés Perez de Leon. The other picaresque romances are: *Alonso Mozo de muchos Amos*, by Geronimo de Alcalá (two parts, 1624 and 1626); the *Historia y Vida del Gran Tacaño Pablo de Segovia* (1626), in which

Quevedo has made his most brilliant display of style and wit; the *Garduña de Sevilla* (1634) of Alonso de Castillo Solorzano; *La Vida y Hechos de Estebanillo Gonzalez* (1646), described as *compuesto por el mesmo*, but an Estéban Gonzalez is unknown in the literary history of the 17th century.

By degrees the picaresque romance was combined with the novel of Italian origin and gave rise to a new type,—half novel of manners, half romance of adventure,—of which the characteristic example appears to be the *Relacion de la Vida y Aventuras del Escudero Marcos de Obregon* (1618), by Vicente Espinel, one of the most genial and best written works of the 17th century. To the same class belong almost all the novels of Alonso Gerónimo de Salas Barbadillo, such as *La Ingeniosa Helena*, *Don Diego de Noche*, *El Caballero puntual*, etc.; Luiz Velez de Guevara's *Diablo Cojuelo* (1641), the model of Lesage's *Diable Boiteux*; and Francisco Santos's highly popular pictures of life in Madrid, *Dia y Noche de Madrid* (1663), *Periquillo, el de las Gallineras*, etc. On the contrary, the novels of Tirso de Molina (*Los Cigarrales de Toledo*, 1624), Perez de Montalban (*Para Todos*, 1632), Maria de Zayas (*Novelas*, 1637), are more in the manner of the *Novelas Ejemplares* of Cervantes, and consequently of the Italian type. Among the so-called historical romances one only deserves to be mentioned,—the *Guerras Civiles de Granada* by Gines Perez de Hita, which deals with the last years of the kingdom of Granada and the insurrection of the Moors of the Alpujarras in the time of Philip II. *Don Quixote*, the masterpiece of Miguel Cervantes de Saavedra (1547–1616), is too great a work to be treated along with others; and, besides, it does not fall strictly within the limits of any of the classes just mentioned. If it has to be defined, it may be described as the social romance of 16th and 17th century Spain. Cervantes undoubtedly owed much to his predecessors, notably to the picaresque romancers, but he considerably enlarged the scope of the type, and, what had as yet been done by no one, supported the framework of the story by a lofty moral idea. His main purpose was, as we are beginning to realize, not to turn into ridicule the books of chivalry, which were already out of fashion by his time, but to show by an example pushed to absurdity the danger of *hidalgism*, of all those deplorable prejudices of pure blood and noble race with which three-fourths of the nation were imbued, and which, by the scorn of all useful labor which they involved, were destined to bring Spain to ruin. The lesson is all the more effective as his *hidalgo*, although ridiculous, was not put beyond the pale of the reader's sympathy, and the author condemns only the exaggeration of the chivalrous spirit, and not true courage and devotion when these virtues have a serious object. The same thing happened to *Don Quixote* which had happened to *Guzman de Alfarache*. After the publication of the first part (1605), Cervantes allowed his pen to lie too long idle; and so it occurred to some one to anticipate him in the glory of completing the story of the heroic deeds of the knight of La Mancha. In 1614 a second part of the adventures of Don Quixote made its appearance—the work of a certain Avellaneda, a pseudonym under which people have sought to recognize the inquisitor Luis de Aliaga. Cervantes was thus roused from inactivity, and the following year gave to the world the true second part, which soon effaced the bad impression produced by Avellaneda's heavy and exaggerated imitation.

Drama of 17th century.

The stage in the 17th century in some measure took the place of the romance of the previous age; it is, as it were, the medium of all the memories, all the passions, and all the aspirations of the Spanish people. Its style, being that of the popular poetry, made it accessible to the most illiterate classes, and gave it an immense range of subject. From the books of the Bible, the acts of the martyrs, national traditions, the chronicles of Castile and Aragon, and foreign histories and novels, down to the daily incidents of contemporary Spanish life, the escapades and nightly brawls of students, the gallantries of the Calle Mayor and the Prado of Madrid, balcony escalades, sword thrusts and dagger strokes, duels and murders, fathers befooled, jealous ladies, pilfering and cowardly valets, inquisitive and sprightly waiting-maids, sly and tricky peasants, fresh country girls,—all are turned to dramatic account. The enormous mass of plays with which the literature of this period is inundated may be divided into two great classes—a secular and a religious, the latter again subdivided into (1) the liturgical play, *i.e.*, the *auto* either *sacramental* or *al nacimiento*, and (2) the *comedia divina* and the *comedia de santos*, which have no liturgical element and differ from a secular play only in the fact that the subject is religious, and frequently, as one of the names indicates, derived from the history of a saint. In the secular drama, classification might be carried almost to any extent if the nature of the subject be taken as the criterion. It will be sufficient to distinguish the *comedia* (*i.e.*, any tragic or comic piece in three acts) according to the social types brought on the stage, the equipment of the actors, and the artifices resorted to in the representation. We have (1) the *comedia de capa y espada*, which represents any everyday incident, the actors belonging to the middle class, simple *caballeros*, and consequently wearing the garb of ordinary town-life, of which the chief items were the cloak and the sword, and (2) the *comedia de teatro* or *de ruido*, or again *de tramoya* or *de aparencias* (*i.e.*, the theatrical, spectacular, or scenic play), which prefers kings and princes for its *dramatis personæ* and makes a great display of mechanical devices and decorations. Besides the *comedia*, the classic stage has also a series of little pieces subsidiary to the play proper: the *loa* or prologue, the *entremes*, a kind of interlude which afterwards developed into the *saynete*, the *baile*, or ballet accompanied with singing, and the *zarzuela*, a sort of operetta thus named after the royal residence of La Zarzuela, where the kings of Spain had a theatre. As to the dramatic poets of the golden age, even more numerous than the lyric poets and the romancers, it is rather difficult to group them. All are more or less pupils or imitators of the great chief of the new school, Lope Felix de Vega Carpio (1562–1635); everything has ultimately to be brought back to him whom the Spaniards call the "monster of Nature." Among Lope's contemporaries, only a few poets of Valencia—Gaspar de Aguilar, Francisco Tarrega, Guillem de Castro (1569–1631), the author of the *Mocedades del Cid* (from which Corneille derived his inspiration)—formed a small school, as it were, less subject to the master than that of Madrid, which was bound to merit the applause of the public by copying as exactly as possible the manner of the great initiator. Lope left his mark on all varieties of the *comedia*, but did not attain to equal excellence in all. He was especially successful in the comedy of intrigue (*enredo*), of the *capa y espada* class, and in dramas whose subjects are derived from national history. His great and most incontestable merit is to have given the Spanish stage a range and scope of which it had not been previously thought capable, and of having taught his contemporaries to find dramatic situations and to carry on a plot. It is true he wrote nothing perfect: his prodigious productiveness and facility allowed him no time to mature anything; he wrote negligently, and, besides, he considered the stage an inferior department, good for the *vulgo*, and consequently did not judge it worthy of the same regard as lyric or narrative poetry borrowed from the Italians. Lope's first pupils exaggerated some of his defects, but, at the same time, each, according to his own taste, widened the scope of the *comedia*. Antonio Mira de Amescua and Luis Velez de Guevara (died 1644) were successful especially in tragic histories and *comedias divinas*. Fr. Gabriel Tellez (1570–1648), better known under the pseudonym of Tirso de Molina, one of the most flexible, ingenious, and inventive of the dramatists, displayed no less talent in the comedy of contemporary manners than in historical drama. *El Burlador de Sevilla* (*Don Juan*), the most celebrated of his plays since the Italians and the French have taken possession of the subject, is reckoned his masterpiece; but he showed himself a much greater poet in *El Vergonzoso en Palacio*, *Don Gil de las Calzas Verdes*, *Marta la Piadosa*. Finally Juan Ruiz de Alarcon (died 1639), the most serious and most observant of Spanish dramatic poets, successfully achieved the comedy of character in *La Verdad Sospechosa*, closely followed by Corneille in his *Menteur*. The remaining play-writers hardly did anything but increase the number of the *comedias;* they added nothing to the real elements of the drama. The second epoch of the classical drama is represented mainly by Pedro Calderon de la Barca (1600–1681), the Spanish dramatist who has obtained most celebrity abroad, where his pieces have been studied and admired (perhaps extravagantly) by certain critics who have not feared to rank him with Shakespeare. It is Calderon who first made honor, or more correctly the point of honor, an essential motive in the conduct of his personages (*e.g.*, *el Médico de su Honra*); it is he also who made the *comedia de capa y espada* uniform even to monotony, and gave the comic "part" of the *gracioso* (confidential valet of the *caballero*) a fixity which it never previously possessed. There is depth and poetry in Calderon, but vagueness also and much bad taste. His most philosophic drama, *La Vida es Sueño*, is a bold and sublime idea, but indistinct and feebly worked out; that his *autos sacramentales* give evidence of extensive theological knowledge is all that can be said in their favor. Calderon was imitated, as Lope had been, by exaggerating his manner and perverting his excellencies. Two poets only of the second half of the 17th century deserve to be cited along with him—Francisco de Rojas, author of the fine historic play *Del ray abajo ninguno*, and Agustin Moreto (1618–1662), author of some pleasant comedies. Among those who worked in secondary forms mention must be made of Luis Quiñones de Benavente, a skilful writer of *entremeses*, and in fact the greatest master of the form.

History.

A new manner of writing appears with the revival of learning: the purely objective style of the old chroniclers, with their tagging on of one fact after another, without showing the logical connection or expressing any opinion on men or things, begins to be thought puerile. An attempt is now made to treat the history of Spain in the manner of Livy, Sallust, Tacitus, whose methods of narration were directly adopted. The 16th century, however, still presents certain chroniclers of the mediæval type, with more erudition, precision, and a beginning of the critical element. *La Crónica General de España* by Ambrosio de Morales, the *Compendio Historial* of Estéban de Garibai, the *Historia General de las Indias Occidentales* by Antonio de Herrera, are, as far as the style is concerned, continuations of the last chronicles of Castile. Gerónimo de Zurita (1512–1580) is emphatically a scholar: no one in the 16th century knew as he did how to turn to account documents and records for the purpose of completing and correcting the narratives of the ancient chronicles; his *Anales de la Corona de Aragon* is a book of great value, though written in a painful style. With Juan de Mariana (1536–1623) history ceases to be a mere compilation of facts or a work of pure erudition, in order to become a work of art and of thought. The *Historia de España* by the celebrated Jesuit, at first written in Latin in the interest especially of foreigners, was afterwards rendered by its author into excellent Castilian; as a general survey of its history, well-planned, well written, and well thought out, Spain possesses nothing that can be compared with it; it is eminently a national work, steeped throughout in the prejudices of the race. Various works of less extent—accounts of more or less important episodes in the history of Spain—may take their place beside Mariana's great monument: for example, the *Guerra de Granada* by Diego Hurtado de Mendoza (a history of the revolt of the Moors of the Alpujarras under Philip II.), written about 1572, immediately after the events, but not published till about thirty years later, after the author's death; the narrative of the expedition of the Catalans in the Morea in the 14th century by Francisco de Moncada (died 1635); that of the revolt of the same Catalans under the reign of Philip IV. by Francisco Manuel de Melo (died 1666), a Portuguese by birth; and that of the conquest of Mexico by Antonio de Solis. Each of these writers has been more or less inspired by some Latin author, one preferring Livy, another Sallust, etc. These imitations, it must be admitted, have something artificial and stilted, which in the long run proves as fatiguing as the unskilfulness and heaviness of the chroniclers of the Middle Ages. On the other hand, the historians of the wars of Flanders, such as Carlos Coloma, Bernardino de Mendoza, Alonso Vazquez, Francisco Verdugo, are less refined, and for that very reason are more vivid and more thoroughly interest us in that struggle of the two races, so foreign to each other and of such different genius. As for the accounts of the trans-Atlantic discoveries and conquests, they are of two kinds,—either (1) memoirs of the actors or witnesses of those great dramas, as, *e.g.*, the *Historia Verdadera de la Conquista de la Nueva España* by Bernal Diaz del Castillo, one of the companions of Cortes, and the *Historia de las Indias* by P. Bartolomé de las Casas, the apostle of the Indians; or (2) works by professional writers, such as Francisco Lopez de Gomara,—official historiographers who wrote in Spain on information sent to them from the newly-discovered lands.

Letter writers.

Letter writers, a rather numerous body in Spanish literature, are nearly related to the historians; in fact, letters written to be read by others than the persons addressed, or in any case revised afterwards, are only another method, a little more familiar, of writing history. Fernando del Pulgar appended to his *Claros Varones* a series of letters on the affairs of his time; and at the commencement of the 16th century Antonio De Guevara (died 1545) collected, under the title of *Epistolas Familiares*, his correspondence with his contemporaries, which throws a great light on the early part of the reign of Charles V., although it must be used with caution because of the numerous *rifacimentos* it has undergone. A celebrated victim of Philip II., Antonio Perez (died 1611), revenged himself on his master by relating in innumerable letters, addressed during his exile to his friends and protectors, all the incidents of his disgrace, and by selling to the ministers of France and England the secrets of the Spanish policy in which he had a hand; some of these letters are little masterpieces of sprightliness and gallantry.

Philosophy.

Philosophy is rather poorly represented in the 16th and 17th centuries in the literature of the vernacular. The greater number of the Spanish thinkers of this epoch, whatever the school to which they belonged,—scholastic, Platonic, Aristotelian, or independent,—wrote in Latin. Ascetic and mystical authors alone made use of the vulgar tongue for the readier diffusion of their doctrine among the illiterate, from whose ranks a good number of their disciples were recruited. Fr. Luis de Granada (died 1588) the great preacher, Juan de la Cruz (1542–1591), Fr. Luis de Leon (1528–1598), Teresa de Jesus (1515–1582), and Malon de Chaide are the brighter lights of this class of writers. Some of their books, like the *Guia de Pecadores* of Fr. Luis de Granada, the *Confessions* of St. Teresa, Malon de Chaide's *Conversion*

Mysticism.

of the Magdalen, have obtained a brilliant and lasting success beyond the limits of the Peninsula, and have not been without some influence on the development of mysticism in France. The Spanish mystics are not only remarkable for the depth or subtlety of their thoughts and the intensity of the divine love with which they are inspired; many of them are masters of style; some, like Juan de la Cruz, have composed verses which rank with the most delicate in the language.

Moralists.

A notable fact is that those men who are regarded as illuminati profess the most practical ideas in the matter of morality. Nothing is more sensible, nothing less ecstatic, than the manual of domestic economy by Fr. Luis de Leon—*La Perfecta Casada.* Lay moralists are very numerous in the 16th and 17th centuries. Some write long and heavy treatises on the art of governing, the education of princes, the duties of subjects, etc. Pedro Fernandez de Navarrete's *Conservacion de Monarquias*, Diego de Saavedra Faxardo's *Idea de un Principe Cristiano*, Quevedo's *La Politica de Dios y Gobierno de Cristo*, give a correct idea of the ability which the Spaniards have displayed in this kind of didactic and preceptorial literature,—ability of no high order, for the Spaniard, when he means to teach and work out a doctrine, loses himself in distinctions and rapidly becomes diffuse, pedantic, and obscure. But there is a kind of morality in which he indubitably excels, namely, in social satire, which, under all its forms,—dialogue and dream in the style of Lucian, epistle after the manner of Juvenal, or pamphlet,—has produced several masterpieces and a host of ingenious, caustic, and amusing compositions. Juan de Valdes, the most celebrated of the Spanish Protestants, led the way by his *Dialogo de Mercurio y Caron*, where all the great political and religious questions of the first half of the 16th century are discussed and resolved with admirable vigor and freedom. The king in the department of social satire, as in those of literary and political satire, is Quevedo. Nothing escapes his scrutinizing spirit and pitiless irony. All the vices of the society of his time are, in his *Sueños* and many other little pamphlets, remorselessly placed in the pillory and cruelly cut to pieces. While this great satirist, in philosophy a disciple of Seneca, imitates his master even in his style of writing, he is none the less one of the most vigorous and original writers of the 17th century. The only serious defect in his style is that it is too full, not of figures and epithets, but of thoughts. His phrases are of set purpose charged with a double meaning, and we are never sure on reading whether we have taken in all that the author meant to convey. *Conceptism* is the name that has been given to this refinement of thought, which was doomed in time to fall into the ambiguous and equivocal; it must not be confounded with the *cultism* of Góngora, the artifice of which lies solely in the choice and arrangement of words. This new school, of which Quevedo may be regarded as the founder, had its Boileau in the person of Baltasar Gracian, who in 1642 published his *Agudeza y Arte de Ingenio*, in which all the subtleties of conceptism are very exactly reduced to a code. Gracian, who had the gift of sententious moralizing rather than of satire, produced in his *Criticon* animated pictures of the society of his own day, while he also displayed much ingenuity in little collections of political and moral aphorisms which have procured him a great reputation abroad,—*El Heroe*, *El Politico Fernando el Catolico*, *Oraculo Manual y Arte de Prudencia.*

18th century.

Spanish thought as well as public spirit and all other forms of national activity began to decline towards the close of the 17th century. The advent of the house of Bourbon, and the increasing invasion of French influence in the domain of politics as well as in literature and science, confirmed this decay by rendering abortive the efforts of a few writers who had remained faithful to the pure Spanish tradition. In the hands of the second-rate imitators of Calderon the stage sank ever lower and lower; lyric poetry, already compromised by the pomp and galimatias of Góngora, was abandoned to wretched rhymesters, who tried without success to make up by extravagance of style for meanness of thought. In a word, everything was suffering from anæmia. The first symptoms, not of a revival, but of a certain resumption of intellectual production appear in the department of linguistic study. In 1714 there was created, on the model of the French academies, La Real Academia Española, intended to maintain the purity of the language and to correct its abuses. This Academy set itself at once to work, and in 1726 was able to commence the publication of its dictionary in six volumes folio, the best title of this association to the gratitude of men of letters. The *Gramatica de la Lengua Castellana*, drawn up by the Academy, did not appear till 1771. For the new ideas which were introduced into Spain as the result of more intimate relations with France, and which were in many cases repugnant to a nation for two centuries accustomed to live a self-contained life, it was necessary that fully sanctioned patrons should be found. D. Ignacio de Luzan, well read in the literatures of Italy and France, a disciple of Boileau and the French rhetoricians, yet not without some originality of his own, undertook in his *Poetica* (1737) to expound to his fellow-countrymen the rules of the new school, and, above all, the principle of the famous "unities" accepted by the French stage from Corneille's day onward. What Luzan had done for letters, Benito Feyjoo (1676–1764), a Benedictine of good sense and great learning, did for the sciences. His *Teatro Critico* (1726–1729) and *Cartas Eruditas y Curiosas* (1742–1760), collections of dissertations in almost every department of human knowledge, introduced the Spaniards to the leading scientific discoveries of foreign countries, and helped to deliver them from many superstitions and absurd prejudices. The study of the ancient classics and the department of learned research in the domain of national histories and literatures had an eminent representative in Gregorio Mayans y Siscar (died 1782), who worthily carried on the great traditions of the renaissance; besides publishing good editions of old Spanish authors, he gave to the world in 1757 a *Retórica* which is still worth consulting and a number of learned memoirs. What may be called the *littérature d'agrément* did not recover much lost ground; it would seem as if the vein had been exhausted.

Romance.

Something of the old picaresque novel came to life again in the *Historia del Famoso Predicador Fray Gerundio de Campazas* of the Jesuit José Francisco de Isla, a biographical romance which is also and above all—to the detriment, it is true, of the interest of the narrative—a satire on the follies of the preachers of the day; the history of Fray Gerundio is merely a pretext, as it were, for displaying and holding up to ridicule the eloquence of the pulpit at the sorry pass to which it had then been brought by the ignorance and bad taste of the Spanish clergy. Isla is known also by his translation of *Gil Blas*, a work which he professed to restore to his native country, trying to make out—unsuccessfully, of course—that Le Sage had no other merit than that of rendering it into French.

Poetry.

The lyric poetry of this period is very pale and colorless when compared with its dazzling splendor in the preceding century. Nevertheless one or two poets can be named who were possessed of refinement of taste, and whose collections of verse, though wanting in genuine inspiration, at least show respect for the language and will always meet with some appreciation. At the head of the new school is Juan Menendez Valdés (1754–1817), and with his are associated the names of P. Diego Gonzales (1733–1794), José Iglesias de la Casa (1748–1791), known especially by his *letrillas*, Nicasio Alvarez de Cienfuegos (1764–1809), and some others.

Among the verse writers of the 18th century who produced odes and didactic poetry it is only necessary to mention Leandro Fernandez de Moratin (1760–1828) and Manuel José Quintana (1772–1857), but the latter belongs rather to the present century, during the first half of which he published his most important works. The poverty of the period in lyric poetry is even exceeded by that of the stage. Here no kind of comedy or tragical drama arose to take the place of the ancient *comedia*, whose platitudes and absurdities of thought and expression had ended by disgusting even the least exacting portion of the public. The attempt was indeed made to introduce the comedy and the tragedy of France, but the stiff and pedantic adaptations of such writers as Agustin de Montiano y Luyando (1697–1764), Tomas de Iriarte (1750–1791), Garcia de la Huerta, and the well-known economist Gaspar de Jovellanos (1744–1811) were unable to interest the great mass of play-goers. The only one who was really successful in composing on the French pattern some pleasant comedies, which owe much of their charm to the great purity of the language in which they are written, is Leandro Fernandez de Moratin; his best pieces are *La Nueva Comedia*, a parody on the extravagant work of Comella, a playwright of the period, *El Viejo y la Niña*, *El Baron*, and particularly *El Sí de las Niñas*. It has to be added that the *saynete* was cultivated in the 18th century by one writer of genuine talent, Ramon de la Cruz; nothing helps us better to an acquaintance with the curious Spanish society of the reign of Charles IV. than the intermezzos of this genial and light-hearted author.

19th century.

The terrible struggle of the War of Independence (1808–1814), which was destined to have such important consequences in the world of politics, did not exert any immediate influence on the literature of Spain. One might have expected as a consequence of the rising of the whole nation against Napoleon that Spanish writers would have given up seeking their inspiration from those of France, and would have tried to resume the national traditions which had been broken at the end of the 17th century. But nothing of the sort occurred. Not only the *afrancesados* (as those were called who had accepted the new régime), but also the most ardent partisans of the patriotic cause, continued in literature to be the submissive disciples of France. Quintana, who in his inflammatory odes preached to his compatriots the duty of resistance and revenge, has nothing of the innovator about him; by his education and by his literary doctrines he remains a man of the 18th century. The same may be said of Francisco Martinez de la Rosa (1789–1848), who, however, from his intercourse with Horace, whom he translated with skill into good Castilian verse, had a greater independence of spirit and a more highly trained and classical taste. And, when romanticism begins to find its way into Spain and to enter into conflict with the spirit and habits of the 18th century, it is still to France that the poets and prose writers of the new school turn, much more than either to England or to Germany. The first decidedly romantic poet of the generation which flourished about 1830 was the duke of Rivas, Angel de Saavedra (1791–1856); no one succeeded better in reconciling the genius of Spain and the tendencies of modern poetry; his epic poem *El Moro Expósito* and his drama of *Don Alvaro ó la Fuerza del Sino* belong as much to the old romances and old theatre of Spain as to the romantic spirit of 1830. On the other hand, José de Espronceda (1808–1842), who has sometimes been called the Spanish Musset, savors much less of the soil than the duke of Rivas; he is a quite cosmopolitan romanticist of the school of Byron and the French imitators of Byron; an exclusively lyric poet, he did not live long enough to give full proof of his genius, but what he has left is certainly exquisite. José Zorrilla (born 1817) has a more flexible and exuberant but much more unequal talent than Espronceda, and if the latter has written too little it cannot but be regretted that the former should have produced too much; nevertheless, among a multitude of hasty performances, brought out before they had been matured, his *Don Juan Tenorio*, a new and fantastic version of the legend treated by Tirso de Molina and Molière, will always remain as one of the most curious specimens of Spanish romanticism. In the dramatic literature of this period it is noticeable that the tragedy more than the comedy is modelled on the examples furnished by the French drama of the Restoration; thus, if we leave out of account the play of Garcia Gutierrez (born 1813) entitled *El Trovador*, which inspired the well-known opera of Verdi, and *Los Amantes de Teruel* of Juan Eugenio Hartzenbusch (born 1806), and a few others, all the dramatic work belonging to this date recalls more or less the manner of the professional playwrights of the boulevard theatres, while on the other hand the comedy of manners still preserves a certain originality and a genuine local color. Manuel Breton de los Herreros (1796–1873), who wrote as many as a hundred comedies, some of them of the first order after their kind, apart from the fact of their being written in language of great excellence, adheres with great fidelity to the tradition of the 17th century; he is the last of those writers who have preserved the feeling of the ancient *comedia*. One prose writer of the highest talent must be mentioned along with Espronceda, with whom he has in the moral aspect several features in common,—namely, D. José de Larra (1809–1837), so famous by his pseudonym of "Figaro," with which he signed the greater number of his works. Caustic in temper, of a keenly observant spirit, remarkably sober and clear as a writer, he was specially successful in the political pamphlet, the *article d'actualités*; to this category belong his *Cartas de un Pobrecito Hablador*, in which he ridicules without pity the vices and oddities of his contemporaries; his reputation is much more largely due to these letters than either to his somewhat feeble play of *Macias* or to his not very attractive novel *El Doncel de Enrique el Doliente*. With Larra must be associated two other humoristic writers. The first of these is Ramon Mesonero Romanos, "El Curioso Parlante" (born 1803), whose *Escenas Matritenses*, although not possessed of the literary value of Larra's articles, give pleasure by their good-natured gayety and by the curious details they furnish with regard to the contemporary society of Madrid. The other is Serafin Estébanez Calderon, "El Solitario" (1799–1867), who in his *Escenas Andaluzes* sought to revive the manner of the satirical and picaresque writers of the 17th century; in a uselessly archaic language of his own, patched up from fragments taken from Cervantes, Quevedo, and others, he has delineated with a peculiar but somewhat artificial grace various piquant scenes of Andalusian or Madrilenian life. The most prominent literary critics belonging to the first generation of the century were Alberto Lista (1775–1848), whose critical doctrine may be described as a compromise between the ideas of French classicism and those of the romantic school, and Agustin Duran (died 1862), who made it his special task to restore to honor the old literature of Castile, particularly its romances, which he had studied with unequalled thoroughness, and of which he published highly esteemed collections.

If the struggle between classicists and romanticists continued even after 1830, and continued to divide the literary world into two opposing camps, it is plain that the new generation—that which occupied the scene from 1840 till about 1868—had other preoccupations. The triumph of the new ideas is now assured; only a few reactionaries are still seen to cling to the principles bequeathed by the 18th century. What was now being aimed at was the creation of a new literature which should be truly national and no longer a mere echo of that beyond the Pyrenees. To the question whether contemporary Spain has indeed succeeded in calling into existence such a literature, we may well hesitate to give an affirmative answer. It is true that in every species of composition, the gravest as well as the lightest, it can show works of genuine talent; but many of them are strikingly deficient in originality; all of them either bear unmistakable traces of imitation of foreign models, or show (more or less happily) the imprint of the older literature of the 17th century, to which the historical criticism of Duran and the labors of various other scholars had given a flavor of novelty. With this observation before him, the student can divide the authors of this period into two groups,—the one composed of those who, won by modern ideas, are more or less liberal in politics, and draw their inspiration in all they write from France or from what they are able to assimilate of other literatures through France; the other consisting of ultra-conservatives, whose dream in every sphere—letters, art, and politics—is the restoration of the Spain of the past. Nowhere does this antagonism manifest itself more clearly than in the drama. A play of Aureliano Fernandez Guerra might have been conceived and written by a contemporary of Lope or of Calderon, while a comedy of Adelardo Lopez de Ayala is moulded in the pattern given by the younger Dumas and by Augier. In the department of romance, on the other hand—much neglected by the writers of the first half of the century—the Spaniards have recovered something of the genius of Cervantes and their 17th century *novelas picarescas*. The art of constructing a story and of telling it in an agreeable way, which seemed for a long time to have been lost, is recovered in such authors as Fernan Caballero, Antonio de Trueba, Pedro Antonio de Alarcon, Juan Valera, Perez Galdos, and Pereda. These novelists are far from alike in method or in spirit; how widely separated, for example, are the somewhat banal facility and the sentimental catholicism of Fernan Caballero on the one hand, and the searching psychological analysis and the fine skepticism of Juan Valera on the other. But all have this in common, that they understand how to interest their readers, and how to make their characters live and speak. Incontestably the novel is the triumph of contemporary Spanish literature; it is almost the only kind of composition that actually lives with a life of its own and makes steady progress. One cannot say as much of lyric poetry, represented feebly enough by Ramon de Campoamor, Nuñez de Arce, and some others. Deficient inspiration, diffuseness of style, and want of precision in language characterize them all; it is unfortunately very easy to make mediocre verses in Spanish, and too many people give themselves over to the pursuit. Passing from the literature of amusement, we have still some very distinguished names to enumerate. Philosophy, indeed, has but one representative of merit, the traditionalist Jaime Balmes,—for the Krausist school, an importation from Germany, may be ignored here, —but history and literary criticism have been cultivated during the last thirty years or so with genuine success. Modesto Lafuente is in some sort the Mariana of the 19th century; much inferior as a writer to the celebrated Jesuit, he has, however, always manifested the same passion for his subject, the same persevering determination to raise a worthy monument of his fatherland; his *Historia de España*, in spite of all its defects, deserves respect, and is at least readable. Although primarily a politician, Antonio Cánovas del Castillo has many of the qualities which go to the making of a good historian; he has evinced greater acuteness and larger acquirements than Lafuente, and his *Ensayo sobre la Casa de Austria en España*, founded upon a careful examination of a large number of documents, gives evidence of a correct judgment and praiseworthy impartiality. The literary history of old Spain has been treated in a masterly manner by Aureliano Fernandez Guerra in various studies devoted to the great writers of the 17th century, notably Quevedo, and also quite recently by a young and talented scholar, Marcelino Menéndez Pelayo, whose *Historia de las Ideas Estéticas en España*, a work as solid in its substance as it is pure in its style, would do honor to any veteran in literature. As regards criticism of contemporary literature, no one shows more spirit and taste than Juan Valera, whose delicate Andalusian nature has been matured by a refining education and by an adequate knowledge of foreign literatures.

Bibliography.—The base of the student's operations is always the great work of Nicolas Antonio, *Bibliotheca Hispana Vetus* and *Bibliotheca Hispana Nova*, in the revised and completed edition of Francisco Perez Bayer, Tomas Antonio Sanchez, and Juan Antonio Pellicer (Madrid, 1783-88, 4 vols. fol.). The student can afford to disregard all general histories which preceded Ticknor's *History of Spanish Literature* (New York, 1849, 3 vols. 8vo; 4th ed., Boston, 1872, 3 vols. 8vo), a work of solid value, especially from the bibliographical point of view; it is quite indispensable that the reader should consult also the Spanish translation by D. Pascual de Gayangos and Enrique de Vedia (Madrid, 1851-56) and the German translation of Julius with some important additions by Ferdinand Wolf (Leipsic, 1852-67). Nothing can be said in favor of the French translation by J. G. Magnabal (Paris, 1864-72). The *Historia Critica de la Literatura Española* of José Amador de los Rios (Madrid, 1861-65, 7 vols. 8vo), although deficient in criticism and full of errors in fact, supplies some useful information as to the period prior to the 15th century, with which it exclusively deals. Menendez Pelayo's *Historia de las Ideas Estéticas en España* (Madrid, 1884-86, 3 vols. 8vo), already referred to, is very instructive. For the 18th century, Leopoldo A. de Cueto's "Bosquejo Histórico-Crítico de la Poesia Castellana en el Siglo xviii.," prefixed to the first vol. of Rivadeneyra's *Poetas Líricos del Siglo xviii.*, is indispensable. For the 19th century there is not as yet any satisfactory work dealing with the literature as a whole; that of M. G. Hubbard, *Histoire de la Littérature Contemporaine en Espagne* (Paris, 1876, 1 vol. 8vo), although superficial and inaccurate, is useful in the absence of anything better. Some descriptions of Castilian literature have been specially studied with care and competence, notably the drama, on which we have two thorough works,—Frederick von Schack's *Geschichte der dramatischen Literatur u. Kunst in Spanien* (Frankfort-on-the-Main, 1846-54, 3 vols. 8vo), unfortunately now much behindhand, and in no way improved in this respect in the Spanish translation now in course of publication at Madrid under the superintendence of Eduardo de Mier, and Cayetano Alberto de la Barrera's excellent *Catálogo Bibliográfico y Biográfico del Teatro Antiguo Español* (Madrid, 1860, large 8vo). On the Castilian literature of the Middle Ages, the works to be consulted are Ferdinand Wolf's *Studien zur Geschichte der Spanischen u. Portugiesischen Nationalliteratur* (Berlin, 1859, 1 vol. 8vo) and Manuel Milá y Fontanals's *De la Poesia Heroico-Popular Castellana* (Barcelona, 1874, 1 vol. 8vo).

Poetry of Middle Ages.

II. CATALAN LITERATURE.—Although the Catalan language is simply a branch of the southern Gallo-Roman, the literature, in its origin at least, ought to be considered as a mere appendix of that of Provence. Nay more, until about the second half of the 13th century there existed in the Catalan districts no other literature than the Provençal, and the poets of northeastern Spain used no other language than that of the troubadours. Guillem de Bergadan, Uc de Mataplana, Ramon Vidal de Besalú, Guillem de Cervera, Serveri de Gerona, and several other verse writers of a still more recent date are all genuine Provençal poets, in the same sense as are those of Limousin, Quercy, or Auvergne, since they write in the *langue d'oc* and make use of all the forms of poetry cultivated by the troubadours north of the Pyrenees. Ramon Vidal (end of 12th century and beginning of 13th) was a grammarian as well as a poet; his *Rasos de Trobar* became the code for the Catalan poetry written in Provençal, which he called *Lemosi*, a name still kept up in Spain to designate, not the literary idiom of the troubadours only, but also the local idiom—Catalan,—which the Spaniards choose to consider as derived from the former. The influence of R. Vidal and other grammarians of his school, as well as that of the troubadours we have named, lasted for a very long time; and even after Catalan prose—an exact reflection of the spoken language of the southeast of the Pyrenees—had given evidence of its vitality in some considerable works, the Catalan poetry remained faithful to the Provençal tradition. From the combination of spoken Catalan with the literary language of the troubadours there arose a sort of composite idiom, which has some analogy with the Franco-Italian current in certain parts of Italy in the Middle Ages, although in the one case the elements of the mixture are more distinctly apparent than are the romance of France and the romance of Italy in the other. The poetical works of Raymond Lully (Ramon Lull) (died 1315) are among the oldest examples of this Provençalized Catalan; one has only to read the fine piece entitled *Lo Desconort* ("Despair"), or some of his stanzas on religious subjects, to apprehend at once the eminently composite nature of that language. Muntaner in like manner, whose prose is exactly that spoken by his contemporaries, becomes troubadour when he writes in verse; his *Sermó* on the conquest of Sardinia and Corsica (1323), introduced into his *Chronicle* of the kings of Aragon, exhibits linguistically quite the same mixed character as is found in Lully, or, we may venture to say, in all the Catalan verse writers of the 14th century. These are not very numerous, nor are their works of any great merit. The majority of their compositions consist of what were called *noves rimades*, that is, stories in octosyllabic verse in rhymed couplets. There exist poems of this class by Pere March, by a certain Torrella, by Bernat Metge (an author more celebrated for his prose), and by others whose names we do not know; among the works belonging to this last category special mention ought to be made of a version of the romance of the *Seven Sages*, a translation of a book on good breeding entitled *Facetus*, and certain tales where, by the choice of subjects, by various borrowings, and even occasionally by the wholesale introduction of pieces of French poetry, it is clearly evident that the writers of Catalonia understood and read the *langue d'oui*. Closely allied to the *noves rimades* is another analogous form of versification—that of the *codolada*, consisting of a series of verses of eight and four syllables, rhyming in pairs, still made use of in one portion of the Catalan domain (Majorca).

Of 15th century.

The 15th century is the golden age of Catalan poetry. At the instigation and under the auspices of John I. (1387–1395), Martin I. (1395–1410), and Ferdinand I. (1410–1416), kings of Aragon, there was founded at Barcelona a consistory of the "Gay Saber," on the model of that of Toulouse, and this official protection accorded to poetry was the beginning of a new style much more emancipated from Provençal influence. It cannot be denied, indeed, that its forms are still of foreign importation, that the Catalan verse writers accept the prescriptions of the *Leys d'Amor* of Guillaume Molinier, and the names which they gave to their *cobles* (stanzas) are all borrowed from the same *art de trobar* of the school of Toulouse; but, a very noteworthy fact, their language begins to rid itself more and more of Provençalisms and tends to become the same as that of prose and of ordinary conversation. With Pere and Jaume March, Jordi de Sant Jordi, Johan de Masdovelles, Francesch Ferrer, Pere Torroella, Pau de Bellviure, Antoni Vallmanya, and, above all, the Valencian Auzias March (died 1459), there flourished a new school, of which the éclat lasted till the end of the 15th century, and which, as regards the form of its versification, is distinguished by its almost exclusive employment of eight-verse *cobles* of ten syllables, each with "crossed" or "chained" rhymes (*cobla crohada* or *encadenada*), each composition ending with a *tornada* of four verses, in the first of which the "device" (*divis* or *senyal*) of the poet is given out. The greater number of these poems are still unedited or have only recently been extracted from the *cançoners*, where they had been collected in the 15th century. Auzias March alone, the most inspired, the most profound, but also the most obscure of the whole group, had the honor to be printed in the 16th century; his *cants d'amor* and *cants de mort* contain the finest verses ever written in Catalan, but the poet fails to keep up to his own high level, and by his studied obscurity occasionally becomes unintelligible to such a degree that one of his editors accuses him of having written in Basque. Of a wholly different class, and in quite another spirit, is the *Libre de les Dones* of Jaume Roig (died 1478), a Valencian also, like March; this long poem is a *nova rimada*, only *comediada*, that is to say, it is in quadrisyllabic instead of octosyllabic verse. A bitter and caustic satire upon women, it purports to be a true history,—the history of the poet himself and of his three unhappy marriages in particular. Notwithstanding its author's allegations, however, the *Libre de les Dones* does not seem to be other than a fiction; but it derives a very piquant interest from its really authentic element, its vivid picture of the Valencia of the 15th century and the details of the manners of that time. After this bright period of efflorescence Catalan poetry rapidly fell off, a decline due more to the force of circumstances than to any fault of the poets. The union of Aragon with Castile, and the resulting predominance of Castilian throughout Spain, inflicted a death blow on Catalan literature, especially on its artistic poetry, a kind of composition more ready than any other to avail itself of the triumphant idiom which soon came to be regarded by men of letters as the only noble one, and alone fit to be the vehicle of elevated or refined thoughts. The fact that a Catalan, Juan Boscan, inaugurates in the Castilian language a new kind of poetry, and that the Castilians themselves regard him as the head of a school, is important and characteristic; the date of the publication of the works of Boscan (1543) marks the end of Catalan poetry.

Prose of 13th–15th centuries.

The earliest prose works in Catalan are later indeed than the poems of the oldest Catalan troubadours of the Provençal school, not dating farther back than from the close of the 13th century, but they have the advantage of being entirely original; their language is the very language of the soil which we see appearing in charters from about the time of the accession of James I. (1213). This is true especially of the chronicles, a little less so of the other writings, which, like the poetry, have difficulty in escaping the influence of the more polished dialect of the country to the north of the Pyrenees. Its chronicles are the best ornament of mediæval Catalan prose. Four of them,—that of James I., apparently reduced to writing a little after his death (1276) with the help of memoirs dictated by himself during his lifetime; that of Bernat Des Clot, which deals chiefly with the reign of Pedro III. of Aragon (1276–1286); that of Ramon Muntaner (first half of the 14th century), relating at length the expedition of the Catalan company to the Morea and the conquest of Sardinia by James II.; finally that of Pedro IV., The Ceremonious (1336–1387), genuine commentaries of that astute monarch, arranged by certain officials of his court, notably by Bernat Des Coll,—these four works are distinguished alike by the artistic skill of their narration and by the quality of their language; it would not be too much to liken these Catalan chroniclers, and Muntaner especially, to Villehardouin, Joinville, and Froissart. The Doctor Illuminatus, Raymond Lully, whose acquaintance with Latin was very poor,—his philosophical works were done into that language by his disciples,—wrote in a somewhat Provençalized Catalan various moral and propagandist works,—the romance *Blanquerna* in praise of the solitary life, the *Libre de les Maravelles*, into which is introduced a "bestiary" taken by the author from *Kalilah and Dimnag*, and the *Libre del Orde de*

Cavalleria, a manual of the perfect knight, besides a variety of other treatises and opuscula of minor importance. The majority of the writings of Lully exist in two versions,—one in the vernacular, which is his own, the other in Latin, originating with his disciples, who desired to give currency throughout Christendom to their master's teachings. Lully—who was very popular in the lay world, although the clergy had a low opinion of him and in the 15th century even set themselves to obtain a condemnation of his works by the Inquisition—had a rival in the person of Francesch Ximenez or Eximeniz, a Franciscan, born at Gerona some time after 1350. His *Crestiá* (printed in 1483–84) is a vast encyclopædia of theology, morals, and politics for the use of the laity, supplemented in various aspects by his three other works—*Vida de Jesu Christ*, *Libre dels Angels*, and *Libre de les Dones;* the last-named, which is at once a book of devotion and a manual of domestic economy, contains a number of curious details as to a Catalan woman's manner of life and the luxury of the period. Lully and Eximeniz are the only Catalan authors of the 14th century whose works written in a vulgar tongue had the honor of being translated into French shortly after their appearance.

We have chiefly translators and historians in the 15th century. Antoni Canals, a Dominican, who belongs also to the previous century, translates into Catalan Valerius Maximus and a treatise of St. Bernard; Bernat Metge, himself well-versed in Italian literature, presents some of its great Masters to his countrymen by translating the *Griselidis* of Petrarch, and also by composing *Lo Sompni* ("The Dream"), in which the influence of Dante, of Boccaccio, and, generally speaking, of the Italy of the 13th and 14th centuries is very perceptible. The *Feyts d'Armes de Catalunya* of Bernat Boades, a knightly chronicle brought to a close in 1420, reveals a spirit of research and a conscientiousness in the selection of materials which are truly remarkable for the age in which it was written. On the other hand, Pere Tomich, in his *Histories é Conquestes del Reyalme d'Aragó* (1438), carries us back too much to the manner of the mediæval chroniclers; his credulity knows no bounds, while his style has altogether lost the naive charm of that of Muntaner. To the list of authors who represent the leading tendencies of the literature of the 15th century we must add the name of Johanot Martorell, a Valencian, author of the celebrated romance of chivalry *Tirant lo Blanch* (finished in 1460), which the reader has nowadays some difficulty in regarding as that "treasury of contentment" which Cervantes will have it to be.

16th–18th centuries.

With the loss of political was bound to coincide that of literary independence in the Catalonian countries. Catalan fell to the rank of a patois and was written less and less; lettered persons ceased to cultivate it, and the upper classes, especially in Valencia, owing to the proximity of Castile, soon affected to make no further use of the local speech except in familiar conversation. The 16th century, in fact, furnishes literary history with hardly more than a single poet at all worthy of the name—Pere Serafí, some of whose pieces, in the style of Auzias March, but less obscure, are graceful enough and deserve to live; his poems were printed at Barcelona in 1565. Prose is somewhat better represented, but, to tell the truth, it is only the erudite who persist in writing in Catalan,—antiquaries and historians like Pere Miguel Carbonell, compiler of the *Chroniques de Espanya* (1547), Francesch Tarafa, Pere Anton Beuter, also chroniclers, and some others not so well known. In the 17th and 18th centuries the decadence becomes still more marked. A few scattered attempts to restore to the Catalan, now more and more neglected by men of letters, some of its old life and brilliance, fail miserably. Neither Hieronim Pujades the historian, author of a *Coronica Universal del Principat* (Barcelona, 1609), nor even Dr. Vicens Garcia, rector of Vallfogona (1582–1623), a verse-writer by no means destitute of verve or humor, but whose literary talent and originality have been very greatly exaggerated by the Catalans of the present day, was able to bring back his countrymen to a cultivation of the local idiom. Some sermons, some lives of saints, some books of devotion, some relations and complaints for the use of the people, exhaust the catalogue of everything written in Catalan throughout the whole area of its domains down to the beginning of the present century; not a single book of importance can be mentioned. Writers who were Catalan by birth had so completely unlearned their mother-tongue that it would have seemed to them quite inappropriate, and even ridiculous, to make use of it in serious works, so profoundly had Castilian struck its roots in the eastern provinces of Spain, and so thoroughly had the work of assimilation been carried out to the advantage of the official language of the court and of the Government.

Revival of Catalan language and literature.

In 1814 appeared the *Gramática y Apologia de la Llengua Cathalana* of Joseph Pau Ballot y Torres, which may be considered as marking the origin of a genuine renaissance of the grammatical and literary study of Catalan. Although the author avows no object beyond the purely practical one of giving to strangers visiting Barcelona for commercial purposes some knowledge of the language, the enthusiasm with which he sings the praises of his mother-tongue, and his appended catalogue of works which have appeared in it since the time of James I., sufficiently show that this was not his only aim. In point of fact the book, which is entitled to high consideration as being the first systematic Catalan grammar, written, too, in the despised idiom itself, had a great influence on the authors and literary men of the principality. Under the helping influence of the new doctrines of romanticism twenty years had not passed before a number of attempts in the way of restoring the old language had made their appearance, in the shape of various poetical works of very unequal merit. The *Oda á la Patria* (1833) of Buenaventura Carlos Aribau is among the earliest if not actually the very first of these, and it is also the best; the modern Catalan school has not produced anything either more inspired or more correct. Following in the steps of Aribau, Joaquin Rubió y Ors (*Lo Gayter del Llobregat*), Antonio de Bofarull (*Lo Coblejador de Moncada*), and soon afterwards a number of other verse writers took up the lyre which it might have been feared was never to sound again since it fell from the hands of Auzias March. The movement spread from Catalonia into other provinces of the ancient kingdom of Aragon; the appeal of the Catalans of the principality was responded to at Valencia and in the Balearic Isles. Later, the example of Provence, of the *felibritge* of the south of France, accelerated still further this renaissance movement, which received official recognition in 1859 by the creation of the *jochs florals*, in which prizes are given to the best competitors in poetry, of whom some succeed in obtaining the diploma of *mestre en gay saber*. It is of course impossible to foresee the future of this new Catalan literature,—whether it is indeed destined for that brilliant career which the Catalans themselves anticipate. In spite of the unquestionable talent of poets like Mariano Aguiló (Majorca), Teodoro Llorente (Valencia), and among the younger of them, Jacinto Verdaguer (Catalonia), author of an epic poem *Atlantida* and of very fascinating *Cants Mistichs*, it is by no means certain that this generation will be succeeded by another to follow in its footsteps, or that such a restoration of a provincial literature has much chance of permanence at the very moment when all the peoples of Europe are tending rather towards unity and centralization in the matter of language. At all events, in order to secure even a comparative success for such a revival, it would be well if the language serving as its instrument were somewhat more fixed, and if its writers would no longer hesitate, as they at present do, between a pretentious archaism and the incorrectness of the most vulgar colloquialism. The few attempts of modern Catalans in the direction of romance writing and dramatic composition have not hitherto been particularly felicitous, and have not led to anything noteworthy.

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SPALATIN, George (1484–1545). George Burkhardt, a subordinate figure of some interest in the history of the Reformation in Germany, was born on January 17, 1484, at Spalt (whence he assumed the name Spalatinus), about 25 miles from Nuremberg, where his father was an artisan. He went to Nuremberg for education when he was thirteen years of age, and two years afterwards to the university of Erfurt, where he took his bachelor's degree within a year, in 1499. There he attracted the notice of

Marschalk, the most influential professor, who made Spalatin his amanuensis and took him to Wittenberg. In 1505 Spalatin went to Erfurt to study jurisprudence, was recommended to Mutianus, and was welcomed by the little band of German humanists of whom Mutianus was chief. His friend got him the post of teacher of young monks in a convent in the Georgenthal and pastor in the high church there. In 1508 he was ordained priest by Bishop John von Laasphe, who had ordained Luther. He had no great love for convent or pastoral work, and in 1509 Mutianus recommended him to Frederick the Wise, the elector of Saxony, who employed him to act as tutor to his son, the future elector, John Frederick. This appointment really determined Spalatin's life and work. He speedily gained the confidence of the famous elector, who employed him in many affairs. He sent him to Wittenberg in 1511 to act as tutor to his nephews, and procured for him a canon's stall in Altenberg. In 1512 the elector made him his librarian. This brought him into correspondence with a large number of literary men, and he began to collect all kinds of literary and especially of historical information, of which he made extensive use later in his chronicles. He was promoted to be court chaplain and confidential secretary to the elector and took charge of all his private and public correspondence. He thus became one of the most important men at the electoral court, which then was the centre of German life.

Spalatin had never cared for theology, and, although a priest and a preacher, had been a mere humanist. It was to Luther that he owed his awakening to the reality of a spiritual life. How he first became acquainted with the reformer it is impossible to say—probably at Wittenberg; but Luther from the first exercised a great power over him, and became his chief counsellor in all moral and religious matters. His letters to Luther have been lost, but Luther's answers remain, and are extremely interesting. Spalatin was Luther's devoted friend during the stormiest days of the Reformation, and was the means of bringing the great elector to take the side of the outspoken professor in his university of Wittenberg. He read Luther's writings to the elector, and translated for his benefit those in Latin into German. He accompanied Frederick to the diet of Augsburg, and shared in the negotiations with the papal legates, Cajetan and Miltitz. He was with the elector when Charles was chosen emperor and when he was crowned. He was with his master at the diet of Worms. In short, he stood beside Frederick as his confidential adviser in all the troubled diplomacy of the earlier years of the Reformation. Singularly cautious, perhaps timid, before the crisis came and while it could be averted, Spalatin found courage when the crisis had come. He would have dissuaded Luther again and again from publishing books or engaging in overt acts against the papacy, but, when the thing was done, none was so ready to translate the book, or to justify the act.

On the death of Frederick the Wise, Spalatin was as much engaged in diplomatic service as before, but he no longer lived at court. He went into residence as canon at Altenberg, and incited the chapter to institute reforms somewhat unsuccessfully. He married in the same year. During the later portion of his life, from 1526 onwards, he was chiefly engaged in the visitation of churches and schools in electoral Saxony, reporting on the confiscation and application of ecclesiastical revenues. His practical experience in German affairs made him very successful in his delicate task, and he was asked to undertake the same work for Albertine Saxony. He was also permanent visitor of Wittenberg university, and made an annual report of its condition to the elector. Shortly before his death he fell into a state of profound melancholy, and died January 16, 1545, at Altenberg.

Spalatin left behind him a large number of literary remains, both published and unpublished. His original writings are almost all historical. A list of them may be found in Seelheim's *George Spalatin als sächs. Historiograph*, 1878. There is no good life of Spalatin, nor can there be until his letters have been collected and edited, a work still to be done.

SPALATO (Slav. *Split*), a city of Dalmatia, at the head of one of the thirteen departments (area 730 square miles; population in 1880 31,003), is situated on the seaward side of a peninsula lying between the Gulf of Braza and the Gulf of Salona. Though not the capital, it is the most important city in the principality, is the see of a bishop, has a valuable museum of antiquities, and carries on an extensive trade in wine and oil. Since 1879 it has been the terminus of a railway running northwards to Sebenico and Siveric. Built on the low ground at the head of a beautiful bay, and thrown into relief by a background of picturesque hills rising close behind, Spalato has a striking sea-front, in which the leading feature is still the ruined façade of the great palace of Diocletian, erected in 303 A.D., to which the city owes its origin. In ground plan this is almost a square, with a quadrangular tower at each of the four corners. "Its faces correspond nearly with the four points of the compass. The south front (towards the harbor) measures 521 feet, or, with the towers, 598 feet 8 inches, and the eastern and western sides are each 705 feet 8 inches" (Wilkinson). The area included is 348,175 square feet, or, comprising the towers, 352,614 square feet, a little more than eight acres, or rather less than the area of the Escorial. There were four principal gates, with four streets meeting in the middle of the quadrangle, after the style of a Roman camp. The eastern gate (Porta Aenea) is destroyed; but, though the side towers are gone, the main entrance of the building, the beautiful Porta Aurea, in the west front, is still in fairly good preservation. The streets were lined with massive arcades. The vestibule now forms the Piazza del Duomo or public square; to the northeast of this lies the mausoleum (not, as the older antiquaries had it, the temple of Jupiter), which has long been the smallest and darkest of cathedrals; and to the southeast is the temple of Æsculapius, which served originally as a kind of court chapel and has long been transformed into a baptistery. Architecturally the most important of all the many striking features of the palace is the arrangement in the vestibule by which the supporting arches spring directly from the capitals of the large granite Corinthian columns. This, as far as the known remains of ancient art are concerned, is the first instance of such a method; and thus, in Mr. Freeman's words, "all Gothic and Romanesque architecture was in embryo in the brain of Jovius or his architect."

The name Spalato, or Spalatro (a very old spelling), which used to be explained as a corruption of Salonæ Palatium, is pretty certainly of different origin—the oldest form extant being Aspalathum (Constantine Porphyrogenitus) and early variants Spalathon, Spalathron, Spalatrum (*Geogr. Rav.*). Dr. Evans suggests a connection with Aspalathus (the name of a prickly shrub) or perhaps with Asphaltus. Not long after Diocletian's death the buildings seem to have been turned into an imperial cloth factory, and as most of the workers were women we find it called a *gynæcium* (*Notitia*). About 4 miles from the palace lay the ancient city of Salona (Σαλῶνα or Σαλῶναι), which consisted of two parts, the earlier Roman city to the west and a later portion incorporated previous to the time of the Antonines. There are still remains at Salona of ancient city walls, an amphitheatre, etc., and a long line of walls extending "from the western side of the city for a mile and more nearly along the present road to Trau (Tragurium)." The purpose of this line of walls is not evident, and the date of its construction has been the subject of much discussion. Mr. Freeman is disposed to consider them Roman workmanship.

Salona in its best days was one of the chief ports of the Adriatic, on one of the most central sites in the Roman world. Made a Roman colony after its second capture by the Romans (B.C. 78), it appears as Colonia Martia Julia and Colonia Claudia Augusta Pia Veteranorum, and bears at different periods the titles of respublica, conventus, metropolis, præfectura, and prætorium. In Christian times it became a bishop's see; and St. Doimo or Domnius, its first bishop, still gives his name to the cathedral of Spalato. The city was taken by Odoacer in 481 and by Totila in the 6th century. Recovered by Justinian in 535, it was in 544 and 552 the starting-point of Belisarius and Narses for their Italian expeditions. In the 7th century Salona was completely destroyed by the Avars; but the empty palace of Diocletian afforded an asylum for its inhabitants. The limits of the building proved sufficient for the new city up to the time that it passed under Hungarian and Venetian protection. Hungarian additions may still be seen above the Porta Aurea; and the large octagonal tower bears the name of Torre d'Harvoye from the Bosnian general who was created duke of Spalato by Ladislaus. The Venetians enclosed the town with regular curtains and bastions in 1645–1670. About 1807–1809 the castle was dismantled and parts of the walls were thrown down.

See Robert Adam, *Ruins of the Palace of Diocletian*, 1764; Cassas and Lavallée, *Voyage Pittoresque et Historique de l'Istrie*, 1802; Wilkinson, *Dalmatia and Montenegro*, 1848; Freeman, *Historical Essays*, 3d series, 1879, and *Subject and Neighbor Lands of Venice*, 1881. Both the first-mentioned works contain magnificent views and restorations of the architecture of the palace.

SPALDING, a market-town of Lincolnshire, England, in the Parts of Holland, is situated on the river Welland, and on the Great Northern and Great Eastern Railways, 93 miles from London. The town, standing in the heart of the Fens, is the centre of a rich agricultural district. Amongst the public buildings are five churches, the Johnson hospital (1881), the corn exchange (1856–57), the buildings of the mechanics' institute and of the Christian association and literary institute, and the district union-house. The parish church of St. Mary and St. Nicholas was built in 1284 and restored in 1865–66. The adjoining lady chapel (St. Mary and St. Thomas a Becket) was built in 1315; in 1588 it was appropriated for the grammar school endowed in 1568 by John Blanke and again in 1588 by John Gamlyn. A new grammar school was erected in 1881. Spalding has had a prison for upwards of 600 years; the present building, erected in 1824–25, was closed in 1884. The Welland is crossed at Spalding by two stone bridges. The existing high bridge, constructed in 1838, took the place of a wooden erection dating from the end of the 17th century; this last was built on the site of an older Roman bridge of two arches, the foundations of the centre pier of which were disclosed when the wooden bridge was constructed. The population of the town in 1871 was 9111, and in 1881 9260.

In 1051 Thorold of Bockenhale (now Bucknall, near Horncastle) gave his castle of Spalding and the chapel attached to it as a cell or monastery for the Benedictines of Crowland. Out of this grew the priory, which, however, was dissolved in 1535; the last fragments of its ruins were removed in 1832. About two miles northeast of Spalding stands the ruined chapel of Wykeham, dedicated to St. Nicholas and built in 1311 by Prior Clement Hatfield. The building is of the Decorated period, and has been roofless since 1782; its interior dimensions are 43 feet long by 22 feet wide; the walls are 44½ feet high. Each side contains three three-light windows with moulded flowing tracery, and each end one four-light window of similar character. The only one which retains its original mullions and tracery is the centre window on the south side. After the Conquest the estates and priory of Spalding were given by William I. to Ivo Tailbois, who found such a stout antagonist in Hereward the Wake, lord of Brunne or Bourn.

SPALDING, William (1809–1859), logician and literary historian, was born in Aberdeen in 1809. After a thorough education at the grammar school and at Marischal College there, he came to Edinburgh in 1830, where he was called to the bar in 1833. In that year he published a *Letter on Shakespeare's Authorship of the Two Noble Kinsmen*, which, by its critical acumen and the knowledge of the old dramatists which it displayed, attracted the notice of Jeffrey and procured the author an invitation to become a contributor to the *Edinburgh Review*. Before settling down to the business of the bar he undertook a prolonged Continental tour. He was absent fifteen months, the greater part of the time being spent in Italy, and in 1841 the fruits of his stay appeared in three volumes entitled *Italy and the Italian Islands from the Earliest Ages to the Present Time*. This learned and comprehensive work went through five editions in a few years. His attempts to gain a legal practice not proving successful, he became a candidate in 1838 for the chair of rhetoric in Edinburgh university, which he held till 1845, when he was appointed professor of logic in the university of St. Andrews. He held the latter post till his death on the 16th November, 1859.

Besides the works already mentioned, and various articles contributed to the *Edinburgh Review* and *Blackwood's Magazine*, he was the author of a concise *History of English Literature*, which has many merits and has been much used as a text-book. He also wrote the articles "Logic" and "Rhetoric" (as well as a number of literary biographies) for the eighth edition of the *Encyclopædia Britannica*. The former article, written mainly on Hamiltonian lines, constitutes a systematic treatise on Formal Logic, and is honorably distinguished by its clear scientific exposition. By these two articles and his *History of English Literature* Spalding is chiefly remembered.

SPALLANZANI, Lazaro (1729–1799), is one of the most important and certainly also one of the most picturesque figures in the history of science during the 18th century. Born at Scandiano in Modena in 1729, he was at first educated by his father, who was an advocate. At the age of fifteen he was sent to the Jesuit college at Reggio di Modena, and was pressed to enter that body. He went, however, to the university of Bologna, where his famous kinswoman Laura Bassi, was professor, and it is to her influence that his scientific impulse has been usually attributed. With her he studied natural philosophy and mathematics, and gave also great attention to languages, both ancient and modern, but soon abandoned the study of law, and afterwards took orders. His reputation soon widened, and in 1754 he became professor of logic, metaphysics, and Greek in the university of Reggio, and in 1760 was translated to Modena, where he continued to teach with great assiduity and success, but devoted his whole leisure to natural science. He declined many offers from other Italian universities and from St. Petersburg until 1768, when he accepted the invitation of Maria Theresa to the chair of natural history in the university of Pavia, which was then being reorganized. He also became director of the museum, which he greatly enriched by the collections of his many journeys along the shores of the Mediterranean. In 1785 he was invited to succeed Vallisneri at Padua, but to retain his services his sovereign doubled his salary and allowed him leave of absence for a visit to Turkey, where he remained nearly a year, and made many observations, among which may be noted those of a copper mine in Chalki and of an iron mine at Principi. His return home was almost a triumphal progress: at Vienna he was cordially received by Joseph II., and on reaching Pavia he was met with acclamations outside the city gates by the students of the university. During the following year his students exceeded five hundred. His integrity in the management of the museum was called in question, but a judicial investigation speedily cleared his honor, to the satisfaction even of his accusers. In 1788 he visited Vesuvius and the volcanoes of the Lipari Islands and Sicily, and embodied the results of his researches in a large work published four years later. He died from an apoplectic seizure in 1799, at the age of seventy.

His indefatigable exertions as a traveller, his skill and good fortune as a collector, his brilliance as a teacher and expositor, and his keenness as a controversialist no doubt aid largely in accounting for Spallanzani's exceptional fame among his contemporaries, yet greater qualities were by no means lacking. His life was one of incessant eager questioning of nature on all sides, and his many and varied works all bear the stamp of a fresh and original genius, capable of stating and solving problems in all departments of science,—at one time finding the true explanation of "ducks and drakes" (formerly attributed to the elasticity of water) and at another helping to lay the foundations of our modern vulcanology and meteorology. His main discoveries, however, were in the field of physiology: he wrote valuable and suggestive papers on respiration, on the senses of bats, etc., while his highly important controversy with Needham and Buffon, in which he experimentally disproved the occurrence of spontaneous generation, has been already referred to under ABIOGENESIS. In this regard also he was led to pay considerable attention to the infusorial animalcules. His great work, however, is the *Dissertationi de Fisica Animale e Vegetale* (2 vols., 1780). Here he first interpreted the process of digestion, which he proved to be no mere mechanical process of trituration, but one of actual solution, taking place primarily in the stomach, by the action of the gastric juice. Verifying this by the important experiment of artificial digestion outside the stomach in sealed tubes, he was attacked by John Hunter, but emerged victorious from the encounter. Of no less importance are his researches on reproduction, in which he experimentally settled the relative functions of the ovum and the spermatozoon. See REPRODUCTION.

SPANDAU, a strongly fortified town in the province of Brandenburg, Prussia, is situated at the confluence of the Havel and Spree, 8 miles to the northwest of Berlin. It has recently been converted into a fortress of the first class, and is now the key of the defences of the capital. The Julius tower in the citadel, which is surrounded by water, contains the imperial war treasure (Reichskriegsschatz)—a sum of £6,000,000 [$29,160,000] in gold, kept in readiness for any warlike emergency. Besides numerous barracks, Spandau contains various military establishments appropriate to an important garrison town; and its chief industries are connected with the preparation of munitions of war. The Government factories for the manufacture of small arms, artillery, gunpowder, etc., cover upwards of 200 acres, and employ about 4000 workmen. The other industries are not very important; they comprise miscellaneous manufactures, fishing, boat-building and some shipping on the Havel. The population in 1885, including the garrison of nearly 4000 men, was 31,463.

Spandau is one of the oldest places in the Altmark, and received town-rights in 1232. It afterwards became a favorite residence of the Hohenzollern electors of Brandenburg, and was fortified in 1577–83. In 1631 it surrendered to the Swedes, and in 1806 to the French. A short investment in 1813 restored it to Prussia. The population in 1816 was 6250.

SPANGENBERG, AUGUST GOTTLIEB (1704–1792), Count Zinzendorf's successor, and bishop of the Moravian Brethren, was born July 14, 1704, at Klettenberg, on the south of the Harz Mountains, where his father was court-preacher, and ecclesiastical inspector of the grafschaft of Hohenstein. Left an orphan at the early age of ten, he was sent to the excellent high school at Ilefeld, and passed thence (1722), in poorest circumstances, to Jena to study law. Prof. Buddeus received the poor youth into his family, and a "stipendium" was procured for him. Theology rather than law was his natural destination, and it needed only the impulse of the remark of Buddeus that the inevitable prospect before a true theologian is ignominy and trial to convert the student of law, who was profoundly exercised with religious conflicts, into a student of theology. Somewhat after the manner of the Wesleys at Oxford a little later, he studied the mystics, read the Bible, observed rigid devotional exercises, sought to quicken his sense of sin, avoided taking the Lord's Supper with unbelievers in the Lutheran Church, and took an active part in a religious union of students and in schools for poor children just outside Jena. He took his degree in 1726, and began to give free lectures on theology. In 1727 he made the acquaintance of the Moravian colony at Herrnhut and its head, Count Zinzendorf. A "collegium pastorale practicum" for the care of the sick and poor was in consequence founded by him at Jena, which the authorities at once broke up as a "Zinzendorfian institution." But Spangenberg's relations with the Moravians were confirmed by several visits to the colony, and the accident of an unfavorable appeal to the lot alone prevented his appointment as chief elder of the community, March, 1733. Meanwhile, his free lectures in Jena met with much acceptance, and led to an invitation from Gotthelf Francke to the post of assistant professor of theology and superintendent of the educational department of his orphanage at Halle. He accepted the invitation, and entered on his duties in September, 1732. But it soon appeared that the differences between the Pietists of Halle and himself were far too serious to admit of any harmonious co-operation. He found their religious life too formal, legal, external, and worldly; and they could not sanction his comparative indifference to doctrinal correctness and his incurable tendency to separatism in church life. Spangenberg's participation in private observances of the Lord's Supper brought matters to a crisis. His intimate connection with Count Zinzendorf was made a further charge against him. His preaching was pronounced "singular," and an "affected humility towards common people" obnoxious. He was offered by the senate of the theological faculty of Halle the alternative of doing penance before God, submitting to his superiors, and separating himself from Zinzendorf, or leaving the matter to the decision of the king, unless he preferred to "leave Halle quietly." The case came before the king, and on April 8th, 1733, Spangenberg was conducted by the military outside the gates of Halle. At first he bent his steps to Jena, but Zinzendorf at once sought to secure him as a fellow-laborer, though, with that "jesuitry" of which Wesley subsequently complained, the count wished to obtain from him a declaration which would remove from the Pietists of Halle all blame with regard to the disruption. Spangenberg found amongst the Moravians his life-work. He could amongst them carry out his fundamental principle that the churches are but spheres in *all* of which Christians are to be found, and that the one church of Christ is only where believers live in Christian fellowship. He joined the Moravians at a moment when the stability of the society was threatened, and a wise organizer, enterprising missionary, and theological teacher, was imperatively required. He became its theologian, its apologist, its statesman and corrector, through sixty long years of incessant labor. For the first thirty years (1733–62) his work was mainly devoted to the superintendence and organization of the extensive missionary enterprises of the body in Germany, England, Denmark, Holland, Surinam, Georgia, and elsewhere. His missionary work tended to still further modify and broaden his theological opinions, unsatisfactory as the Pietists of Halle had found them in 1733. It was on an island off Savannah that Spangenberg startled John Wesley with his questions and profoundly influenced his entire future career. One special endeavor of Spangenberg in Pennsylvania was to bring over the scattered Schwenkfeldians to his faith. In 1741–42 he was in England collecting for his mission and obtaining the sanction of the archbishop of Canterbury. During the second half of this missionary period of his life he superintended as bishop the churches of Pennsylvania, defended the Moravian colonies against the Indians at the time of war between France and England, became the apologist of his body against the attacks of the Lutherans and the Pietists, and did much to moderate the mystical extravagances of Zinzendorf, with which his simple, practical, and healthy nature was out of sympathy. The second thirty years of his work (1762–92) were devoted to the consolidation of the German Moravian Church. Zinzendorf's death (1760) had left room and need for his labors at home. At Herrnhut there were conflicting tendencies, doctrinal and practical extravagances, and the organization of the brethren was very defective. Spangenberg proved himself to be the man required. In 1777 he was commissioned to draw up an *idea fidei fratrum*, or compendium of the Christian faith of the United Brethren, which was published two years afterwards and became the accepted declaration of the Moravian belief. As compared with Zinzendorf's own writings, this book exhibits the finer balance and greater moderation of Spangenberg's nature, while those offensive descriptions of the relation of the sinner to Christ in which the Moravians at first indulged are almost absent from it. In his last years Spangenberg devoted special attention to the education of the young, in which the Moravians have since been so successful. He died at Berthelsdorf, September 18, 1792. In addition to the *Idea Fidei Fratrum*, Spangenberg wrote, besides other apologetic books, a *Declaration über die zeither gegen uns ausgegangenen Beschuldigungen* (Leipsic, 1751), an *Apologetische Schlussschrift* (1752), *Leben des Grafen Zinzendorf* (1752–75); and his hymns are well known beyond the Moravian circle.

See Risler, *Leben Spangenbergs*, Barby, 1794; K. F. Ledderhose, *Das Leben Spangenbergs*, Heidelberg, 1846; Frick, *Beiträge zur Lebensgeschichte A. G. Spangenberg's*, Halle, 1884; Herzog-Plitt's *Realencyklopädie*, s. v. "Spangenberg."

SPARROW (A. S. *Spearwa;* Icel. *Spörr;* Old High Germ. *Sparo*), a word perhaps (like the equivalent Latin *Passer*) originally meaning almost any small bird, but gradually restricted in signification and nowadays in common English applied to only four kinds, which are further differentiated as Hedge-Sparrow, House-Sparrow, Tree-Sparrow, and Reed-Sparrow,—the last being a BUNTING (vol. iv. p. 470)—though when used without a prefix the second of these is usually intended.

1. The HEDGE-SPARROW, called "Dunnock" in many parts of Britain, the *Accentor modularis* of ornithologists, is the little brown-backed bird with an iron-gray head and neck that is to be seen in nearly every garden throughout the country, unobtrusively and yet tamely seeking its food, which consists almost wholly of insects, as it progresses over the ground in short jumps, each movement being accompanied by a slight jerk or shuffle of the wings. Though on the Continent it regularly migrates, it is one of the few soft-billed birds that reside throughout the year with us, and is one of the earliest breeders,—its well-known greenish-blue eggs, laid in a warmly-built nest, being recognized by hundreds as among the surest signs of returning spring; but a second or even a third brood is produced later. The cock has a sweet but rather feeble song; and the species has long been accounted, though not with accuracy, to be the most common dupe of the Cuckow. Several other species are assigned to the genus *Accentor;* but all, except the Japanese *A. rubidus*, which is the counterpart of the British Hedge-Sparrow, inhabit more or less rocky situations, and one, *A. collaris* or *alpinus*, is a denizen of the higher mountain ranges of Europe, though it has several times strayed to England. The taxonomic position of the genus is regarded by some systematists as doubtful; but to the present writer there seems no good reason for removing it from the group which contains the Thrushes and Warblers (*Turdidæ* and *Sylviidæ*), to which it was long referred.

2. The HOUSE-SPARROW, the *Fringilla domestica* of Linnæus and *Passer domesticus* of modern authors, is far too well known to need any description of its appearance or habits, being found, whether in country or town, more attached to human dwellings than any other wild bird; nay, more than that, one may safely assert that it is not known to thrive anywhere far away from the habitations or works of men, extending its range in such countries as Northern Scandinavia and many parts of the Russian empire as new settlements are formed and land brought under cultivation. Thus questions arise as to whether it should not be considered a parasite throughout the greater portion of the area it now occupies, and as to what may have been its native country. Moreover, of late years it has been inconsiderately introduced to several of the large towns of North America and to many of the British colonies, in nearly all of which, as had been foreseen by ornithologists, it has multiplied to excess and has become an intolerable nuisance, being unrestrained by the natural checks which partly restrict its increase in Europe and Asia. Whether indeed in the older seats of civilization the House-Sparrow is not decidedly injurious to the agriculturist and horticulturist has long been a matter of discussion, and no definite result that a fair judge can accept has yet been reached. It is freely admitted that the damage done to growing crops is often enormous, but as yet the service frequently rendered by the destruction of insect-pests cannot be calculated. Both friends and foes of the House-Sparrow write as violent partisans,[1] and the truth will not be known until a series of experiments, conducted by scientifically-trained investigators, has been instituted, which, to the shame of numerous agricultural and horticultural societies, has not yet been done. It is quite likely that the result will be unfavorable to the House-Sparrow, from what has been said above as to its being so dependent on man for its subsistence; but, while the evil it does is so apparent,—for instance, the damage to ripening grain-crops,—the extent of the counter-balancing benefit is quite uncertain, and from the nature of the case is often overlooked. In the South of Europe the House-Sparrow is in some measure replaced by two allied species, *P. hispaniolensis* and *P. italiæ*, whose habits are essentially identical with its own; and it is doubtful whether the Sparrow of India, *P. indicus*, is specifically distinct; but Africa has several members of the genus which are decidedly so.

3. The TREE-SPARROW, the *Fringilla montana* of Linnæus and *Passer montanus* of modern writers, in appearance much resembling the House-Sparrow, but easily distinguishable by its reddish-brown crown, the black patch on the sides of its neck, and its doubly-barred wings,[2] is a much more local species, in England generally frequenting the rows of pollard-willows that line so many rivers and canals, in the holes of which it breeds; but in some Eastern countries, and especially in China, it frequents houses, even in towns, and so fills the place of the House-Sparrow. Its geographical distribution is extensive, and marked by some curious characters, among which may be mentioned that, being a great wanderer, it has effected settlements even in such remote islands as the Færoes and some of the Outer Hebrides.

That the genus *Passer* properly belongs to the *Fringillidæ* is admitted by most ornithologists, yet there have been some who would refer it to the Weaver-birds, *Ploceidæ*, if they are to be accounted as forming a distinct Family,—a matter which is not at all clear. The American birds called "Sparrows" have little in common with the members of the genus *Passer*, and probably belong rather to the family *Emberizidæ* than to the *Fringillidæ*. (A. N.)

SPARROWHAWK. See HAWK.

SPARTA, after Athens, was the most powerful and important of the Greek states. Her fame rested mainly on her soldiers, her military discipline, her somewhat narrow patriotism, and her intense political conservatism; in general intellectual culture, in art and in everything connected with it, she was immeasurably inferior to Athens, and even to some of the other Greek states, though there is evidence to show that a genius and a taste for sculpture and music were by no means wanting to her citizens. Her eminent men were almost all eminent as soldiers, and few of them had any pretensions to rank as able and enlightened statesmen. No such man as Themistocles or Pericles ever appeared in Sparta; she produced no great thinkers or philosophers; the typical Spartan, in short, was a brave and well-trained soldier, with a decided simplicity of character and strong religious scruples, amounting to what we must call superstition, which from time to time were a hindrance to prompt action and discredited the state in the public opinion of Greece.

Sparta was not so much a city as a cluster of open villages in a plain in the heart of Laconia (see vol. xi. plate I.), in the middle valley of the Eurotas, on the west bank of the river, between the ranges of Taygetus and Parnon, and built in part on the spurs of these mountains. Its situation was very picturesque: "hollow, lovely Lacedæmon"[1] is Homer's description. Taygetus on the west rises to its greatest height of nearly 8000 feet just above the city, with primeval forests on its lower slopes, in which Spartans hunted the stag and the wild boar. Sparta seems to have been about six miles in circuit; it was not, like most Greek cities, near the coast,—Gythium, the chief port of Laconia, being 30 miles distant; nor was it built with anything like the compactness of an Athens or a Corinth. The houses for the most part stood in spacious gardens, an open-air life being altogether to the Spartan taste, and well suited to the pleasant genial climate of the valley. The olive still grows to great perfection in the neighborhood, and the silk is said to be of particularly fine quality. The mountain ranges round the city gave it a very strong defensive position, and for a long period Sparta was without walls or fortifications, trusting exclusively to the prowess of her citizens till she was seriously menaced by the victorious Macedonians in the 4th century B.C. The city was never a very splendid one; the houses were plain and simple and there seem to have been no public buildings of striking magnificence. There was the so-called Brazen House of Athene on a hill within a large enclosure, with plates of bronze which gave it its name, on which, among other mythological scenes, were represented the labors of Hercules and the exploits of the great twin brethren, Castor and Pollux, who were specially honored at Sparta. There was the theatre, still to be traced in huge quadrangular blocks of stone, and there were porticos and colonnades, and the chapels and tombs of Spartan heroes, such as Lycurgus, Leonidas, Brasidas. Sparta delighted to honor her worthy citizens, and paid them divine honors after death. The site of the city has not been thoroughly investigated, but it is a question whether much remains worth bringing to light. What has hitherto been discovered is poor and disappointing. Sparta's greatness as a city, as Thucydides (i. 10) clearly implies, fell very far short of her political importance as a state.[2]

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[1] The most recent attacks upon it are contained in the various issues of the *Report of Observations of Injurious Insects and Common Crop Pests*, annually made by Miss Eleanor Ormerod, and in a little volume bearing the title of *The House Sparrow*, published in 1885, and consisting chiefly of three essays by Mr. J. H. Gurney, Jr., Lieut.-Col. C. Russell, and Prof. Coues, but the last has only reference to the behavior of the bird in the United States of America, where, from the reason above assigned, its presence was expected by almost all well informed persons to be detrimental.

[2] A more important difference is that the two sexes have almost the same plumage, while in the House-Sparrow they are unlike in this respect.

Sparta's history, passing over her share in the prehistoric Trojan War under her king Menelaus, the brother of Agamemnon, begins with the legislation of Lycurgus in the ninth century B.C. It was this, as has been explained in the article LYCURGUS, which made Sparta what she was, a state whose aim it was rather to hold her own within the Peloponnesus than to launch out into doubtful enterprises far away from home. Sparta was not naturally aggressive or ambitious; she was not easily roused to action even in great emergencies. She was safe amid her mountains from the perils to which other Greek cities were exposed. It would seem that in early days Argos had been decidedly the first power in the Peloponnesus, Sparta being second to her by a long interval. The relative position of the two states was reversed soon after the time of Lycurgus. The spirit and vigor which his discipline infused no doubt enabled Sparta, after two severe wars in the 8th and 7th centuries, to accomplish at last the complete conquest of Messene, the southwestern portion of the Peloponnesus, and so to become the undisputed mistress of at least two-fifths of the whole peninsula. By the year 600 B.C. Sparta was quite in the first rank of Greek states, and it was generally felt that she had a right to take the lead in Greek politics. In the sixth century she put down the tyrants, the heads of the democratic and popular party, in several Greek cities, and drove, for a time at least, the reforming and innovating Clisthenes from Athens. Sparta was the steady foe of democracy and popular government. The Spartans were themselves a small landowning aristocracy, in the midst of a comparatively numerous population, consisting of so-called Periœci (dwellers round about), the aboriginal inhabitants, in fact, of Laconia, and of Helots or serfs, taken to a great extent from the conquered Messenians. The government was highly centralized; it was wholly in the hands of the Spartans, the Periœci having no share in it, though many of them may have themselves been landowners, or at any rate have held land under Spartan landlords, and been well-to-do and prosperous. The Helots were farm laborers bound to the soil, slaves in every sense of the word, anything like self-respect being studiously made impossible for them. Spartans could put down a popular rising or a slave insurrection with cold-blooded cruelty, and in a panic following on an earthquake of unusual violence in 464 there was a deliberately-planned massacre of a multitude of Helots for the safety of Sparta, carried out and executed by Spartans in person. A calculating selfishness was a marked trait in Spartan character. Sparta seems always to have put her own interests before those of Greece, though she claimed to be the leading and representative Greek state. She was cautious and even timid, though the courage of her individual citizens in war was unsurpassed. Every Spartan was a hero on the battlefield, and a Spartan army was long assumed to be invincible. Sparta was not much of a colonizing state, but she could point to the famous city of Tarentum in Southern Italy as her offspring, and to Lyctus (*Il.*, ii. 647; xvii. 611) in Crete, whence came warriors to the Trojan war. In 491, when Greece was threatened with invasion by Persia, we find Athens appealing to Sparta and urging a complaint against the Æginetans as traitors to Greece for having given earth and water, the symbols of submission, to the emissaries of the great king. In 480 a Spartan admiral commanded the Greek fleet off Artemisium against Xerxes, and in the following year a Spartan general, Pausanias, commanded the united forces of Greece in the famous battle of Platæa. All this implies a distinct recognition of Sparta as the head of Greece. The Persian War over, Athens under Cimon and Pericles developed extraordinary energy and took Sparta's place. Sparta indeed seems to have retired upon her laurels, and it was not without reluctance and much urgent pressure that she embarked in the Peloponnesian War, which, after twenty-eight years of hard fighting, ended in the overthrow of the Athenian empire and the capture of Athens by Lysander in 405. Sparta contributed greatly to the final result by despatching an able officer, Gylippus, to the relief of Syracuse in 414, when the city was on the point of surrendering to the Athenian armament. It was the decisive success of Gylippus in Sicily which turned the scale against Athens. The crushing blow of Ægospotami in 405, which annihilated her fleet and left her defenceless, and the subsequent surrender of the city transferred the supremacy of Greece once more to Sparta, but not for much more than thirty years. Sparta's policy was ungenerous and short-sighted; it consisted in establishing little oligarchical factions under Spartan control in the Greek cities, and soon degenerated into a tyranny which became utterly odious. All Sparta's worst qualities came out during this period: "autonomy," which had been her watchword throughout the war against Athens, became a dead letter under her rule; and the freedom of city life, so dear to a Greek, was crushed out under her officials and commissioners, whom she thrust on a number of Greek cities. Still more did she disgust all the better men of Greece by concluding, after a series of intrigues for her own selfish ends, a peace with Persia in 387, known as the peace of Antalcidas, the Spartan through whom it was negotiated. It was a dishonorable peace for Greece, as its effect was to facilitate Persian intervention in Greek affairs and make the king of Persia the arbiter of Greek disputes and differences. Meanwhile Athens was recovering herself; the tables were soon turned on Sparta, and her maritime power collapsed before the united action of Athens and Persia. In the Peloponnesus Sparta was still supreme, but Thebes, she felt, might become a dangerous rival and must be humbled. She insisted that the townships of Bœotia must be "autonomous" and independent of Thebes, and so contrived to pick a quarrel with that state, which to Sparta's cost had at that time the famous Epaminondas, the greatest, perhaps, of Greek generals, among her leading citizens. In 371 came Sparta's crushing defeat at Leuctra, a blow from which she never really recovered, though her courage and military discipline long survived it. But her prestige was gone. Epaminondas carried the war into the heart of Laconia and penetrated to Sparta itself. His victory at Mantinea in 362 gave independence to Messene, and Sparta was now politically ignored by her old allies.

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[1] Lacedæmon was simply another name for Sparta, though sometimes it seems to stand for the surrounding district.

[2] For topographical details we must refer the reader to the elaborate works of the German scholar Curtius on the Peloponnesus and works based on them. Mure's *Greece* and Leake's *Morea* should be consulted.

From this time Sparta almost drops out of Greek history. She took no part in the struggle against Macedon; no Spartan soldier stood by the side of the Athenians and Thebans at Chæronea. She seems to have sunk into political apathy; very possibly she may have had to concentrate all her remaining strength and energy in keeping down her Helots and the native population of Laconia. When Alexander was winning his victories in Asia, she intrigued feebly against Macedon, and she would take no part in the congress of the Greek states at Corinth which declared Alexander "Leader of the Greeks."

She appears once again, but as not much more than the ghost of her former self, in the 3d century B.C., attempting vainly in 281 to unite Greece against the Macedonian Antigonus, and repulsing Pyrrhus from her walls in 272, Spartan women working at the city's defence, and a few Spartan warriors driving back the formidable soldier-king. There was still the old spirit about her, but the number of her citizens is said to have dwindled down to 700, and in her last days, with a wealthy few in the midst of a poor and needy people, Sparta had shrunk into the narrowest and feeblest of oligarchies. In the latter half of the 3d century B.C., in the days of the Achæan league, a vigorous but unsuccessful attempt at internal reforms and restoration of the old discipline of Lycurgus was made by two of her kings, Cleomenes and Agis. She sank finally, we know not how, under the degrading dominion of a sort of robber chief, Nabis, who fastened his tyranny upon her by the support of emancipated slaves and mercenaries of the lowest class. Her best citizens were put to death or banished, and she was debased into a refuge of pirates and robbers. Nabis and his vile gang were put down by Philopœmen in the name of the Achæan league, and Philopœmen completed his work by razing the walls of Sparta and abolishing her old institutions. Rome simply looked on, knowing well that she was mistress of the situation, and let matters drag on till 146, when she captured Corinth, and closed the page of Greek history. (W. J. B.)

SPARTACUS, the leader of a formidable insurrection of slaves against Rome in the 1st century B.C., was a Thracian by birth, and perhaps a descendant of the kings of Panticapæum whose name he bore. He served in the Roman army, but seems to have deserted, for we are told that he was taken prisoner and sold as a slave. Destined for the arena, he, with a band of his fellow-gladiators, broke out of a training-school at Capua and took refuge on Mount Vesuvius (73 B.C.). Here he maintained himself as a captain of brigands, his lieutenants being Crixus and Œnomaus, who like himself had been gladiators. Their numbers soon swelled through the accession of runaway slaves and desperados from the neighborhood. A hastily-collected force of 3000 men under Claudius endeavored to besiege and starve out the rebels, but the latter clambered down the precipices and put the Romans to flight. Swarms of hardy and desperate men now joined the rebels, and when the prætor Publius Varinius took the field against them he found them entrenched like a regular army on the plain. But they gave him the slip, and when he advanced to storm their lines he found them deserted. From Campania the rebels marched into Lucania, a country better suited for guerilla warfare. Here, in spite of the commands and entreaties of Spartacus, the slaves committed excesses of lust and cruelty. Varinius followed him, but was defeated in several engagements and narrowly escaped being taken prisoner. Spartacus, whose heart was "where his rude cottage by the Danube lay," now endeavored to push northward. His object was to cross the Alps and allow the slaves, who were mostly Thracians, Germans, and Gauls, to disperse to their homes. But intoxicated by success his wild followers refused to listen to him; their thoughts were all of plunder, and their track was marked by the devastation of Italy. Vola, Nuceria, Thurii, Metapontum, were sacked with every circumstance of savage cruelty. In this serious position of affairs the senate despatched both consuls against the rebels (72 B.C.). The German slaves under Crixus, who had separated from the rest, were defeated and cut in pieces at Mount Gargarus in Apulia by the prætor Arrius. But Spartacus overthrew both consuls, one after the other, and then pressed towards the Alps. Cassius, governor of Cisalpine Gaul, and the prætor Manlius flung themselves in his way at the head of 20,000 men, but were trampled under foot. Freedom was within sight, but with fatal infatuation the slaves declined to abandon Italy. Spartacus led them against Rome, but their hearts seemed to have failed them, for the capital was not attacked. Spartacus then occupied the port of Thurii and tried to procure supplies of iron and bronze, probably through the pirates. He also endeavored by means of the herds of horses captured in southern Italy to form a body of cavalry. The conduct of the war against Spartacus, together with eight legions, was now committed to the prætor Marcus Crassus. He restored discipline by decimating the first troops that ran before the enemy. In the next battle Spartacus was worsted and retreated towards the straits of Messina, intending to cross into Sicily, where he would have been welcomed by fresh hordes of slaves; but the pirates who had agreed to transport his army proved faithless. Crassus endeavored to shut in the rebels by carrying a ditch and rampart right across the peninsula, a distance of 32 miles. But on a wintry night Spartacus forced the lines and once more Italy lay at his feet. Disunion, however, was at work in the rebel camp. The Gauls and Germans had again drawn off from the main body. Crassus attacked and destroyed them. Spartacus was now fain to secure a retreat into the mountains of Petelia (near Strongoli in Calabria), and succeeded in inflicting a reverse on the pursuing army. But his men refused to retreat farther, and in a pitched battle which followed soon afterwards the rebel army was annihilated. Spartacus, who had stabbed his horse before the battle began, fell sword in hand. A body of the rebels which had escaped from the field was met and cut in pieces by Pompey, who, with his usual knack of reaping where other men had sowed, claimed and received the credit of having put an end to the war (71 B.C.). Six thousand slaves, who had not found a soldier's death, were crucified along the high road from Capua to Rome.

A history of the war against Spartacus has to be pieced together with much uncertainty from the vague, scrappy, and somewhat discrepant accounts of Plutarch (*Crassus*, 8–11), Appian (*Bell. Civ.*, i. 116–120), Florus (ii. 8 [iii. 20]), Livy (*Epit.*, xcv., xcvi., xcvii.), and Sallust (fragments of the *Histories*). Sallust's description seems to have been full and graphic, but unfortunately only a few fragments of it remain.

SPECIES. In logic the term "species" is applied to any group of individuals agreeing in some common attribute or attributes, and included along with other groups in a higher category, that of "genus," which comprehends the fewer and more general attributes in which all agree and ignores those in which they differ. The application of these terms in logic is thus purely relative; any genus, however large, may be but a species of a still larger genus. But in arranging the innumerable objects of the natural sciences the naturalist finds it necessary to restrict the terms "species" and "genus" to the two lowest groupings and to distinguish the higher aggregates by special terms, as "family," "order," "class," etc. Early writers had but a loose conception of many different "kinds" of animals and plants, and spoke only of species and genus in their purely logical relations, with varying breadth of content. The term "species" was limited to its natural history usage in the end of the 17th century by John Ray. His conception of "specific characters" rested, not only on close and constant resemblance in outward form, but also on the likeness of offspring to parent, a considerable measure of variability being, however, recognized. Amongst subsequent authors this conception of common descent or parentage became more and more prominent, while the progress of successful definition of species made the limits of their variability seem always narrower and of less importance; and in this way the useful working conception of the tolerable definiteness of species gradually crystallized into the absolute dogma of their fixity. Then Linnæus in his *Philosophia Botanica* gave the aphorism "species tot sunt diversæ, quot diversæ formæ ab initio sunt creatæ" (we reckon just as many species as there were forms created at the beginning), which was generally accepted. Buffon's obstinate rejection of the Linnæan classification was associated with a belief in the modifiability of species, and showed some foresight of the doctrine elaborated soon afterwards by LAMARCK (*q.v.*). The general acceptance of this dogma was, however, effected by the influence of Cuvier; its overthrow dates only from the publication of Darwin's *Origin of Species* (1859), of which the argument need not be here repeated. (See EVOLUTION, MORPHOLOGY.) The genealogical conception of species was thus established more firmly than ever, though cleared from its former associations; in Haeckel's phrase, the species is the whole succession of organisms which exhibit the same form in the same environment. The rash generalization, that distinct species are to be recognized by their incapacity for the production of fertile hybrids, was next overthrown, while closer study has cleared away the notion of the equal definiteness of all specific forms. We now know that, while many forms, like the pearly nautilus or the Venus's fly-trap, do indeed exhibit the most perfect specific definiteness, the demarcation of equally definite species in other genera is rendered impossible by the existence of the most complete series of transitional forms, and the number of the species defined thus comes to depend simply on the personal equation of the systematist, on his predilection for "lumping" or "splitting," as the case may be. Thus, for example, the number of described German species of hawkweed (*Hieracium*) has ranged from 300 for one author, through 106 for another and 52 for a third, to less than 20 for a fourth. Similar instances of variable genera are afforded by the willows and the brambles, and many other common forms. This wide variability, as might be expected, seems to be more prevalent among the lowest forms of life, and the classical example of the relativity and variability of species has been furnished by Haeckel's beautiful monograph on the calcareous sponges (*Monographie der Kalkschwämme*, Jena, 1872), in which he offers twelve distinct arrangements of the same set of forms from various points of view, among which the two most nearly conventional propose respectively 21 genera and 111 species and 39 genera and 289 species. All such variable forms are in fact species in the making, which become definite in proportion as certain varieties become especially adapted to their environment, and become isolated by the dying out of the intermediate forms. With these limitations, however, the working usefulness of the morphological conception of species remains undiminished. The want of any absolute standard of specific difference is largely made up by practical experience and common sense; and the evolutionary systematists are less in danger than were their predecessors of either exaggerating or understating the importance of mere varieties. (See VARIATION.)

SPECIFIC GRAVITY. See HYDROMETER, vol. xii. p. 568 *sq.*

SPECTACLES are flat glasses, prisms, spherical or cylindrical lenses, employed to detect and correct defects of the eyes. They are made usually of crown glass or rock crystal ("pebbles"), the latter being somewhat lighter and cooler to wear. They are mounted in the well-known rigid spectacle frame when for continuous use,—eye-glasses being preferable where they are worn intermittently, and hand-glasses or lorgnettes where they are required to supplement temporarily the spectacles usually worn, or where, as with extreme shortness of sight, no glass could be employed with comfort for any length of time.

Preserves.—Preserves are used to conceal deformities or to protect the eyes in the many conditions where they cannot tolerate bright light, such as ulceration and inflammation of the cornea, certain diseases of the iris, ciliary body, choroid, and retina. They are made of bluish, "smoked," or almost black colored glass, and are of very various shapes, according to the amount of obscuration necessary.

Prisms.—Prisms are of great value in cases of double vision due to a slight tendency to squinting, caused by weakness or over-action of the muscular apparatus of the eyeball. Prisms deflect rays of light towards their bases. Hence, if a prism is placed in front of the eye with its base towards the nose, a ray of light falling upon it will be bent inwards, and seem to come from a point further out from the axis of vision. Conversely, if the base of the prism is turned towards the temple, the ray of light will seem to come from a point nearer the axis, and will induce the eye to turn inwards, to converge towards its fellow. In cases of myopia or short-sight owing to weakness of the internal recti muscles, the eyes in looking at a near object, instead of converging, tend to turn outwards, and so double vision results. If a suitable prism is placed in front of the eyes the double vision may be prevented. These prisms may be combined with concave lenses, which correct the myopia, or, since a concave lens may be considered as composed of two prisms united at their apices, the same effect may be obtained by making the distance between the centres of the concave lenses greater than that between the centres of the pupils. Again, to obviate the necessity for excessive convergence of the eyes so common in hypermetropia, the centre of the pupil should be placed outside the centre of the corrective convex lenses; these will then act as prisms with their bases inwards. Where, on the other hand, there is no tendency to squinting, care must be taken in selecting spectacles that the distances between the centres of the glasses and the centres of the pupils are quite equal, otherwise squinting, or at any rate great fatigue, of the eyes may be induced.

Spherical Lenses.—Biconcave, biconvex, and concavo-convex (meniscus) lenses are employed in ophthalmic practice in the treatment of errors of refraction. Until recently these spherical lenses were numbered in terms of their focal length, the inch being used as the unit. Owing principally to differences in the length of the inch in various countries, this method had great inconveniences, and is now giving place to a universal system, in which the unit is the refractive power of a lens whose focal length is one metre. This unit is called a "dioptric" (usually written "D"). A lens of twice its strength has a refractive power of 2 D, and a focal length of half a metre, and so on.

Concave lenses are used in the treatment of myopia or short-sight. In this condition the eye is elongated from before backwards, so that the retina lies behind the principal focus. All objects, therefore, which lie beyond a certain point (the conjugate focus of the dioptric system of the eye, the far point) are indistinctly seen; rays from them have not the necessary divergence to be focused in the retina, but may obtain it by the interposition of suitable concave lenses. Concave lenses should never be used for work within the far point; but they may be used in all cases to improve distant vision, and in very short-sighted persons to remove the far point so as to enable fine work such as sewing or reading to be done at a convenient distance. The weakest pair of concave lenses with which one can read clearly test types at a distance of 18 feet is the measure of the amount of myopia, and this fully correcting glass may be worn in the slighter forms of short-sight. In higher degrees, where full correction might increase the myopia by inducing a strain of the accommodation, somewhat weaker glasses should be used for near work. In the highest degrees the complete correction may be employed, but lorgnettes are generally preferred, as they can be removed when the eyes become fatigued. It must be remembered that short-sight tends to increase during the early, especially the school, years of life, and that hygienic treatment, good light, good type, and avoidance of stooping are important for its prevention.

Convex Lenses.—In hypermetropia the retina is in front of the principal focus of the eye. Hence in its condition of repose such an eye cannot distinctly see parallel rays from a distance and, still less, divergent rays from a near object. The defect may be overcome more or less completely by the use of the accommodation. In the slighter forms no inconvenience may result; but in higher degrees prolonged work is apt to give rise to aching and watering of the eyes, headache, inability to read or sew for any length of time, and even to double vision and internal strabismus. Such cases should be treated with convex lenses, which should be theoretically of such a strength as to fully correct the hypermetropia. Practically it is found that a certain amount of hypermetropia remains latent, owing to spasm of the accommodation, which relaxes only gradually. At first glasses may be given of such a strength as to relieve the troublesome symptoms; and the strength may be gradually increased till the total hypermetropia is corrected. Young adults with slighter forms of hypermetropia need glasses only for near work; elderly people should have one pair of weak glasses for distant and another stronger pair for near vision. These may be conveniently combined, as in Franklin glasses, where the upper half of the spectacle frame contains a weak lens, and the lower half, through which the eye looks when reading, a stronger one.

Anisometropia.—It is difficult to lay down rules for the treatment of cases where the refraction of the two eyes is unequal. If only one eye is used, its anomaly should be alone corrected; where both are used and nearly of equal strength, correction of each often gives satisfactory results.

Presbyopia.—Where distant vision remains unaltered, but, owing to gradual failure of the accommodative apparatus of the eye, clear vision within 8 inches becomes impossible, convex lenses should be used for reading of such a strength as to enable the eye to see clearly about 8 inches distance. Presbyopia is arbitrarily said to commence at the age of forty, because it is then that the need of spectacles for reading is generally felt; but it appears later in myopia and earlier in hypermetropia. It advances with years, requiring from time to time spectacles of increasing strength.

Cylindrical Lenses.—In astigmatism, owing to differences in the refractive power of the various meridians of the eye, great defect of sight, frequently accompanied by severe headache, occurs. This condition may be cured completely, or greatly improved, by the use of lenses whose surfaces are segments of cylinders. They may be used either alone or in combination with spherical lenses. The correction of astigmatism is in many cases a matter of considerable difficulty, but the results to vision almost always reward the trouble.

Convex spectacles were invented towards the end of the 13th century, perhaps by Roger Bacon. Concave glasses were introduced soon afterwards. Airy, the astronomer, about 1827, corrected his own astigmatism by means of a cylindrical lens. Periscopic glasses were introduced by Dr. W. H. Wollaston. (A. BR.)

SPECTROSCOPY. The spectroscope is an instrument which separates luminous vibrations of different wave-lengths, as far as is necessary for the object in view. It consists of three parts,—the collimator, the prism or grating, and the telescope. The collimator carries the slit through which the light is admitted and a lens which converts the diverging pencil of light into a parallel pencil. The pencils carrying light of different wave-lengths are turned through different angles by the prism or grating, which is therefore the essential portion of the spectroscope. The telescope serves only to give the necessary magnifying power, and is dispensed with in small direct vision spectroscopes. For a description of the different kinds of prism used, see OPTICS; and for an explanation of the action of the grating, see UNDULATORY THEORY. The most important adjustment in the spectroscope is that of the collimator. Especially in instruments of large resolving power it is essential for good definition that the light should enter the prism or fall on the grating as a parallel pencil. For a method allowing an easy and accurate adjustment for each kind of ray, see an article in *Phil. Mag.*, vol. vii. p. 95 (1879).

Prisms are nearly always used in the position of minimum deviation, but, if the collimator is properly adjusted, this is by no means a necessary condition for good definition. Prisms as generally cut, with an isosceles base, give the greatest resolving power in the position of minimum deviation, but the loss in resolving power is not great for a small displacement. The dispersion and magnifying power of a prism can be considerably altered by a change of its position, and a knowledge of this fact is of great value to an experienced observer. The use of a prism in a position different from that of minimum deviation is, however, a luxury which only those acquainted with the laws of optics can indulge in with safety.

Lord Rayleigh has given the theory of the spectroscope under OPTICS, and shown on what its resolving power depends. There is no connection between resolving power and dispersion, any value of resolving power being consistent with any value of dispersion. To obtain large resolving power with small dispersion requires, however, the use of inconveniently large telescopes and prisms or gratings. It is easy, on the other hand, to obtain small resolving power together with large dispersion.

The following definitions would be found of general use if adopted. *Resolving Power.*—The unit resolving power of a spectroscope in any part of the spectrum is that resolving power which allows the separation of two lines differing by the thousandth part of their own wave-length or wave-number,—the wave-number being the number of waves in unit length. *Purity.*—The unit purity of a spectrum is that purity which allows the separation of two lines differing by the thousandth part of their own wave-length or wave-number. We speak of the resolving power of a spectroscope and of the purity of a spectrum. The resolving power is a constant for each spectroscope, and independent of the width of the slit. The purity of a spectrum, on the other hand, depends on the width of the slit, unless that width is small compared to a certain quantity presently to be mentioned. The resolving power of a spectroscope is numerically equal to the greatest purity of spectrum obtainable by it.

Adopting these definitions, we get from Lord Rayleigh's equations for the resolving power R of a grating

$$1000\,R = mn,$$

where n is the total number of lines used on the grating and m the order of the spectrum. For a spectroscope with simple prisms we get

$$1000\,R = -(t_2 - t_1)\frac{\delta\mu}{\delta\lambda},$$

where t_2 and t_1 are the greatest and smallest lengths of paths in the dispersive medium. If we put for the refractive index of the medium $\mu = A + B/\lambda^2$ we may write

$$1000\,R = 2B(t_2 - t_1)/\lambda^3.$$

It will be seen that, while the resolving power of a spectroscope with grating depends only on the order of the spectrum and is independent of the wave-length for each order, the resolving power of a spectroscope with prism will vary inversely as the third power of the wave-length λ, so that the resolving power will be about eight times as great in the violet as in the red (see OPTICS). If compound prisms are used we must write

$$1000\,R = 2B_2t_2 - B_1t_1)/\lambda^3,$$

where t_2 is the greatest effective length of path in one medium, t_1 in the other medium, B_2 and B_1 being the dispersive constants for the two media.

The purity P of a spectrum is given by the equation

$$P = \frac{\lambda}{d\psi + \lambda} R,$$

where d denotes the width of slit and ψ is the angle subtended by the collimator lens at the slit. If the slit is sufficiently narrowed, $d\psi$ may be made small compared to λ, and in that case the purity of the spectrum is independent of the width of slit, and equal to the resolving power. If, on the other hand, a wide slit is used, so that $d\psi$ is large compared to λ, the purity becomes inversely proportional to the width of slit. In actual work the slit is generally of such width that neither term in the denominator of the expression for purity can be neglected.

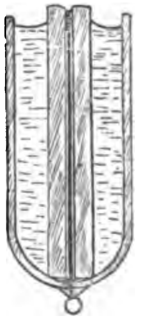
There is a necessary limit to the resolving power of all optical instruments, depending on the fact that light consists of a series of groups of waves incapable of interfering with each other. If it is true, as is generally believed, but without sufficient reason, that a retardation of 50,000 wave-lengths is sufficient to destroy the capability of interference—that is to say, that the groups consist on the average of approximately 50,000 waves—the maximum purity obtainable in any spectroscope is 50. The closest line resolved with a grating, as far as the present writer is aware, requires a resolving power of about 100. Professor Piazzi Smyth has with prisms realized a purity of 50. It would seem, therefore, that the theoretical limit of purity has very nearly been reached, for, though the estimate of 50,000 waves to the group is in all probability too small, there are other considerations which render it highly improbable that the total number of waves to the group should, for sunlight at any rate, be more than two or three times larger. The limit of possible purity will very likely depend on the temperature of the luminous body.

Almost the greatest practical difficulty which the spectroscopist has to contend with generally is the want of sufficient light. The following remarks apply to line spectra principally, but they hold also almost entirely for the spectra of fluted bands, which break up into lines under high resolving power. The maximum illumination for any line is obtained when the angular width of the slit is equal to the angle subtended by one wave-length at a distance equal to the collimator aperture. In that case, $d\psi = \lambda$, and the purity is half the resolving power. Hence, when light is a consideration, we shall not, as a rule, realize more than half the resolving power of the spectroscope. If the visual impression depended only on the intensity of illumination, a further widening of the slit should not increase the visibility of a line. As a matter of fact, spectroscopists generally work with slits wider than that which theoretically gives full illumination. The explanation of the fact is physiological, visibility depending on the apparent width of the object. If different spectroscopes have their slits of such width that the apparent width of a line as seen by the eye is the same, and if the magnifying power is such that the pupil is just filled with light, the purity of the spectrum is directly proportional to the resolving power. We come to the conclusion, therefore, that for both narrow and wide slits the efficiency of a spectroscope depends exclusively on its resolving power. It has been pointed out by Lord Rayleigh that, owing to the want of definition in the optical images on the retina when the full aperture of the pupil is used, the pencil must be contracted to a third or a quarter of its natural width, if full resolving power is to be obtained. This is accompanied with a serious loss of light, which can be partly obviated by contracting the horizontal aperture only (the refracting edge being supposed vertical). There are two ways of doing this. One consists in the use of magnifying half prisms. But the loss of light by reflection in simple half prisms more than counterbalances the advantage; compound half prisms like those used by Christie may, however, be employed. We may also use prisms of three or four times the height of the effective horizontal aperture, with correspondingly large telescopes, and then by the eye-piece contract the beam until its vertical section fills the pupil. The latter plan, though theoretically best, involves more expensive apparatus, and prisms of very homogeneous material.

The question of illumination is important also when photography is used for spectroscopic analysis. For a given intensity of the source of light the intensity of the image on the sensitive film will be directly proportional to the solid angle of the cone of light forming the last image, and will be independent of the arrangement of intermediate lenses. Hence, lenses with as short a focus compared to aperture as is consistent with good definition should be used in the camera.

The methods of recording and reducing spectroscopic observations are described in all books and treatises on the subject, and may therefore be passed over here.

A lens is often used to concentrate the light of the source on the slit. There is some loss of light due to reflection from the surface of the lens, but its position, aperture, and focal length do not affect the luminosity of the spectrum seen as long as the whole collimator is filled with light.



Bodies are rendered luminous for spectroscopic investigation either by being placed in the Bunsen flame or by the help of the electric current. A little difficulty may arise where the body is given in solution, and does not show its characteristic lines in the flame. Lecoq de Boisbaudran takes the spark from the surface of the solution. The present writer has found the tube sketched in the accompanying figure a great improvement on those commonly used, if a sufficient quantity of the solution is at hand; otherwise, the method is too wasteful. The current is brought into the solution by a platinum wire, sealed into a small glass tube; the platinum wire reaches about to the level of the open end of the tube. A capillary of thick-walled glass tubing is placed over the platinum wire; the liquid rises in the capillary and sparks can be taken as from a solid. The lines due to the glass are easily eliminated. If a small quantity of material only is available, the plan adopted by Bunsen and extensively used by Hartley[1] seems the most successful. Pointed pieces of charcoal (Bunsen) or pieces of graphite pointed to a knife-edge (Hartley) are impregnated with the liquid, and the spark is taken from them. Some substances, when introduced into a vacuum tube, especially near the negative pole, and under great exhaustion, show a characteristic phosphorescence. Becquerel was the first to examine the spectra shown under these circumstances, and Crookes has lately used the same method with great success.

Spectra of Metalloids.

A good deal of discussion has taken place on the spectra of the metalloids, owing to the fact that they seem to be able to give different spectra under different circumstances. Spectra have occasionally been assigned to the elements which on further investigation were found to belong to some compound present. According to the general opinion of spectroscopists at present, different spectra of the same elements are always due to different allotropic conditions. If a complex molecule breaks up into simpler molecules the breaking up is always accompanied by a change of spectrum.

Nitrogen.—(*a*) The line spectrum appears whenever a strong spark (jar discharge) is taken in nitrogen gas. It is always present when metallic spectra are examined by the ordinary method of allowing the jar discharge to pass between metallic poles.[2] Hartley (*Phil. Trans.*, 1884, part i.) has measured the ultra-violet lines of the air spectrum, but has not separated the oxygen from the nitrogen lines. (*b*) The band spectrum of the positive discharge, which is generally called the band spectrum of nitrogen, always appears when the discharge is sufficiently reduced in intensity. The spectrum consists of two sets of bands of different appearance, one in the less refrangible part and one in the more refrangible part of the spectrum,—the two sets of bands overlapping in the green. Hence some observers believe the spectrum to be made up of two distinct spectra. Plücker and Hittorf (*Phil. Trans.*, 1865) give a colored drawing of this spectrum, which is one of the most beautiful that can be observed. The most complete drawing of it is given by Piazzi Smyth (*Trans. Roy. Soc. Edin.*, vol. xxxii. part iii.), and there is also a good drawing by Hasselberg (*Mém. Acad. Imp. de St. Pétersb.*, vol. xxxii.). (*c*) The glow which surrounds the negative electrode in an exhausted tube shows in many cases a spectrum which, as a rule, is not seen in any other part of the tube. The memoir of Hasselberg contains a drawing of it. The spectrum seen when a weak spark is taken in a current of ammonia is neither that of nitrogen nor that of hydrogen, but must be due to a compound of these gases. When the pressure of the gas is reduced, a single band is seen having a wave-length from 5686 to 5627 *X*th metres (*Nature*, vi. p. 359). When a spark is taken from a liquid solution of ammonia a more complicated spectrum appears (Lecoq de Boisbaudran), and, if ammonia and hydrogen are burnt together either in air or oxygen, a complicated spectrum is obtained the chemical origin of which has not been satisfactorily explained. Drawings of it are given by Dibbits (*Pogg. Ann.*, cxxii. p. 518) and by Hofmann (*Pogg. Ann.*, cxlvii. p. 95). The absorption spectrum of the red fumes of nitrogen tetroxide has often been mapped; the most perfect drawing is given by Dr. B. Hasselberg (*Mém Acad. Imp. de St. Pét*, xxvi.). According to Moser (*Pogg. Ann.*, clx. p. 177), three bands close to the solar line C disappear when the vapor is heated. Recently Deslandes has obtained in vacuum tubes some ultra-violet bands which seem to be due to a compound of nitrogen and oxygen (*C. R.*, chap. i. p. 1256. 1885).

Oxygen.—(*a*) The elementary line spectrum of oxygen is that which appears at the highest temperature to which we can subject oxygen, that is, whenever the jar and air break are introduced into the electric circuit. It consists of a great number of lines, especially in the more refrangible part of the spectrum. (*b*) The compound line spectrum of oxygen appears at lower temperatures than the first. It consists, according to Piazzi Smyth, of six triplets and a number of single lines. This spectrum corresponds to the band spectrum of nitrogen. (*c*) The continuous spectrum of oxygen appears at the lowest temperature at which oxygen is luminous. The wide part of a Plücker tube, for instance, filled with pure oxygen generally shines with a faint yellow light, which gives a continuous spectrum. Even at atmospheric pressure this spectrum can be obtained by putting the contact breaker of the induction coil out of adjustment, so that the spark is weakened. (*d*) The spectrum of the negative glow was first accurately described by Wüllner, and is always seen in the glow surrounding the negative electrode in oxygen. It consists of five bands, three in the red and two in the green. For further information respecting these spectra, see Schuster (*Phil. Trans.*, clxx. p. 37, 1879) and Piazzi Smyth (*Trans. Roy. Soc. Edin.*, vol. xxxii. part iii.). According to Egoroff, the A and B lines of the solar spectrum are due to absorption by oxygen in our atmosphere, and some recent observations of Janssen seem to support this view.

Carbon.—(*a*) The line spectrum appears when a very strong spark is sent through carbonic oxide or carbonic acid. The ultra-violet lines observed by Hartley when sparks are taken from graphite electrodes also belong probably to this spectrum. (*b*) Considerable discussion has taken place as to the origin of the spectrum seen at the base of a candle or a gas flame. At first observations seemed to point to the fact that it was due to a hydrocarbon. It has been ascertained, however, that sparks taken in cyanogen gas, even when dried with all care, show the spectrum, and a flame of cyanogen and oxygen gives the same bands brilliantly. These facts have convinced the majority of observers that the spectrum is a true carbon spectrum. The best drawing is given by Piazzi Smyth, who ascribes the spectrum, however, to a hydrocarbon. The flame of cyanogen, which had already been examined by Faraday and Draper before the days of spectrum analysis, shows a series of bands in the red, reaching into the green. There is no doubt that they are due to a compound of nitrogen and oxygen. Another series of bands in the blue, violet, and ultra-violet have been also proved by Liveing and Dewar to be due to a compound of nitrogen and carbon. If the discharge is passed at low pressure through carbonic acid or carbonic oxide a spectrum is seen which seems to belong to carbonic oxide. A very beautiful and remarkable drawing of this spectrum, especially of its most brilliant band, has been published by Piazzi Smyth.

Very little need be said of the remaining metalloids, as we do not possess a sufficiently careful examination of their spectra. Chlorine, bromine, and iodine show bands of absorption. If a spark is passed through the gases line spectra appear. Sulphur volatilized in a vacuum tube may show either a line or a band spectrum under the influence of the electric discharge. The absorption through the vapor of sulphur is continuous at first on volatilization, but as the vapor is heated to 1000° the continuous spectrum gives way to a band spectrum. A spark through the vapor of phosphorus gives a line spectrum. We may obtain the spectra of fluorine, silicon, and boron by comparing the spectra given by sparks taken in atmospheres of fluoride of boron and fluoride of silicon.

Spectra of Metals and their Compounds.

Hydrogen.—If sparks are taken through hydrogen, four well-known lines appear in the visible region of the spectrum. The remarkable series of ultra-violet lines photographed by Dr. Huggins in the spectra of some stars which in their visible part show hydrogen chiefly has suggested the question whether the whole series is not due to that gas. This has now been proven to be the case by Cornu, who has recently examined the hydrogen spectrum with great care. In vacuum tubes filled with hydrogen a complicated spectrum often appears which is so persistent that nearly all observers have ascribed it to hydrogen (though Salet had given reasons against that conclusion). According to Cornu, the purer the gas the feebler does this spectrum become, so that the above-mentioned line spectrum seems to be the only true hydrogen spectrum. A flame of hydrogen in air or oxygen shows a number of lines in the ultra-violet belonging apparently to an oxide of hydrogen (Liveing and Dewar, Huggins). Aqueous vapor gives an absorption spectrum principally in the yellow.

Alkali Metals.—The metals of the alkali group are distinguished by the fact that their salts give the true metal spectra when rendered luminous in the Bunsen burner; that is to say, their salts are decomposed and the radiation of their metallic base is sufficiently powerful to be visible at the temperature of the flame. Their spectra are not so easily seen if sparks are taken from the liquid solution, but Lecoq de Boisbaudran has obtained fine spectra of sodium and potassium by taking the spark from a semi-fluid bead of the sulphates. The most complete description of the spectra of sodium and potassium seen when the metals are heated up in the voltaic arc is given by Liveing and Dewar (*Proc. Roy. Soc.*, xxix. p. 378, 1879), who have also mapped their ultra-violet lines (*Phil. Trans.*, 1883, pt. i.). Abney has found a pair of infra-red lines belonging to sodium, with wave-lengths 8187 and 8199 (*Proc. Roy. Soc.*, xxxii. p. 443, 1881). Becquerel finds lines in the infra-red at 11,420. The vapor of sodium and potassium heated up in a tube is colored and shows a spectrum of fluted band; but in the case of sodium the yellow line is always present at the same time. It is probable that the band spectrum belongs to the vapor, containing two atoms in each molecule, and that at higher temperatures the molecules are split up, the single atoms showing the line spectra. Both potassium and sodium show an additional absorption line (5510 for Na and 5730 for Ka) at the temperature at which the fluted bands appear. According to a suggestion of Liveing and Dewar, these lines may depend on the presence of hydrogen, which it is very difficult to exclude. These experimenters have also described interesting but complicated absorption phenomena depending on the simultaneous presence of two or more metals. Thus sodium and magnesium show a band in the green ($\lambda = 5300$), which does not appear when sodium alone or magnesium alone is volatilized. Potassium and magnesium show similarly two lines in the red (*Proc. Roy. Soc.*, xxvii. p. 350, 1878). If a spark is taken from potassium in an atmosphere of carbonic oxide a band appears (5700) depending probably on a combination between the potassium and the carbonic oxide. Lockyer has observed certain curious phenomena (*Proc. Roy. Soc.*, xxii. p. 378) taking place at the temperature at which the band spectrum of sodium changes into the line spectrum; these phenomena deserve a fuller investigation. Lithium furnishes a good example of a change in the relative intensity of lines at different temperatures. At the temperature of the flame the red line is the most powerful, an orange line being also seen. When a spark is taken from a liquid solution the orange line is far the strongest, and a blue line is seen, which in its turn rapidly gains in intensity as the temperature is raised. When the spark is taken from solutions of different strengths the more concentrated solution shows a change in relative intensity of lines in the direction in which an increase of temperature would act. Combination of the metals with transparent acids does not when in solution show any appreciable absorption in the visible part of the spectrum; but Soret has mapped their ultra-violet absorption.

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[1] *Phil. Trans.*, clxxv. p. 49 (1884).

[2] We may refer once for all to Watts, *Index of Spectra*, for a list of wave-lengths of the different spectra.

Metals of Alkaline Earths.—Calcium, strontium, and barium are distinguished by the fact that their volatile compounds give fine spectra in the Bunsen flame. The more stable salts, as the phosphates and silicates, give the reaction only feebly or not at all. When a salt like the chloride of barium is introduced into the flame the spectrum is seen to change gradually; the spectrum seen at first is different according as the chloride, bromide, or iodide is used, while the spectrum which finally establishes itself is the same for the different salts of the same metal. Mitscherlich, who was the first to investigate carefully these phenomena (*Pogg. Ann.*, cxxi. p. 459, 1864), ascribes the spectra seen at first to the compound placed in the flame, while gradually the oxide spectrum gets the upper hand. This explanation has always been accepted, and receives support from the fact that the bromide spectrum is strengthened by introducing bromine vapor into the flame, and the other compound spectra can be similarly strengthened by introducing suitable vapors. There is an observation, however, made by Professors Liveing and Dewar which in one case is not compatible with Mitscherlich's explanation. "A mixture of barium carbonate, aluminium filings, and lamp-black heated in a porcelain tube gave two absorption lines in the green, corresponding in position to bright lines seen when sparks are taken from a solution of barium chloride, at wave-lengths 5242 and 5136 marked α and β by Lecoq de Boisbaudran." These two lines, or rather bands, are the brightest in the spectrum commonly ascribed to barium chloride. In addition to the compound spectra the brightest of the metallic lines seen at a low temperature appear in the flame. The metallic line is in the violet with calcium, in the blue with strontium, and in the green with barium. Sparks taken from a solution of the metallic salts show the compound spectra well, and in addition more of the true metallic lines than the flame. The best drawings of the compound spectra are those given in Lecoq de Boisbaudran's *Atlas;* but measurements with higher resolving powers are much wanted. When the salts are introduced into the voltaic arc numerous metallic lines appear which have been mapped by Thalén. Liveing and Dewar have investigated those lines which can be reversed and have also mapped the ultra-violet spectra. Captain Abney has mapped a pair of infra-red lines belonging to calcium between 8500 and 8600, and, according to Becquerel, with the help of a phosphorescent screen bands or lines appear of still lower refrangibility (8830 to 8880). Lockyer (*Phil. Trans.*, clxiii. p. 253, 1873, and clxiv. p. 805, 1874) has measured and mapped as regards their length the lines of these as well as of many of the other metals.

Metals of Magnesium Group.—Beryllium presents comparatively simple spectroscopic phenomena, as far as it has hitherto been investigated. Two green lines were mapped by Thalén and five in the ultra-violet by Hartley (*Jour. Chem. Soc.*, June, 1883). The spectrum of magnesium is well known from its green triplet; but the vibrations of the metal seem very sensitive to a change of conditions. Full details are given by Liveing and Dewar in *Proc. Roy. Soc.*, xxxii. p. 189. These authors have found that some of the bands seen occasionally, when magnesium wire is burned in air, are due to a compound of magnesium and hydrogen. The spectrum appears when sparks are taken from magnesium poles in an atmosphere containing hydrogen. For a description of the peculiarities of the flame, arc, and spark spectrum, the reader is referred to the original paper. The ultra-violet spectrum, which contains several repetitions of the green triplet, has also been mapped and measured by Hartley and Adeney (*Phil. Trans.*, clxxv., 1874, pt. i.). The spectra of zinc and cadmium are obtained either by sparks from liquid solution or by the spark, with Leyden jar, from the metal poles. The ultra-violet spectra show for both elements a remarkable series of triplets, the lines of the cadmium triplet being about three times as far apart as those of the zinc triplets. The least refrangible of the series is in the blue with wave-lengths 5085.1, 4799.1, 4677.0 for cadmium, and 4809.7, 4721.4, 4679.5 for zinc.

Lead Group.—The spectrum of lead is best obtained by taking the spark from the metallic poles. Care must be taken, however, to renew the surface frequently, otherwise the oxide spectrum will gradually make its appearance. The oxide itself shows its spectrum, according to Lecoq de Boisbaudran, in the Bunsen burner. The salts of thallium show the principal metal line at the temperature of the flame. The spark spectrum is more complicated. The ultra-violet spectra of both lead and thallium have been mapped.

Copper Group.—The spectra of the metals belonging to this group are easily obtained in the ordinary way. When copper chloride is introduced into the Bunsen flame a fine spectrum of bands is seen. It is the same spectrum which is found when common salt is thrown upon white hot coals. This reaction for copper chloride is very sensitive, but it has never been satisfactorily decided whether the presence of copper is really necessary for its production or whether the spectrum belongs to a peculiar condition of chlorine vapor. Silver when first volatilized gives a green vapor, which at a low temperature shows continuous absorption, but at a higher temperature a spectrum of fluted bands (Lockyer). Mercury shows its lines with great brilliancy if introduced and heated in a vacuum tube. Some of the lines widen easily, and at higher pressures a continuous spectrum completely covers the background. The copper salts in aqueous solution absorb principally the red end of the spectrum, the green salts also the violet end. The glass, colored green with oxide of copper, transmits through sufficient thickness exclusively the yellow and green rays between D and E (H. W. Vogel).

Cerium Group.—*Yttrium* gives a good spark spectrum from the solution of the chloride; the salts show no absorption bands. Crookes has found, however, that a certain substance yields brilliant phosphorescent bands under the influence of the negative pole in a vacuum tube. These bands he has, after a lengthy investigation put down to yttrium compounds, and explained the changes they undergo in different compounds and the sensitiveness of the reaction. Lecoq de Boisbaudran, who obtains the same spectrum by taking a spark (without Leyden jar) from solutions, making the solution the positive pole, has expressed an opinion that the bands are not due to yttrium but to two substances provisionally called by him *Zα* and *Zβ*. He has also under certain conditions seen a higher temperature spectrum, which he ascribes to *Zγ*, leaving it undecided whether *Zγ* is a new substance or identical with *Zα* (*Phil. Trans.*, 1883, p. 891, and *C. R.*, ci. p. 552, cii. p. 153).—*Lanthanum* is easily recognized by a strong spark spectrum.—*Cerium*, like yttrium and lanthanum, has no peculiar absorption spectrum when in combination and solution; although the salts are strongly colored yellow, its line spectrum has characteristic lines in the blue.—*Didymium* is characterized spectroscopically by the fine absorption spectra of its salts. Different salts show slightly different spectra, but they can be recognized at first sight as didymium spectra. The crystals of didymium salts show remarkable differences in the absorption spectra according to the direction in which the ray traverses the crystal. Light reflected from the powdered salts shows the characteristic spectrum. According to Auer von Welsbach (*Monatsschr. f. Chemie*, vi. p. 477), didymium has lived up to its name δίδυμοι, "twins," for by fractional crystallization he has found it to be an intimate mixture of two substances, each of them giving half the absorption spectrum and half the emission spectrum of didymium.—*Terbium* has a characteristic line spectrum when the spark is taken from a solution of the salts.—The salts of *erbium* give a characteristic absorption spectrum, but till recently the drawings of it contained also absorption bands due to thulium and holmium. The spectrum of erbium, as previously mapped by Thalén, belongs almost exclusively to ytterbium; but he has recently mapped the lines belonging to what is now known as erbium (*C.R.*, xci. p. 326). Erbium salts heated in the Bunsen burner show a spectrum of bright bands without apparent volatilization.—*Ytterbium*, discovered by Marignac (atomic weight 17.3, Nilson), gives an absorption band in the ultra-violet. Its luminous spectrum is rich in lines (Thalén, *C.R.*, xci. p. 326).—*Samarium*, also discovered by Marignac and called by him originally Yβ, gives absorption bands in the visible part and in the ultra-violet (Soret, *C.R.*, xc. p. 212). It frequently occurs with didymium, and most of the maps of the didymium spectrum contain the samarium bands. When precipitated with another metal it shows a brilliant phosphorescent spectrum (Crookes), which, however, is slightly different according to the metal. The peculiar yttrium spectrum is very weak even when it is mixed in considerable quantities with samarium. But when the quantity of yttrium is increased to about 60 per cent. a very rapid change takes place, and afterwards it is the samarium spectrum which is very weak. A band in the orange peculiar to the mixture, weak in pure samarium and absent in yttrium, is strongest in a mixture containing about 80 per cent. of samarium and 20 per cent of yttrium.—*Holmium*, identified as a separate element by Soret (*C. R.*, xci. p. 378), has absorption bands in the visible part of the spectrum (6405, 5363, 4855 on Lecoq's map of chloride of erbium), and also a strongly marked ultra-violet absorption spectrum.—*Thulium*, likewise first recognized by Soret, is band 6840 on Lecoq's drawing of chloride of erbium, and also possesses a band at 4645. Thalén has measured the bright line spectrum (*C. R.*, xci. p. 376, 1880).—*Scandium* is characterized by a bright line spectrum (Thalén, *C.R.*, xci. p. 48, 1880).—*Gadolinium* (Marignac's Yα) has a weak absorption spectrum in the ultra-violet and a characteristic phosphorescent spectrum (*Proc. Roy. Soc.*, February, 1886); but the latest researches of Crookes have rendered it probable that it is a mixture of several new elements (*Proc. Roy. Soc.*, 10th June, 1886).—The *mosandrium* of Lawrence Smith seems a mixture of gadolinium and terbium. The *philippium* of De la Fontaine was a mixture of yttrium and terbium; and the latest *decipium* of the same chemist is probably holmium.

Aluminium Group.—The spectra of the metals belonging to this group can be obtained in the ordinary way by means of the electric spark. The chloride of indium shows the two strongest metallic lines, one in the indigo and one in the violet, when introduced into the Bunsen flame. According to Claydon and Heycock, a number of other lines appear when the spark is taken from the metal electrodes. When a weak spark is taken from aluminium electrodes in air a band spectrum is often seen belonging apparently to the oxide, for it disappears when the spark is taken in hydrogen. Gallium, another metal belonging to this group, was first discovered by means of its spectroscopic reaction. The chloride shows two violet lines feebly in the Bunsen flame, but strongly if a spark is taken from the liquid solution. The ultra-violet lines of indium and of aluminium have been photographed by Hartley and Adeney, as well as by Liveing and Dewar. Some of the lines had been previously mapped by Cornu, whose researches extend furthest into the ultra-violet. According to Stokes, aluminium shows lines more refrangible than those of any other metal, and the wave-lengths of their lines as measured by Cornu are for one double line 1934, 1929, and for another 1860, 1852.

Metals of the Iron Group.—The spectroscopic phenomena of this group are somewhat complicated. The line spectra can be obtained either by taking sparks from the metal or from the solution of a salt, and also by placing the metal in the voltaic arc. The lines are very numerous and very liable to alter in relative intensity under different circumstances. The great difference shown, for instance, between the arc and spark spectra of iron in the ultra-violet region is shown in the map by Liveing and Dewar in *Phil. Trans.*, 1885, pt. i. The visible part has also been investigated by the same authors and by Lockyer, and much information has thus been added to the knowledge previously obtained by Kirchhoff, Ångström, and Thalén. That part of the iron spectrum lying between a wave-length of 4071 and 2947 has been mapped by Cornu; Liveing and Dewar's observations refer chiefly to the more refrangible region. Considering the very important part which the iron spectrum plays in solar observations, a full investigation of its changes by a variation of temperature would at the present time be of great value. If observations with the method adopted by Lecoq de Boisbaudran were repeated with higher resolving powers they would add much to our knowledge. Some of the manganese salts, such as the chloride or carbonate, seem to be the only salts belonging to this group which show a characteristic spectrum when heated in the Bunsen burner or the oxyhydrogen flame. The spectrum observed in these cases is, according to Watts, the characteristic spectrum of the Bessemer flame, which disappears at the right moment for stopping the blast; it is probably due to an oxide of manganese. When a spark spectrum is taken from a solution of the chloride the same spectrum is seen, but the relative intensity of the lines depends on the length and the strength of the spark. The green-colored manganates show a continuous absorption at the two ends of the spectrum, transmitting in concentrated solutions almost exclusively the green part of the spectrum. The absorption bands of permanganate of potassium are well known and seem to be due to the permanganic acid, as they appear also with other permanganates. The green salts of nickel show a continuous absorption at the two ends of the spectrum. The cobalt salts show well-defined absorption bands. Their careful investigation by Dr. W. J. Russell deserves special notice (*Proc. Roy. Soc.*, xxxii. p. 258, 1881).

Metals of Chromium Group.—The metallic spectra of this group have been measured principally by Thalén in the usual way. Lockyer and Roberts have obtained a channelled spectrum of chromium by absorption. As regards the spectra of compounds of chromium, the absorption of the vapor of chloro-chromic anhydride has been measured by Emerson and Reynolds (*Phil. Mag.*, xlii. p. 41, 1871), and consists of a series of regularly distributed bands. The chromium salts all possess a decided color and show interesting absorption phenomena. The chromates absorb the violet and blue completely, also the extreme red, and transmit only the orange, yellow, and in dilute solutions part of the green. The most complete investigation of the salts in which chromium plays the part of a base is due to Erhard in a dissertation published at Freiburg. Potassium chrom-alum, ammonia chrom-alum, sulphate of chromium, when in solution, give an identical absorption for the same amount of chromium. The extreme red is freely transmitted by the violet solution, but the absorption grows rapidly towards the yellow. An indistinct absorption band ($\lambda = 6790$ to $\lambda = 6740$) is seen when the layer is thick or the solution concentrated. The strongest absorption takes place for a wave-length of 5800. The green is transmitted again more freely, the minimum absorption taking place for a wave-length 4880; the absorption then grows rapidly towards the violet. When the solutions are heated the color changes to green, the absorption is increased throughout the spectrum, except in the green, where it remains nearly unchanged, and the minimum of absorption shifts to a wave-length of 5090. The solution, which remains green on cooling, has, when compared with its original state, an increased absorption in the red and blue and a slightly diminished absorption in the green. When light is sent through plates cut out of crystals of potassium chrom-alum, or ammonia chrom-alum, three absorption bands (6860, 6700, 6620) are seen in the red. The green and blue show the same absorption as the solution. The chloride in solution gives the same absorption as the chrom-alums,—transmitting, however, slightly more light for the same quantity of chromium. The hot solution also shows the same changes, but with this difference that color and absorption phenomena are almost entirely recovered on cooling. The nitrate (solution of chromic hydroxide in nitric acid) agrees with chrom-alum, but transmits more light. Red crystals of potassic chromic oxalate only transmit the red with an absorption band slightly less refrangible than B ($\lambda = 6867$). The blue salt has the absorption band at a wave-length of 7040 and transmits part of the light in the green and blue. The solutions of the salts show the same absorption as the crystals, with the position of the absorption band apparently unchanged. The warm solutions absorb more than the cold ones. The oxalate of chromium gives an absorption band of 6910 to 6860 and transmits the green and blue more freely than the double salt. The tartrate only shows the absorption band in the red very weakly and absorbs more red than the previously mentioned solutions. The acetate transmits more yellow than the other salts and has some broad absorption bands near a wave-length of 7170. When the solution is heated it becomes green, absorbing the red more than when cold, but leaving the green and blue absorption unchanged. The absorption phenomena shown by uranium salts are more complicated than those of the chromium salts, but they are at the same time more characteristic, as the spectra are more definitely broken up into bands. According to Vogel, the uranic and uranous salts behave differently (*Praktische Spectral-Analyse*, p. 247), but a more careful investigation is desirable. Sorby finds that a mixture of zirconium and uranium dissolved in a borax bead shows characteristic bands, which are visible neither with uranium nor with zirconium alone.

There is little to be said as regards the remaining groups of metals (tin, antimony, gold). Their spectra are best obtained by taking the spark from metallic electrodes or by volatilization in the voltaic arc.

Influence of Temperature and Pressure on Spectra of Gases.

If the spectrum of an element is examined under different conditions of temperature or pressure, it is often found to differ considerably. The change may be small—that is to say, the lines or bands may only show a different distribution of relative intensity—or it may be so large that no relationship at all can be discovered between the spectra. It has been pointed out by Kirchhoff that a change in the thickness of the luminous layer may produce a change in the appearance of the spectrum, and Zöllner and Wüllner have endeavored to explain in this way a number of important variations of spectra. But their explanation does not stand the test of close examination. The thickness of layer cannot be neglected in the discussion of solar and stellar spectra, or in the comparison of absorption spectra of liquids; but none of the phenomena which we shall notice here are affected by it.

Widening of Lines.—The lines of a spectrum are found to widen under certain conditions, and, although probably all spectra are subject to this change, some are much more affected by it than others. The lines of hydrogen and sodium, for instance, widen so easily that it is sometimes difficult to obtain them quite sharp. When a system of lines widens it is generally found that the most refrangible lines widen most easily. A line may expand equally towards both sides or chiefly towards one side; in the latter case the expansion towards the less refrangible side preponderates pretty nearly in every case. It is the almost unanimous opinion of spectroscopists that the widening is produced by an increase of pressure. If sparks are passed through gases, the lines are always broader at high than at low pressures, and the metallic lines are also broader when a spark is taken from them at higher pressure. Without altering the pressure, we may often produce a widening of lines by an increase in the intensity of the discharge, but here the pressure is indirectly increased by the rise of temperature. According to the molecular theory of gases, the following explanation might be given for the widening of lines. As long as a molecule vibrates by itself uninfluenced by any other molecule, its vibrations will take place in regular periods. The lines of its spectrum will consequently be sharp. But, if the molecule is placed in proximity with others, its vibrations will be disturbed by occasional encounters. During each encounter forces may be supposed to act between the molecules, and these forces will affect the regularity of the vibration. The question arises, whether for a given temperature and pressure a line may be of different width according as the molecule is placed in an atmosphere of similar or dissimilar molecules. Such a difference exists in all probability. If gases are mixed in different proportions, the lines are sharper when an element is present in small quantities, although the total pressure may be the same. There is one cause which limits the sharpness of the spectroscopic lines: the molecules of a gas have a translatory motion. Those molecules which are moving towards us will send us light which is slightly more refrangible than those which move away from us; hence each line ought to appear as a band. In reality the width of lines generally is greater than that due to this cause.

Spectra of Different Orders.—Spectra may be classified according to their general appearance. The different classes have been called orders by Plücker and Hittorf. At the highest temperature we always obtain spectra of lines which need no further description. At a lower temperature we often get spectra of channelled spaces or fluted bands. When seen in spectroscopes of small resolving power these seem made of bands which have a sharp boundary on one side and gradually fade away on the other. With the help of more perfect instruments it is found that each band is made up of a number of lines which lie closer and closer together as the sharp edge is approached. Occasionally the bands do not present a sharp edge at all, but are made up of a number of lines of equal intensity at nearly equal distances from each other. Continuous spectra, which need not necessarily extend through the whole range of the spectrum, form a third order, and appear generally at a lower temperature than either band or line spectrum. One and the same element may at different temperatures possess spectra of different orders. A discussion has naturally arisen as to the cause of these remarkable changes of spectra, and it is generally believed that they are due to differences of molecular structure. Thus sulphur vapor when volatilized shows by absorption a continuous spectrum until its temperature is raised to 1000°, when the continuous spectrum gives way to a spectrum of bands. We know that the molecule of sulphur is decomposed as the temperature is raised, and we are thus justified in saying that the band spectrum belongs to the molecule containing two atoms, while the continuous spectrum belongs to the more complex molecule which first appears on volatilization. When a strong electric spark is passed through the vapor of sulphur a bright line spectrum is seen, and this is believed to be due to a further splitting up of the molecule into single atoms.

Long and Short Lines.—If the spectrum of a metal is taken by passing the spark between two poles in air the pressure of which is made to vary, the relative intensity of some of the lines is often seen to change. Similar variations take place if the intensity of the discharge is altered, as, for instance, by interposing or taking out a Leyden jar. It is a matter of importance to be able to use a method which in the great majority of cases will give at once a sure indication how each line will behave under different circumstances. This method we now proceed to describe. It has often been remarked, even by the earliest observers, that the metallic lines when seen in a spectroscope do not always stretch across the field of view, but are sometimes confined to the neighborhood of the metallic poles. Some observations which Lockyer made jointly with Professor Frankland led him to conclude that the distance which each metallic line stretched away from the pole could give some clue to the behavior of that line in the sun. In 1872 Lockyer worked out his idea. An image of the spark was formed on the slit of the spectroscope, so that the spectrum of each section of the spark could be examined. Some of the metallic lines were then seen to be confined altogether to the neighborhood of the poles, while others stretched nearly across the whole field. The relative length of all the lines was estimated. Tables and maps are added to the memoir.[1] The longest lines (that is, those which stretch away farthest from the pole) are by no means always the strongest; and there are many instances where a faint line is seen to stretch nearly across the whole field of view, while a strong line may be confined to the neighborhood of the pole, or is reduced sometimes to a brilliant point only. We give a few conspicuous examples of lines which are long and weak or short and strong. In lithium the blue line (4602.7) is brilliant but short. In lead 4062.5, one of the longest lines, is faint and according to Lockyer difficult to observe. In tin 5630.0 is the longest line, but it is faint, while the stronger lines near it (5588.5 and 5562.5) are shorter. The zinc lines 4923.8, 4911.2, 4809.7, 4721.4, 4679.5 are given by Thalén as of equal intensity, but the three most refrangible ones are longer. On reduction of pressure Lockyer found that some of the shorter lines rapidly decreased in length, while the longer lines remained visible and were sometimes hardly affected. When the spark was taken from a metallic salt instead of from the metal the short lines could not be seen, but only the long lines remained. An alloy behaves in the same manner as a compound, and by gradually reducing one constituent of an alloy we may gradually reduce the number of lines, which disappear in the inverse order of their length. Subsequent work has shown that the longest lines are also generally those which are most persistent on reduction of temperature, so that in the voltaic arc the longest lines seen in the spark are absent. In order to explain these facts it seems necessary in the first place to assume that the short lines are lines coming out at a high temperature only; but this explanation is not sufficient. Why should a mixture of different elements only show the longest lines of that constituent which is present in small quantities? In the case of chemical combinations we might assume that, the spark having to do the work of decomposition, the temperature of the metal is lowered, and that therefore the short lines are absent. But this cannot be if a chemical compound is replaced by a mechanical mixture. All these facts would be explained, however, if we assume that the spectrum of a molecule that is excited by molecules of another kind consists of those lines chiefly which a molecule of the same kind is already capable of bringing out at a lower temperature. It would follow from this that the effects of dilution are the same as those of a reduction of temperature,—which is the case.

Other Changes in Relative Intensity of Lines.—Besides the changes we have noticed, there are others which have not been brought under any rule as yet. Lines appear sometimes at a low temperature which behave differently from the proper low-temperature lines. These require further investigation. They may, in some cases at least, be due to some compound of the metal with other elements present. We give some examples: If a spark is taken from lead without the condenser the line 5005 appears, and Huggins has found it to be sensibly coincident with the chief line of the nebulæ. It is given as a strong line by Lecoq de Boisbaudran, who used feeble sparks, and in many cases it seems to behave as a low-temperature line; it ought to be a long line therefore, but it is in reality short. In line 6100 of tin, Salet noticed that when a hydrogen flame contains a compound of tin an orange line appears, which is apparently coincident with the orange line of lithium. This line does not figure on any of the maps of the tin spectrum. Lockyer found that zinc, volatilized in an iron tube, showed by absorption a green line. It is very likely the line 5184 seen by Lecoq de Boisbaudran in sparks taken from solution of zinc salts. In the absorption spectra of sodium and potassium lines appear in the green which were shown by Liveing and Dewar not to be coincident with any known line of these metals. It was suggested by them that they are due to hydrogen compounds. The wave-length of the sodium line is 5510 and that of the potassium line 5730. Lecoq de Boisbaudran mentions that an increase of temperature is often accompanied by a relatively greater increase in the brilliancy of the more refrangible rays. It is often said that such an increase is a direct consequence of the formula established by Kirchhoff. If the absorbing power of a molecule remains the same while the temperature is increased, it follows that the blue rays gain more quickly in intensity than the red ones, but the less refrangible rays ought never to decrease in intensity, the quantity of luminous matter remaining the same. Now such a decrease is actually observed in many cases when there is no reason to suppose that the quantity of luminous matter has been reduced. We must conclude, therefore, that the observed differences in the spectra are not solely regulated by Kirchhoff's law; but it is a perfectly plausible hypothesis that a higher temperature is in general accompanied by a decrease in the absorbing power of the less refrangible rays. As a stronger impact often brings out higher tones, stronger molecular shocks may bring out waves of smaller length. There are several instances of a regular increase in the relative intensity of the blue rays which may be ascribed to this cause. The most remarkable instance is perhaps seen in the spectrum of phosphoretted hydrogen. If a little phosphorus is introduced into an apparatus generating hydrogen, the flame will show a series of bands chiefly in the green. The spectrum gets more brilliant if the flame is cooled. This can be done, according to Salet,[1] by pressing the flame against a surface kept cool by means of a stream of water or by surrounding the tube, at the orifice of which the gas is lighted, by a wider tube through which cold air is blown. The process of cooling the flame, according to Lecoq,[2] changes the relative intensity of the bands in a perfectly regular manner. The almost invisible least refrangible band becomes strong, and the second band, which was weaker than the fourth, now becomes stronger. Another example of a similar change is the spectrum shown by a Bunsen burner. By charging the burner with an indifferent gas[3] (N, HCl, CO_2) the flame takes a greenish color, and, though the spectrum is not altered, the least refrangible of the bands are increased in intensity. While in these instances the changes are perfectly regular, the more refrangible rays gaining in relative intensity as the temperature is increased, there are other cases, some of which have already been mentioned, in which the changes are very irregular; such are those which take place in the spectra of tin, lithium, and magnesium. In the case of zinc the less refrangible of the group of blue rays gains in relative intensity. We cannot, therefore, formulate any general law.

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[1] *Phil. Trans.*, clxiii. p. 253 (1873).

Numerical Relations between the Wave-lengths of Lines belonging to the Spectrum of a Body.

It seems *a priori* probable that there is a numerical relation between the different periods of the same vibrating system. In certain sounding systems, as an organ-pipe or a stretched string, the relation is a simple one, these periods being a submultiple of one which is called the fundamental period. The harmony of a compound sound depends on the fact that the different times of vibration are in the ratio of small integer numbers, and hence two vibrations are said to be in harmonic relation when their periods are in the ratio of integers. We may with advantage extend the expression "harmonic relation" to the case of light, although the so-called harmony of colors has nothing to do with such connections. We shall therefore define an "harmonic relation" between different lines of a spectrum to be a relation such that the wave-lengths or wave-numbers are in the ratio of integers, the integers being sufficiently small to suggest a real connection. Some writers use the word in a wider sense and call a group of lines harmonics when they show a certain regularity in their disposition, giving evidence of some law, that law not being in general the harmonic law. We shall here use the expression in its stricter sense only. We begin by discussing the question whether there are any well-ascertained cases of harmonic relationship between the different vibrations of the same molecule. The most important set of lines exhibiting such a relationship are three of the hydrogen lines which, when properly corrected for atmospheric refraction, are, as pointed out by Johnstone Stoney, very accurately in the ratio of 20 : 27 : 32 (*Phil. Mag.*, xli. p. 291, 1871). Other elements also show such ratios; but when a spectrum has many lines pure accident will cause several to exhibit whatever numerical relations we may wish to impose on them. If we calculate the number of harmonic ratios which, with an assumed limit of accuracy, we may expect in a spectrum like that of iron, we find that there are in reality fewer than we should have if they were distributed quite at random (*Proc. Roy. Soc.*, xxxi. p. 337, 1881). With fractions having a denominator smaller than seventy the excess of the calculated over the observed values is very marked, while there are rather more coincidences than we should expect on the theory of probability if we take fractions having a denominator between seventy and a hundred. The cause of this, probably, is to be sought in the fact that the lines of an element are liable to form groups and are not spread over the whole spectrum, as they would be if they were distributed at random. This increases the probability of coincidence with fractions between high numbers, and diminishes the probability of coincidence with fractions between lower numbers. There is one point which deserves renewed investigation. When the limits of agreement between which a coincidence is assumed to exist are taken narrower, there is an increased number of observed as compared with calculated coincidences in the iron spectrum; and this would seem to point to the existence of some true harmonic ratios. With the solar maps and gratings put at our disposal by Professor Rowland, we may hope to obtain more accurate measurements, and therefore more definite information. Even if the wave-lengths of two lines are found to be occasionally in the ratio of small integer numbers, it does not follow that the vibrations of molecules are regulated by the same laws as those of an organ-pipe or of a stretched string. E. J. Balmer[4] has indeed lately suggested a law which differs in an important manner from the laws of vibration of the organ-pipe and which still leaves the ratios of the periods of vibration integer numbers. According to him, the hydrogen spectrum can be represented by the equation.

$$\frac{m^2}{m^2-4}\lambda_0 = \lambda,$$

where λ_0 is some wave-length and m an integer number greater than 2. The following table (I.) shows the agreement between the calculated and observed hydrogen lines. And the agreement is a very remarkable one, for the whole of the hydrogen spectrum is represented by giving to m successive integer values up to sixteen. The differences between the observed and the calculated numbers show a regular increase towards the ultra-violet. It might be thought that a better agreement could be obtained by taking a number slightly different from four in the denominator; but this is not the case. On the contrary, the agreement in the visible part is at once destroyed if we make the ultra-violet lines fit better. The agreement is not improved but rendered slightly worse if we take account of atmospheric refraction.

$\lambda_0 = 3645$.		Observed Hydrogen Spectrum.	$\lambda_0 = 3645$.		Observed Hydrogen Spectrum.
m.	$m^2\lambda_0/(m^2-4)$.		m.	$m^2\lambda_0/(m^2-4)$.	
3	6561.0	6562.1	10	3796.9	3795.0
4	4860.0	4860.7	11	3769.6	3767.5
5	4339.3	4340.1	12	3749.1	3745.5
6	4100.6	4101.2	13	3733.3	3730.0
7	3969.0	3968.1	14	3720.9	3717.5
8	3888.0	3887.5	15	3711.0	3707.5
9	3834.3	3834.0	16	3702.9	3699.0

As a first approximation Balmer's expression gives a very good account of the hydrogen spectrum. If the law was general we should find that in the iron spectrum, for instance, which is the only spectrum carefully examined, those fractions would occur more frequently than others which can be put into the form $m^2/(m^2-n^2)$, that is to say, $\frac{4}{3}$ and $\frac{9}{8}$ for fractions made up of numbers smaller than 10. A reference to the table in *Proc. Roy. Soc.*, vol. xxxi. p. 337, shows that these fractions do not occur more frequently than others. But, if we change the sign of n^2 in the denominator, we find $\frac{4}{5}$ and $\frac{9}{10}$ as the only fractions falling within the range of spectrum examined, and these two fractions are indeed those which occur more frequently than any others made up of numbers smaller than 10.

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[1] *Ann. Chim. Phys.*, xxviii. p. 57 (1873).
[2] *Spectre Lumineux*, p. 188 (1874).
[3] *Op. cit.*, p. 43 (1874).

[4] *Wied. Ann.*, xxv. p. 80 (1885).

It might be worth trying to see whether the wavelengths of lines making up a fluted band can be put into the form $\frac{m^2}{m^2 \pm n^2}\lambda_0$: according to the sign chosen in the denominator, the band would shade off towards the blue or red. The form of expression seems at first sight well adapted, for it shows how by giving m gradually increasing numbers the lines come closer and closer together towards what appears in the spectrum as the sharp edge of the band. If we take periods of vibration instead of wavelengths Balmer's expression would reduce to

$$T = T_0\left[1 - \left(\frac{n}{m}\right)^2\right],$$

where T_0 is a fixed period of vibration, n a constant integer, and m an integer to which successive values are given from n upwards.

It is often observed, and has already been mentioned, that the spectrum of some elements contains in close proximity two or three lines forming a characteristic group. Such doublets or triplets are often repeated, and if the harmonic law was a general one we should expect the wavelengths of these groups to be ruled by it; but such is not the case. The sodium lines which lie in the visible part of the spectrum are all double, the components being the closer together the more refrangible the group. But neither are the lines themselves in any simple ratios of integers, nor do the distances between the lines show much regularity. The ultra-violet lines of sodium as photographed by Liveing and Dewar are single, with the exception of the least refrangible of them (3301). But this line is a very close double, and it may be that the others will ultimately be resolved. Some elements, such as magnesium, calcium, zinc, cadmium, show remarkable series of triplets; and the relative distances of the three lines seem well maintained in each of them. Even the distances when mapped on the wave number scale are so nearly the same for each element that it would be a matter of great importance to settle definitively whether the slight variations which are found to exist are real or due to errors of measurement. In the following table (II.) we give the position of the least refrangible line of each triplet together with the distances between the first and second (column B) and between the second and third line of each triplet (column C). The figures in column A represent the number of waves in one millimetre. For the zinc and calcium triplets the measurements of Liveing and Dewar are given; the magnesium triplets are put down as measured by Cornu as well as by Hartley and Adeney. The differences in these measurements will give an idea of the degree of uncertainty. The triplets of cadmium are farther apart and are mixed up with a greater number of single lines.

Zinc Triplets.			Calcium Triplets.		
A.	B.	C.	A.	B.	C.
2992	37	19	2245	10	5
3257	38	20	2517	11	5
3571	40	18	2744	10	6
3686	40	19	2868	10	6
3833	40	18	2977	10	5
3975	38	19	3044	11	6
4057	41	17	3101	11	5
			3174	10	5
			3208	10	...

Magnesium Triplets.					
Cornu.			Hartley and Adeney.		
A.	B.	C.	A.	B.	C.
1929.3[1]	4.2	1.9	2605.6	3.9	2.0
2605.8	4.1	1.7	2997.4	4.0	2.4
2999.2	3.8	2.7	3229.8	4.5	2.1
3230.4	3.9	1.9			
3399.0[2]	4.1	1.2			

[1] Measured by Thalén.
[2] Measured by Liveing and Dewar.

Relation between Spectrum of a Body and Spectra of its Compounds.

The spectrum of a body is due to periodic motion within the molecules. If we are justified in believing that the molecule of mercury vapor contains a single atom, it follows that atoms are capable of vibration under the action of internal forces, for mercury vapor has a definite spectrum. We may consider, then, the spectrum to be determined in the first place by forces within the atom, but to be affected by the forces which hold together the different atoms within the molecule. The closer the bond of union the greater the dependence of the vibrations on the forces acting between the different atoms. Experimental evidence seems to favor these views, for we observe that whenever elements are loosely bound together we can recognize the influence of each constituent, while in the compounds which are sufficiently stable to resist the temperature of incandescence the spectrum of the compound is perfectly distinct from the spectra of the elements. The oxides and haloid salts of the alkaline earths, for instance, have spectra in which we cannot trace the vibrations of the component atoms; but the spectra of the different salts of the same metal show a great resemblance, the bands being similar and similarly placed. The spectrum seems displaced towards the red as the atomic weight of the haloid increases. No satisfactory numerical relationship has, however, been traced between the bands. The number of compounds which will endure incandescence without decomposition is very small, and this renders an exhaustive investigation of the relationship between their spectra very difficult.

The compounds whose absorption spectra have been investigated have often been of a more unstable nature, and, moreover, dissociation seems going on in liquid solutions to a large extent; the influence of the component radicals in the molecule is more marked in consequence. Dr. John Hall Gladstone,[3] at an early period in the history of spectrum analysis, examined the absorption spectra of the solution of salts, each constituent of which was colored. He concluded that generally, but not invariably, the following law held good: "When an acid and a base combine each of which has a different influence on the rays of light a solution of the resulting salt will transmit only those rays which are not absorbed by either, or, in other words, which are transmitted by both." He mentions as an important exception the case of ferric ferro-cyanide, which, when dissolved in oxalic acid, transmits blue rays in great abundance, though the same rays are absorbed both by ferrocyanides and by ferric salts. Soret has confirmed, for the ultra-violet rays, Dr. Gladstone's conclusions with regard to the identity of the absorption spectra of different chromates. The chromates of sodium, potassium, and ammonia, as well as the bichromates of potassium and ammonia, were found to give the same absorption spectrum. Nor is the effect of these chromates confined to the blocking out simply of one end of the spectrum, as in the visible part, but two distinct absorption bands are seen, which seem unchanged in position if one of the above-mentioned chromates is replaced by another. Chromic acid itself showed the bands, but less distinctly, and Soret does not consider the purity of the acid sufficiently proved to allow him to draw any certain conclusion from this observation. Erhard's work on the absorption spectra of the salts in which chromium plays the part of base has already been mentioned. Nitric acid and the nitrates of transparent bases, such as potassium, sodium, and ammonia, show spectra, according to Soret, which are not only qualitatively but also quantitatively identical; that is to say, a given quantity of nitric acid in solution gives a characteristic absorption band of exactly the same width and darkness, whether by itself alone or combined with a transparent base. It also shows a continuous absorption at the most refrangible side, beginning with each of the salts mentioned at exactly the same point. The ethereal nitrates, however, give different results. In 1872 Hartley and Huntington examined by photographic methods the absorption spectra of a great number of organic compounds. The normal alcohols were found to be transparent to the ultra-violet rays, the normal fatty acids less so. In both cases an increased number of carbon atoms increases the absorption at the most refrangible end. The fact that benzene and its derivatives are remarkable for their powerful absorption of the most refrangible rays, and for some characteristic absorption bands appearing on dilution, led Hartley to a more extended examination of some of the more complicated organic substances. He determined that definite absorption bands are only produced by substances in which three pairs of carbon atoms are doubly linked together, as in the benzene ring. More recently[1] he has subjected the ultra-violet absorption of the alkaloids to a careful investigation, and has arrived at the conclusion that the spectra are sufficiently characteristic to "offer a ready and valuable means of ascertaining the purity of the alkaloids and particularly of establishing their identity." "In comparing the spectra of substances of similar constitution it is observed that in such as are derived from bases by the substitution of an alkyl radical for hydrogen, or of an acid radical for hydroxyl, the curve is not altered in character, but may vary in length when equal weights are examined. This is explained by the absorption bands being caused by the compactness of structure of the nucleus of the molecule, and that equal weights are not molecular weights, so that by substituting for the hydrogen of the nucleus radicals which exert no selective absorption the result is a reduction in the absorptive power of a given weight of the substance. . . . Bases which contain oxidized radicals, as hydroxyl, methoxyl, and carboxyl, increase in absorptive power in proportion to the amount of oxygen they contain."

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[3] *Phil. Mag.*, xiv. p. 418 (1857).

It would seem, however, by comparing the above results with those obtained by Captain Abney and Colonel Festing[2] that the absorption of a great number of organic substances is more characteristic in the infra-red than in the ultra-violet. Some of the conclusions arrived at by these experimentalists are of great importance, as the following quotations will show: "Regarding the general absorption we have nothing very noteworthy to remark, beyond the fact that, as a rule, in the hydrocarbons of the same series those of heavier molecular constitution seem to have less than those of lighter." This effect agrees with the observations made by Hartley and Huntington in the ultra-violet, in so far as a general shifting of the absorption towards the red seems to take place as the number of carbon atoms is increased. Such a shifting would increase the general absorption in the ultra-violet as observed by Hartley and Huntington, and decrease it in the infra-red as observed by Abney and Festing. Turning their attention next to the sharply defined lines, the last named, by a series of systematic experiments, concluded that these must be due to the hydrogen atoms in the molecule. "A crucial test was to observe spectra containing hydrogen and chlorine, hydrogen and oxygen, and hydrogen and nitrogen. We therefore tried hydrochloric acid and obtained a spectrum containing some few lines. Water gave lines, together with bands, two lines being coincident with those in the spectrum of hydrochloric acid. In ammonia, nitric acid, and sulphuric acid we also obtained sharply marked lines, coincidences in the different spectra being observed, and nearly every line mapped found its analogue in the chloroform spectrum, and usually in that of ethyl iodide. Benzene, again, gave a spectrum consisting principally of lines, and these were coincident with some lines also to be found in chloroform. It seems, then, that the hydrogen, which is common to all these different compounds, must be the cause of the linear spectrum. In what manner the hydrogen annihilates the waves of radiation at these particular points is a question which is, at present at all events, an open one, but, that the linear absorptions, common to the hydrocarbons and to those bodies in which hydrogen is in combination with other elements, such as oxygen and nitrogen, are due to hydrogen, there can be no manner of doubt. The next point that required solution was the effect of the presence of oxygen on the body under examination. . . . It appears that in every case where oxygen is present, otherwise than as a part of the radical, it is attached to some hydrogen atom in such a way that it obliterates the radiation between two of the lines which are due to that hydrogen. . . . If more than one hydroxyl group be present, we doubt if any direct effect is produced beyond that produced by one hydroxyl group, except a possible greater general absorption; a good example of this will be found in cinnamic alcohol and phenylpropyl alcohol, which give the same spectra as far as the special absorptions are concerned. . . . Hitherto we have only taken into account oxygen which is not contained in the radical; when it is so contained it appears to act differently, always supposing hydrogen to be present as well. We need only refer to the spectrum of aldehyde, which is inclined to be linear rather than banded, or rather the bands are bounded by absolute lines, and are more defined than when oxygen is more loosely bonded."

"An inspection of our maps will show that the radical of a body is represented by certain well-marked bands, some differing in position according as it is bonded with hydrogen, or a halogen, or with carbon, oxygen, or nitrogen. There seem to be characteristic bands, however, of any one series of radicals between 1000 and about 1100, which would indicate what may be called the central hydrocarbon group, to which other radicals may be bonded. The clue to the composition of a body, however, would seem to lie between λ 700 and λ 1000. Certain radicals have a distinctive absorption about λ 700 together with others about λ 900, and if the first be visible it almost follows that the distinctive mark of the radical with which it is connected will be found. Thus in the ethyl series we find an absorption at 740, and a characteristic band, one edge of which is at 892 and the other at 920. If we find a body containing the 740 absorption and a band with the most refrangible edge commencing at 892, or with the least refrangible edge terminating at 920, we may be pretty sure that we have an ethyl radical present. So with any of the aromatic group; the crucial line is at 867. If that line be connected with a band we may feel certain that some derivative of benzine is present. The benzyl group show this remarkably well, since we see that phenyl is present, as is also methyl. It will be advantageous if the spectra of ammonia, benzine, aniline, and dimethyl aniline be compared, when the remarkable coincidences will at once become apparent, as also the different weighting of the molecule. The spectrum of nitro-benzine is also worth comparing with benzine and nitric acid. . . . In our own minds there lingers no doubt as to the easy detection of any radical which we have examined, . . . and it seems highly probable by this delicate mode of analysis that the hypothetical position of any hydrogen which is replaced may be identified, a point which is of prime importance in organic chemistry. The detection of the presence of chlorine or bromine or iodine in a compound is at present undecided, and it may well be that we may have to look for its effects in a different part of the spectrum. The only trace we can find at present is in ethyl bromide, in which the radical band about 900 is curtailed in one wing. The difference between amyl iodide and amyl bromide is not sufficiently marked to be of any value."

The absorption spectra of the didymium and cobalt salts afford many striking examples of the complicated effects of solution and combination in the spectra. It is impossible to explain these without the help of illustrations, and we must refer the reader, therefore, to the original papers.[3] Some very interesting changes have been noticed in the position of absorption bands when certain coloring matters are dissolved in different liquids. Characteristic absorption bands appear for each coloring matter in slightly different positions according to the solvent. Hagenbach, Kraus, Kundt,[4] and Claes[5] have studied the question. In a preliminary examination Professor Kundt had come to the conclusion that solvents displaced absorption bands towards the red in the order of their dispersive powers; but the examination of a greater number of cases has led him to recognize that no generally valid rule can be laid down. At the same time highly dispersive media, like bisulphide of carbon, always displace a band most towards the red end, while with liquids of small dispersion, like water, alcohol, and ether, the band always appears more refrangible than with other solvents; and as a general rule the order of displacement is approximately that of dispersive power.

Relations of the Spectra of Different Elements.

Various efforts have been made to connect together the spectra of different elements. In these attempts it is generally assumed that certain lines in one spectrum correspond to certain lines in another spectrum, and the question is raised whether the atom with the higher atomic weight has its corresponding lines more or less refrangible. No definite judgment can as yet be given as to the success of these efforts. Lecoq de Boisbaudran has led the way in these speculations, and some of the similarities in different spectra pointed out by him are certainly of value. But whether his conclusion, that "the spectra of the alkalies and alkaline earths when classed according to their refrangibilities are placed as their chemical properties in the order of their atomic weight," will stand the test of further research remains to be seen. Ciamician[1] has also published a number of suggestive speculations on the question, and Hartley[2] has extended the comparison to the ultra-violet rays.

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[1] *Phil. Trans.*, part ii. (1885).

[2] *Phil. Trans.*, iii. p. 887 (1881).

[3] Bunsen, "On the Inversion of the Bands in the Didymium Absorption Spectra," *Phil. Mag.*, xxviii. p. 246 (1864), and xxxii. p. 177 (1866); Russell, "On the Absorption Spectra of Cobalt Salts," *Proc. Roy. Soc.*, xxxii. p. 258 (1881).

[4] *Wied. Ann.*, iv. p. 34 (1878).

[5] *Wied. Ann.*, iii. p. 389 (1878).

When metallic spectra are examined it is often found that some line appears to belong to more than one metal. This is often due to a common impurity of the metals; but such impurities do not account for all coincidences. The question has been raised whether these coincidences do not point to a common constituent in the different elements which show the same line. If this view is correct, we should have to assume that the electric spark decomposes the metals, and that the spectrum we observe is not the spectrum of the metal but that of its constituents. Further investigation has shown, however, that in nearly all cases the assumed coincidences were apparent only. With higher resolving powers it was found that the lines did not occupy exactly the same place. With the large numbers of lines shown by the spectra of most of the metals some very close coincidences must be expected by the doctrine of chances. The few coincidences which our most powerful spectroscopes have not been able to resolve are in all probability accidental only. (A. S*.)

SPEECH-SOUNDS, the sounds actually used for the conveyance of thought by speech. See PHONETICS.

1. *Symbolization.*—It is necessary to have some system of writing speech-sounds, in order to talk of them. The system used in the present article is the palaeotype of the present writer's *Early English Pronunciation*. All letters or words thus written will be enclosed in (). The following preliminary list of the ordinary sounds, with examples, will render what follows intelligible. For an alphabetical list, see art. 20.

English.—1. b*ee*t b*ai*t b*aa* b*ough*t b*oa*t b*oo*t (biit beet baa bAAt boot buut). 2. kn*i*t n*e*t gn*a*t kn*o*t n*u*t n*oo*k (nit net næt nɔt nət nuk). 3. file f*oi*l f*ow*l f*ue*l (fa'il fɔ'il fa'ul fɪuu·il). 4. *h*ay (h*ee*). 5. *p*ea *b*ee, *t*oe *d*oe, *c*ape *g*ape (pii bii, *t*oo *d*oo, *k*eep *g*eep). 6. *wh*ey *w*ay, *f*eel *v*eal, *th*in *th*en, *s*eal *z*eal, ru*sh* rou*ge*, *h*ue *y*ou (wh*ee* w*ee*, fiil viil, thin dhen, siil ziil, rəsh ruuzh, ɹhɪuu ɹuu). 7. ea*r* *r*ing, gu*ll* litt*le* (iiɹ riq, gəl lit'l). 8. su*m* chas*m*, su*n* ope*n*, su*ng* (səm kæz'm, sən *oo*p'n, səq). 9. *ch*est *j*est (tjest djest).

Foreign.—F French, G German, IT Italian. 10. b*ê*te F, l*â*che F, n*ò* IT, d*û* F, f*eu* F, v*eu*f F, v*in* F, v*en*t F, v*on*t F, *un* F, s*oin* F, s*oi* F, l*ui* F (bEEt, l*aa*sh, no, dyy, fə, vœf, veA, vaA, voA, œA, sŭeA, sŭa, lyi). 11. da*ch* tei*ch*, ta*g*e sie*g*e, *w*ahl, all G (ˎdakh ˎtáikjh, ˎtaaghə, ziigjhə, bhaal). 12. pa*gl*ia IT, beso*gn*e F (pà·ljà, bəzonj).

2. *Nature of Speech-Sounds.*—Speech-sounds result from shocks given to the air by the organs of speech, received by the drumskin of the ear, and transmitted to the auditory nerves in the cochlea. The apparatus is explained by Helmholtz, who deals with musical sounds. But speech is not musical, and its sounds are much obliterated when rendered musical.[3] An original quality of tone generated by the vocal chords is modified by the cavities through which it passes, as explained by Helmholtz (*Sensations of Tone*) on the principle of resonance. There are three ways in which speech-sounds may be produced: (1) by the air in the mouth, without additional breathing, by smacks and clicks; (2) by drawing in air, as orally in chirps, whistles, sobs, gasps, and nasally in snuffles, snores; (3) by expelling air, as in the greater number of speech-sounds. The last are either *flated*, the vocal chords being wide apart and hence not vibrating, but allowing breath to pass freely, or *voiced*, the vocal chords being close together and vibrating fully, or else *whispered*, the vocal chords approximating but not touching, and their edges only vibrating. The last is only a variation of the second and needs no further consideration. Flated and voiced sounds are either *fixed*, the position of the vocal organs remaining unchanged throughout, or *changing*, the position constantly altering from one fixed position to another, forming "glides."

3. *Generic and Specific Speech-Sounds.*—Fixed speech-sounds, intended to be the same, vary from speaker to speaker, and in the same speaker at different times. Those who attempt to write sounds from dictation rapidly find that they have to disregard these specific differences, and simply discriminate genera. And much difference of opinion has always existed as to the discrimination and number of genera.

4. *Vowels*, that is, *vocals*, are so called because their positions allow the voice-sounds to pass with least obstruction. The three genera (ii. aa, uu), which have always been distinguished, differ greatly in the positions of the tongue and lip, that is, in their mouth cavities, and hence resonance. The usual method of describing speech-sounds is by the shape of the cavity, which, however, could be shown to be insufficient for many reasons. As differently shaped cavities resound to a note of the same pitch, Helmholtz proposed the last for discrimination. The pitches of (ii, aa, uu) are widely different, (ii) having the highest and (uu) the lowest; but the extreme diversity of results in attempting to assign the actual pitch of vowel cavities shows that this will not suffice. Resonance cavities do not create but merely modify original vowel qualities of tone, and these last seem to depend upon the will of the speaker, guided by his powers of appreciation and imitation, both extremely variable, partly hereditary, partly depending on conformation of brain, and partly acquired during adolescence.

Melville Bell, Sweet, Storm, and Sievers, and all who have latterly examined the subject distinguish at least two series of vowel genera, that is, two forms of each genus, called "narrow" and "wide"; but they are far from being agreed as to what the difference consists in and how it is produced. Sweet differs from Bell, and Sievers does not wholly agree with Sweet. All, however, call (ii, uu) narrow, and (*i*, *u*) wide.

Besides these two series Bell introduced another distinction applying to both, termed "rounding," consisting in a greater or less closure of the lips, slight for (AA), much for (uu), and intermediate for (*oo*). But this character is not scientifically precise, because all the vowels can be produced with the mouth wide open (by means of a compression of the arches of the palate), and still more easily with the mouth at least as much closed as ordinarily for (uu). Other phonetists wish to introduce distinctions based upon the shape of the apertures between the lips.

There is also a feeling of intermediateness between vowel-sounds. Thus (yy) is felt by many to lie "between" (ii, uu), and (œœ) between (*oo*, *ee*). But we also have other intermediates which arise spontaneously when listening to new languages and dialects. Thus in west Somerset there is a vowel between (ə, i), one between (y, ə), and another between (ə, œ), and the positions for these vowels have not been ascertained. These are only specimens of numerous cases. Hence the positional discrimination breaks down at present. Nevertheless it is very good so far as it goes, but must not be pressed to extremes.

All the vowels may be also flated and whispered; that is, the position and dictating vowel-intention remaining, the totally or partially open vocal chords forbid voice and produce sound more or less recognized as substitutes for the true vowels. Write (ii) voiced, ('ii) whispered, ("ii) flated. This distinction becomes of more importance for consonants.

5. *Glottids and Physems.*—A *glottid* is the action of the vocal chords in altering the form of the *glottis* or tongue-shaped space between them. (1) The glottid is *clear* when there is no attempt to utter the vowel until the chords are brought together, yet the utterance takes place at that instant. This may be written

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[1] *Wien. Ber.*, lxxviii. (1878).
[2] *Journal Chem. Soc.*, September, 1883.
[3] Ellis, *Speech in Song*, sect. iv.

(,ii) initial. Similarly, a vowel may end with a clear glottid (,ii,), no flatus escaping after the vowel ceases. This clear glottid is usually inferred and not written. (2) The glottid is *gradual*, written ([), when flatus passes through the vowel position before the chords are sufficiently approximated for voice, or after they are separated, thus ([ii[) is really (‘‘ii + ‘ii + ii + ‘ii + ‘‘ii). This is an exceedingly common habit with some speakers. (3) The *check* glottid (;), Arabic *hamza* ء, arises from keeping the chords tightly closed so that they cannot vibrate, and then releasing them with an explosion. It may be final in reverted order in Arabic, and it is common as an initial in German, as *;eine ;er;innerung*, and is used as the *catch* accent in Danish, as *ma;nd*, a man, distinct from *man* = F *on*. (4) An exaggeration of (;) gives Arabic (ɛáin) ع the bleat, with a rattle in the cartilaginous glottis.

Physems are the bellows-actions of the lungs. (1) The jerk (H) or sudden puff of either vocalized or flated breath, accompanying either clear or gradual glottid. The first, with voice only, is the singer's and Bengali aspirate; the second, with flatus, is the Scotch or German aspirate. (2) The *wheeze* (*h*), Arabic ح, stated by Czermak to arise from suddenly forcing breath through the cartilaginous glottis.

6. *Vowel Glides and Vanishes.*—So far the positions of the vowel above the larynx have been supposed to remain unchanged. In this case many degrees of length may be distinguished, as (ă) very short, (a) short, (à) medium, (aa) long, (aà) drawled, (aaa) extravagantly prolonged. If the vowel sign consists of two parts, as (ah), only the first is marked doubled or tripled for these lengths, as (ăh, aah), etc. In English it is felt very difficult to preserve the positions for long (*ee*, aa, *oo*), and these vowels gravitate to, without by any means reaching, (i, ə, u). The first and last may be written (*ee*'j, *oo*'*w*), implying what are termed *vanishes* or gliding alterations of sound, accompanied by alterations of position as the vowel ceases. This change is generally unintended and mostly used unconsciously.

7. *Diphthongs.*—But there are conscious changes to quite different positions. The first and last vowels are then taken as fixed, one of them having the chief stress, and there is a vowel glide between them. These form *diphthongs;* the stress and glide being the chief characteristics are marked by (′), and the two elements are juxtaposed. The glide is generally short and close in English, longer in German, still longer and looser, or "slurred," in French and Italian. There are many typical classes. i. With weak final (i), unanalyzed (a′i), analyzed (ái, á*i*, ə′*i*, ɪ′*i*, *é*i, é*i*, E′*i*, æ′*i*), etc., all common. ii. With weak final (u), unanalyzed (a′u), analyzed (áu, á*u*, ə′*u*, ɪ′*u*, *é*u, é*u*, E′*u*, æ′*u*), etc., all very common. iii. Weak final (y), theoretic German *eu* (óy, áy), Devonshire *ow* (œ′y,^{5}). iv. Weak initial (i) or (ĭ), used for (J) in Italy, France, Wales, etc. v. Weak initial (y) in Fr. vi. Weak initial (u) or (ŭ), used for (w) in Italy, Spain, France, Wales, etc. vii. Murmur diphthongs ending in weak (ɐ), common in English, but generally with the option of trilling an (r) after it, and hence written (ɹ), as in *ear*, *air*, *oar*, *lord*, *poor*, *pure*, *pyre*, *power* (iiɹ, eeɹ, ooɹ, lAAɹd, puuɹ, pĭ*uu*ɹ, pa′iɹ, pa′uɹ); the *r* is always trilled in Scotland. viii. The vanish diphthongs (*ee*'j, *oo*'*w*), just considered. ix. Inchoant diphthongs, first *grave*, where the speaker begins too low and corrects himself, as (íi, ú*u*), and secondly *acute*, where he begins with the mouth too open and corrects himself as he proceeds, as (ɪ′*o*); both are common in English dialects.

8. *Glides from and to Mutes, Post-Aspirates, Sonants.*—The essence of the diphthongal character was the glide, which was independent of the sounds of the first and last elements. These might be absolutely mute as in (piip, tAAt, k*oo*k) peep, taught, coke, in which (p, t, k) are mere positions without sounds. But the results are quite different from (ii, AA, *oo*), because while the consonant positions are opened out the vowel is at the same time sounded. Similarly in the reverse order, when final. But here the enclosure of the breath is felt to be uncomfortable, and, if there is no vowel to fall upon, the mouth is opened and a puff of flatus (‘), called the "recoil," is heard in England, as (piip‘) peep! Using then (+) for the gliding sounds, we have (p + ii + p + ‘); but there is no recoil in (p + ii + p + *i* + q) or (p + ii + p b + *oo*'*w*!) peeping, peep-bo! Various nations have very different habits in this respect. In Indian languages (p‘) would be felt as a final post-aspirated mute. So initially in Germany, the (p) position is usually released, not on a vowel with a clear glottid, as in England and Italy, but on a vowel with a gradual glottid, as (p[ii), and hence flatus is heard before the vowel. When this is exaggerated, as (p[hii) or (pH[hii), we have the true Indian post-aspirated mute.

But an attempt to utter the vowel through a mute position may be made before the position is quite opened out, or the vowel may be continued into it after it has been assumed. This gives the English, Italian, and Indian "sonant," as in (b*ee*b) babe. The German is not quite the same. Here the glides are (b + *ee* + b), with possibly a voiced recoil (b + *ee* + b + ’), where (’) represents the most amorphous voice. This voiced recoil is strong in French, but seldom heard in English, except in declamation, is regular in modern Indian, and impossible to a German, who says at most (b*ee*bp‘) or (b*ee*p‘); also Indians and Irish sometimes jerk out their vowel after sonants, as (bH*ee*bH‘), producing the sonant post-aspirates. The ancient Indian never ended words in the pause with sonants, post-aspirated mutes, or post-aspirated sonants, but only with simple mutes, and avoided the recoil.

9. *Glides to and from Hisses, Buzzes.*—In the case of a hiss, flatus passes through the consonant position and is continued part of the time during which the vowel position is assumed, but towards the end of that time voice is put on. Hence in (s + ii) see the glide (+) is partly flated and partly voiced, so that (s) acts in much the same way as a gradual glottid; similarly when final, as (s + ii + s) cease, where the hiss replaces the recoil. But the proportion of voice and flatus in the glide may vary. The voice may be put on during the hiss, and then the change takes place in the hiss position. The result, far less clear than a vowel, is a hiss (s), followed without a positional glide by the buzz (z), then an entirely vocal glide, the vowel, and a vocal glide, a buzz, and a hiss, as (sziizs), seize, sees. The initial (sz) is regular in Germany, where no vowel precedes, as *sie sehen* (szii z*ee*'n), they or you see; and the reverse (zs) is regularly in English seize (siizs) in the pause, and similarly (haavf, briidhth, ruuzhsh, dʝədʝshj), halve, breathe, rouge, judge. In the south-west of England Saxon words beginning with *s*, *f* are pronounced with (z, v) initial, which passes through (sz-, fv-) to (s, f).

10. *Glides to and from Flaps.*—Flaps are consonants where there is a slack organ which flaps with the breath as it passes. The *r* is very varied, but properly voiced, though the flated form occurs. The flap may be made (1) with the lips, as (brh), used in Germany to stop horses; (2) with the tip of the direct tongue, (r, ˎr), used in Italy; with the tip of the reverted tongue, (R), used in the south of England and in modern (not ancient) Indian, where it is called "cerebral"; (3) with the uvula, (*r*), common in France and north Germany, labialized (*rw*) in Northumberland, and harsher in Greek and Arabic; (4) with the glottis, (ɿ), usual in Denmark; and so on. In the educated south of England the tongue is often raised to the (r) position, but not allowed to flap, and is treated as a buzz ($r_{\circ}$).

The above form the *central* flaps; if the point of the tongue is fixed and the voice escapes by the side it causes minute *lateral* flaps of the tongue. The place of the point of the tongue discriminates the various sounds which differ but slightly—(ˎl), advanced tongue at gums, Continental; (l), coronal, tongue near the crown of the palate, English; (ʟ), reverted, in connection with (ʀ) in southwest England.

Both flaps, especially the latter, are extremely vocal, and the glides from and to them are like those from and to vowels, while they glide readily to and from mutes, sonants, hisses, and buzzes.

11. *Glides to and from Hums, Orinasals.*—For (p, t, k) both nasal or oral passages are cut off, the former by pressing the uvula against the back of the pharynx. Let this pressure be relaxed so that the nasal passage is opened, the oral passage remaining closed. The voice passes through the nose, forming the three hums (m, n, q). The glide from these to ordinary vowels is the same as from (b, d, g), and the peculiarity consists in the preceding hum and the closing of the nasal passage as the vowel position is assumed. If the nasal passage is left open at all the vowel is "nasalized," and as it resounds partly in the nose and partly in the mouth it becomes an "orinasal." Four principal orinasals exist in French, as *an*, *on*, *un*, *vin* (aᴀ, oᴀ, œᴀ, veᴀ); there are more in Portuguese, and many others in the modern Indian languages. The oral vowel is altered in character by nasalization, and it is not possible to assign the oral to the orinasal form precisely. If the oral passage is only slightly open, a "nasalized tone" is produced, as in Gaelic, some south German, and American dialects, written as (a,). The hum also may be prolonged, and ('mpaa, 'mbaa, 'ntaa, 'ndaa, 'qkaa, 'qgaa) result. These forms exist in South African languages.

The final hum may be continued like a vowel. If the nose entrance is closed and the voice continued (l*i*m, læm, k*oo*m) become (l*i*mb, læmb, k*oo*mb), which, as the ordinary spelling shows, were probably once pronounced. But not only the nasality, the voice itself may be cut off, and then we have the mere stops (p, t, k), thus (l*i*mp, l*i*nt, l*i*qk), which in the pause have the recoil. Some phonetists consider (m, n, q) to become flated in this case, as (mh, nh, qh). This is no more necessary than to suppose a vowel to be flated before a mute, so that (læp, mæt, hæk) lap, mat, hack should be (l''æp, m''æt, h''æk), a usage unknown.

12. *Palatalization and Labialization.*—When a consonant precedes a diphthong of classes iv, v, vi, in art. 7 beginning with weak (i, y, u), there is a tendency to take these vowels as nearly as possible simultaneously with the consonant, expressed by writing (j, *w*j, *w*) after the consonant. To say (tj) at least two-thirds the length of the tongue from the tip backwards must lie against the palate, for (kj) two-thirds from the root forwards. The first occurs in Hungarian; the second was very common among older speakers of English before (æ), as (kjænd'l). Both (tj, kj) are apt to develop into (tɟ); compare *nature*, *kirk*, say (n*ee*tjᵊɹ, kjᵊᵊɹkj), with colloquial modern (n*ee*tɟᵊ, tɟᵊᵊtɟ). Similarly the voiced sounds (dj, gj) become (dɟ), compare *rig*, *ridge*. These (tɟ, dɟ) are consonantal diphthongs = (tjshj, djzhj), as in *ch*est, *j*est, and are distinct from the Indian sounds (kɟ, gɟ) च, ज, which are true mutes, produced by bringing the tongue from the position for (ᴊ) tight up against the extreme back of the hard palate so as to produce a complete stop. The most important of the palatalized letters are (lj, nj), the Italian *gli*, *gn* in *miglior*, *ognor* (mìljò·r, ònjò·r), where the palatalization brings the Italian advanced (ˎl, ˎn) to the position of the English (l, n). The (lj) has degenerated to (ĭ) or (ᴊ) in France during the 19th century. It exists in Spanish *ll*, Portuguese *lh*. The (nj) exists as *gn* in French, *ñ* in Spanish, and *nh* in Portuguese.

Parallel to the palatal are the labial forms, of which English *queen*, *guano* (k*w*iin, g*w*aa·n*o*) are examples. They seem to exist in abundance in French, as in toi, doigt (ˎt*w*a, ˎd*w*a). The palato-labial form (*w*j), as in *juin* (zh*w*jeᴀ), is much disputed, and a diphthong (zhyéᴀ) is usually assumed.

13. *Syllables.*—A group of speech-sounds increasing in volume from a mute, sonant, hiss, buzz, or flap to a full vowel and decreasing again to one of the former constitutes the ideal syllable (συλλαβή, collection). The initial and final parts may sink to clear glottids, and the middle part to a simple vowel. The type of a syllable is then < >, crescendo followed by diminuendo, as in (‚aa, ĭaaĭ, tĭaaĭt‘, stĭaaĭts), theoretical, and (dɟᵊdɟd, streqkth, t*w*elfths), actual syllables. The hisses or recoil before or after a stop are not felt as belonging to fresh syllables, because they have no vowel, which is the soul of the syllable. Monosyllables present no difficulty, but the division of syllables in polysyllables is not easy to understand. In (pii + p + *i*q) the middle (p) ends one set of glides and begins another. One syllable ends and the other begins with the assumption of the (p) position which is absolutely mute, so that the end of the first and the beginning of the second syllable are simultaneous, as the end of one hour and the beginning of the next. In this case (p) is said to be "medial." But there may be and often is a sensible pause between the two syllables, and then (p) is said to be "double," as (pii + pp + *i*q, piippiq), in which case no recoil can be used, as (piip'piq). In "syllabizing," a totally artificial process, doubling is necessary, and very frequently the recoil is used, but it never is in speech. In (sii + s + *i*q) ceasing, there is a sensible hiss between the glides which end the first syllable and those which begin the second, and the syllable divides during that hiss. If we wished to produce the effect of doubling, we must break the hiss into two either by a silence or a diminution of force, as (m*i*ssent). The same remarks hold for sonants, buzzes, and flaps, where we have a sensible voice sound during which the syllable divides. Syllables may even divide during a vowel, as French *payen*, *fayence*, *vaillant* (paĭeᴀ, faĭaᴀs, vaĭaᴀ), where the syllable divides during (ĭ), which may even be lengthened to show the two syllables; but, if the syllables have to be sung to notes with a pause between them, we must double the (ĭ), thus (paĭ ĭeᴀ, faĭ ĭaᴀs), as either (paĭ eᴀ, faĭ aᴀs) or (pa ĭeᴀ, fa ĭaᴀs) would be unintelligible. The sensation of separate syllables is always easy. It is the essence of versification, the oldest form of literature.

14. *Accent and Emphasis.*—Generally several syllables form a single word, and in many languages—by no means all languages—one syllable in a word is rendered conspicuous. Several plans have been adopted for this purpose. (1) Quantity or length of syllables, which seems to be all that is known to modern Indians, Arabs, and Persians. (2) Heightened or lowered or descending gliding pitch (*con portamento*) of one syllable, which were the acute, grave, and circumflexed syllables of Sanskrit, Latin, and Greek, the position of these syllables in a word there depending partly on the quantity of the syllables and partly on sense; this pitch difference remains in a more complicated form in Norwegian and Swedish. (3) Greater force given to one syllable; this is the English, German, and Italian "stress," and from the end of the 3d century A.D., when the feeling for quantity faded, was used instead of high pitch in Latin and Greek. The modern Italian and modern Greek as a general rule preserve the memory of the syllable which had the high pitch by giving it greater force, with but few exceptions, as Italian *cade·re ri·dere*, to fall, to laugh. (4) By a peculiar pronunciation, as the "catch" of the Danes. In French none of these methods seem to be consciously adopted. Some declare that the last syllable (not counting mute *e*) *always* has the stress, others that it *never* has the stress; others, again, consider the stress to be intentionally even, and when altered to depend mainly on grammatical construction, while there is certainly a raised pitch, frequently towards the close of a phrase or sentence, but sometimes on a penultimate syllable. Turks and Japanese have also even

stress. All these modes of rendering a syllable conspicuous are apt to be called "accent," the Latin translation of *προσῳδία*, the song added to the word, which properly applied to class (2) only. Where pitch accent prevailed there may have been also stress, but that stress was probably as little subject to strict rule as alteration of pitch is in English speech, where it undoubtedly exists, without properly affecting signification. Hence we may say roughly that in Latin and Greek pitch was fixed and stress free, but in English and German stress is fixed and pitch free.

What accent is to a word, emphasis is to a sentence. But there is this difference. Accent always falls on a fixed syllable of a word. Emphasis varies with the word to be made conspicuous. Emphasis does not consist merely in making the stressed syllable of a word louder. It depends upon a number of most subtle varieties of qualities of tone, length, and pitch of utterance,—in short, of those tricks and wiles of speech which form the stock-in-trade of actors and orators. The same words will mean totally different things according to the place and nature of the emphasis used. Different nations emphasize differently. To an Englishman French emphasis is apt to seem placed on the wrong word.

15. *Intonation.*—Although musical accent does not exist in English, almost every county has its peculiar sing-song mode of utterance. And even among educated men the sing-song may frequently be heard in public speaking, or in declaiming poetry, or recitation, or reading aloud generally. For these things no invariable rule exists. But in England questions require the pitch of the voice to be raised, and affirmations to be lowered, towards the end of a clause. In Scotland the pitch is raised in both cases, so that to an Englishman a Scotchman seems to be always asking questions.

16. *Analysis of Speech-Sounds.*—What is heard are sentences consisting of various fixed sounds cemented by gliding sounds, which act one on the other, and thus become greatly modified. To construct an alphabet it is necessary from this mass to separate the fixed elements and the changing glides, to crystallize them into symbols, and finally to make the value of those symbols known to the reader. The last cannot be done satisfactorily except by *viva voce* instruction, but much can be accomplished by a review of the relations of sounds, made dependent on the relations of the motions of the organs of speech by which they are produced. There is a preliminary difficulty in defining an element. Perhaps position, flatus, whisper, and voice are the only ultimate elements. But it is usual to be very lax. Thus (p, t, k) have position only, (f, s, sh, kh) position and flatus, (i, a, u, w, z, zh, gh) position and voice. The analysis is therefore only into "proximate" and not "ultimate" elements. Again, when a new mass of sound is presented to the ear, a long time passes before the ear becomes sufficiently accustomed to the sound to distinguish the proximate elements and their combinations, and therefore before the voice can imitate them at all satisfactorily. Hence the best phonetists differ. It may certainly be considered impossible from a knowledge of a few languages to construct an alphabet which will serve for all. Nevertheless a consideration of some partial schemes is of great value as a stepping-stone. We give Mr. Melville Bell's vowel system and Mr. Henry Sweet's alteration of Mr. M. Bell's consonant system, both supposed to be universal, but neither properly appreciating Asiatic, African, and American-Indian languages and habits of speech. After these follows a modification of a confessedly partial system by the present writer, applying chiefly to English, German, Italian, Spanish, and French, with a few partly theoretical sounds, introduced to show connections. In all these the sounds will be expressed by palaeotype symbols without any explanation in the tables themselves, because that is furnished at better length than would there be possible in the alphabetical list of art. 20.

17. *Mr. Melville Bell's "Visible Speech" Vowels.*—These are arranged primarily according to the height of the tongue, which is supposed to be divided into "back" and "front" or central part, beyond which lies the "point." The heights refer first to the "back" and lastly to the "front," and between them lie the "mixed," for which both back and front are more raised than the "front," so that there is generally a hollow between them. Each set is then divided into "narrow" and "wide," the precise meaning of which, as stated in art. 4, is not settled. Finally come the "rounded" vowels, there being three degrees of rounding—one for "high," one for "mid," and one for "low" tongue. For convenience here the back, the mixed, and the front are formed into separate groups, and all the vowel signs are numbered, being referred to in the following lists by V and the number, thus V4 is (*u*), which in Mr. Bell's nomenclature would be called "high-back wide-round." The letters *n*, *w*, *nr*, *wr* at the heads of columns mean "narrow, wide, narrow-round, wide-round."

Mr. Melville Bell's "Visible Speech" Vowel Table.

Tongue Height.	Tongue Back.				Mixed.				Tongue Front.			
	n.	*w.*	*nr.*	*wr.*	*n.*	*w.*	*nr.*	*wr.*	*n.*	*w.*	*nr.*	*wr.*
High.	1 *œ*	2 ɐ	3 u	4 *u*	13 ʏ	14 *y*	15 ᴜ	16 *u*h	25 i	26 *i*	27 ɪ	28 y
Mid ..	5 ɜ	6 a	7 *o*	8 o	17 ɘ	18 ah	19 *o*h	20 oh	29 *e*	30 e	31 *ə*	32 œ
Low ..	9 ɶ	10 *a*	11 ʌ	12 ɔ	21 əh	22 ɶ	23 *a*h	24 ɔh	33 ᴇ	34 æ	35 *ə*h	36 æh

These positions being insufficient, although supposed to be precisely known, may be "modified" by raising the tongue more (a^{1}) or lowering it more (a_{1}), or bringing it nearer the teeth (ˌa) or nearer the throat (aˌ). And, even this not sufficing, Mr. Sweet has contrived a number of new modifiers, here passed over. And with all this none of the sounds can be produced purely through any position without an effort of will dependent on a conception of the sound. The characteristic of the vowel notation contrived by Mr. Bell is that each sign shows at once the position of the sound in the Table.

18. *Mr. Henry Sweet's "Sound Notation" Consonant Table.*

	a. Tongue Back.	*b.* Tongue Front.	*c.* Tongue Point.	*d.* Point Teeth.	*e.* Blade.	*f.* Blade Point.	*g.* Lips.	*h.* Lip Back.	*i.* Lip Teeth
				Voiceless Consonants.					
1. Open......	kh	ɟh	r₀h	th	s	sh	ph	wh	f
2. Divided..	*l*h	lɟh	lh	ˎlh	...	...	ph₁	...	...
3. Shut......	k	kɟ	t	ˎt	...	...	p	...	...
4. Nasal.....	qh	qɟh	nh	ˎnh	...	...	mh	...	...
				Voiced Consonants.					
5. Open......	gh	ɟ	r₀	dh	z	zh	bh	w	v
6. Divided..	*l*	lɟ	l	ˎl	...	...	bh₁	...	...
7. Shut......	g	gɟ	d	ˎd	...	...	b	...	...
8. Nasal.....	q	qɟ	n	ˎn	...	...	m	...	...

These signs will be referred to as S 8 *c*, or Sweet, line 8, col. *c*, giving (n). The consonants are modified in a similar manner to the vowels. Columns *a*, *b*, *c* indicate straits or contacts between the palate and the parts of the tongue named. By the "blade" is meant the part of the tongue between the "front" and the "point." Mr. Sweet's substitutes for glottids and physems, and his and Mr. Bell's notation of glides are omitted for brevity. Their notation throughout is entirely different from that here used.

19. A. J. Ellis's partial schemes, modified from his *Speech in Song*.

Vowel Trigram.

1 i	2 *i*	3 *e*	4 e	5 ᴇ	6 æ	7 ah	╲
..	16 y	17 *ə*	18 œ	19 ɐ	20 ɘ	21 ɜ	—8 — 22 a
15 u	14 *u*	13 *o*	12 o	11 ɔ	10 ʌ	9 *a*	╱

The meaning of this arrangement is that, if we pronounce the vowels in the order of the numbers, they will form a sufficiently unbroken series of qualities of tone, or, if each line be so pronounced leading to 8 = 22 a, three series of the same kind are produced, and also that the speaker feels that the vowels in the middle line lie "between" the vowels in the first and third lines between which they are written. These intermediate characters refer only to qualities of tone and not to the vowel positions, as they apparently did in the older "vowel triangles" from which the trigram is adapted. The arrangement of Mr. Bell is excellent for showing the relations of the positions, but gives no more clue to the relations of sound than the indispensable ratios

1 : 2, 2 : 3, 3 : 4, 4 : 5, 5 : 6 give to the musical sensations of the intervals known as the octave, fifth, fourth, major third, and minor third. Hence the advantage of this additional arrangement. It will be referred to as T 6, that is, trigram, vowel 6, or (æ).

Consonant Table.

Classes.	Contacts or Straits formed by	1	2	3	4	5	6	7	8	9	10	11	12	13
		I. Tongue Back and			II. Tongue Front and			III. Tongue Point				IV. Lips		
		Uvula.	Soft Palate and Lips.	Soft Palate only.	Back with Palate.	Palate only.	Point with Palate.	Reverted with Palate.	Direct with Palate.	Direct with Gums.	Direct with Teeth.	with Teeth.	Flat.	Round.
	ORAL. CONTACTS.													
i	Mute	K	kw	k	kj	kj	tj	T	t	t	..	P	p$_1$	p
ii	Sonant	G	gw	g	gj	gj	dj	D	d r$_0$	d	..	B	b$_1$	b
	STRAITS. *Fixed.*													
iii	Flated	..	kwh	kh	kjh	jh	sj	sh	shj	s ,s	th, th,	f	ph	wh
iv	Voiced	..	gwh	gh r$_0$	gjh	j	zj	zh R$_0$	zhj	z ,z	dh, dh,	v	bh	w
	Flaps. *Central.*													
v	Flated	..	....	krh rh	..	..	..	..	rh	rh	..	..	..	prh
vi	Voiced	..	rw	grh r	..	..	..	R	r	r	..	..	W	brh
	Lateral.													
vii	Flated	..	....	..	..	..	..	Lh	lh lˏh	lh	..	..	..	..
viii	Voiced	..	....	..	..	..	lj	L	l lˏ	l	..	..	..	..
	NASAL.													
ix	Flated	..	....	qh	..	..	..	..	nh	,nh	..	..	..	mh
x	Voiced	..	....	q	qj	qj	nj	N	n	,n	..	..	..	m

This table will be referred to as C iv 7, or consonant table, class iv, column 7 = (zh). The glottids and physems are sufficiently explained in art. 5, and are here omitted.

20. *Alphabetical List and Explanation of the Palaeotype Symbols.*—Small letters, italics, small capitals, and the forms resulting from turning them must be sought under the large capital of the same class where the order of all the letters is specified. Explanations are greatly condensed and often confined to references to the preceding articles and tables, or to an example. The notation for differences of length, is explained in art. 6.

Abbreviations.	
AR.	Arabic.
B.	Melville Bell.
C.	A. J. Ellis's consonant Table (art. 19).
DN.	Danish.
E.	A. J. Ellis.
E.	English.
F.	French.
G.	German.
IT.	Italian.
LLB.	Prince Louis-Lucien Bonaparte.
LS.	Lowland Scotch.
MG.	Modern Greek.
occ.	occasionally.

Abbreviations.	
PL.	Polish.
PR.	Portuguese.
S.	Sweet's consonants (art. 18).
SN.	Sanskrit.
SP.	Spanish.
St.	Storm.
Sv.	Sievers.
Sw.	Sweet.
SWD.	Swedish.
T.	A. J. Ellis's vowel trigram (art. 19).
V.	Bell's visible speech vowels (art. 17).

A. (a ah a′i a′u aᴀ a′y, a^1, *a* *a*h, A, ɐ).

(a) V 6, T 8 = T 22, short G mann, long E father, art. 6.

(ah) V 18, T 7, occ. E pass, path.

(a′i) art. 7 i, unanalyzed diphthong. E *eye*, G *ei*.

(a′u) art. 7 ii, unanalyzed diphthong, E h*ow*, G b*au*.

(aᴀ) art. 11, F v*en*t, a conventional form.

(a′y) art. 7 iii, unanalyzed G fr*eu*de, often (ɔ′i).

(a^1) or (a) with higher tongue, IT and F short *a*, nearly = (ah).

(*a*) V 10, T 9. B. hears it in E f*a*ther, *a*rms, *a*lms; E. does not. Sw. and E. hear it in LS f*a*ther, E. and LLB. in F di*a*ble, E. in F p*â*te, p*a*s.

(*a*h) V 23. B. says (A) with advanced tongue = (ˏA), (A) on the road to (a).

(A) V 11, T 10, short open in E *au*thority, long closed E *aw*l, almost peculiarly E.

(ɐ) V 2, T 19. B. hears it in E dung*eo*n, moti*o*n, consc*iou*s, aband*o*n, hon*o*r, bell*ow*s. E. hears it in these syllables and in E paren*ta*l, cap*a*ble, cap*a*cious, Chin*a*, and G gab*e*. Sw. and Sv. hear (ə) in all these cases.

Æ. (æ, æh).

(æ) V 34, T 6, E gn*a*t, almost peculiarly E.

(æh) V 36. B. hears it as a Cockney substitute for *ou*, *ow* in *ou*t, n*ow*, which E., a born Londoner, does not know. Sv. finds it to be "open" G ö, see (y).

B. (b bh brh, b$_1$, bh$_1$, B).

(b) S 7 *g*, C ii 13, art. 8, E *b*ee, e*bb*.

(bh) S 5 *g*, C iv 12, G *w*, lips flat, not touching teeth, see (ph).

(brh) C vi 13, used by Germans to stop horses, as *wo!* is in England.

(b$_1$) C ii 12, sonant of (p$_1$), which see, theoretical.

(bh$_1$) S 6 *g*, sonant of (ph$_1$), which see, theoretical.

(B) C ii 11, sonant of (P), which see, theoretical.

C. (ɔ ɔh, ɔ′*i*, ç çh, *ç*, *ç*h).

(ɔ) V 12, T 11, E kn*o*t, almost peculiarly E, replaced on the Continent by (o, oh, *o*h), which see.

(ɔh) V 24. B. calls it an advanced (ɔ), that is (ˏɔ), and hears it as regular short Irish-English *o*, Cockney *a*sk, American Chic*a*go. Sw. hears it in SWD s*o*n. Sv. gives no example. E. does not know it.

(ɔ′*i*) art. 7 i, diphthong E f*oi*l, by some taken as (A′*i*).

(ç) reverted (s), the under part of the point of the tongue against the palate. St.[1] hears it in East Norwegian bö*rs*e and also in SWD.

(çh) reverted (sh), SN. ष, the under part of the point of the tongue against the palate, but lower than for (ç) and pointing further back, see (TJ).

(*ç*) buzz of (ç), theoretical.

(*ç*h) reverted (zh), buzz of (çh), see (DJ).

D. (d dȷ dh dj, ˏd, dh,, *d*, D DȷJ Dh, ƌ ƌj).

(d) S 7 *c*, C ii 8, E *d*oe, sonant of (t), which see.

(dȷ) art. 12, E *j*u*dg*ing, consonantal diphthong = (djzhj), usually assumed as (dzh), and also as SN ज, for which see (gȷ), and AR ج, which Lepsius thinks was also once (gȷ).

(dh) S 5 *d*, C iv 10, E *th*en, MG δ, AR ذ, buzz of (th), see (dh,).

(dj) C ii 6, Hungarian *gy*on*gy*, pearl, art. 12.

(ˏd) S 7 *d*, C ii 9, F *d*oux, tip of tongue against gums, used in some midland and northern E dialects before *r*, *-er*.

(dh,) C iv 10, SP li*d*, lisped (z), retracted (dh).

(*d*) AR ض (*d*aad), described by Lepsius as close emphatic (.ˏl^1), see (*s*, *t*, *z*) and especially (K).

(D) C ii 7, reverted or cerebral SN ड, common in south-west England, in connection with (R), which see, by some taken to be retracted (d,), parent of E (d).

(DȷJ) a reverted consonantal diphthong = (D + *ç*h), heard in Wiltshire (ɪRDȷJ) ridge.

(Dh) reverted (dh), under part of point of tongue against teeth, theoretical.

(ƌ) Irish Gaelic *d*air, an oak, "broad" post-aspirated sonant. The place of tip of tongue unimportant, but generally taken as dental or interdental. Essential points, tongue laterally expanded and slack, back raised, leaving a hollow "front." Followed by a slow voice glide, resembling a preponderating E (sh) mixed with (gh). This glide, occurring between a sonant and a vowel, is closer at first than for an ordinary buzz and then more open. Constantly used for (dh) by Irish speakers of E. [Lecky, MS. communication.]

(ƌj) Irish Gaelic *d*eas, palatalized or slender (ƌ); glide from it like preponderating (J) mixed with (z). [Lecky, MS. communication.]

E. (e eᴀ, *e*, E, ə əh, ə^1, *ə* *e*h, ə$_1$, ɪ, ɪ′*o*).

(e) V 30, T 4, E n*e*t, SP *e*, medial between F and IT close and open (*e*, E), often (E) in dialectal E. B. hears it only long in E th*e*re. Sw. gives F p*è*re, which E. hears with (EE). Sv. gives E m*e*n, G m*ä*nner, *ä*hre, DN tr*æ*. LLB. hears it always and only in unaccented IT syllables.

(eᴀ) art. 11, orinasal, F v*in*, conventional symbol.

(*e*) V 29, T 3, F d*é*, G *eh*re. B. says it is found in E always and only in the vanish (*ee*′j), art. 6; but E. hears the vanish from received speakers only in the pause, otherwise he frequently hears (*ee*) without vanish. Sw., Sv., and St. do not admit (*ee*) in E without vanish.

(E) V 33, T 5. B. considers it the regular E sound in n*e*t, see (e). E. hears it long in G spr*ä*che, F b*ê*te, IT open *e*. Sw. hears it in E *ai*r, LS m*e*n, F v*in* (vEᴀ). Sv. also in DN, l*ä*ra.

(ə) V 17, T 20. E. hears it in his E n*u*t, which B. wrote (nɪt) from E.'s dictation; many think (ɪ,ə) are used respectively in E accented and unaccented syllables where E. hears (ə, ɐ), and he is very familiar with (ɪ) in dialects. Sv. gives "stage G" gab*e*, DN normal gav*e*, SWD goss*e*.

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[1] *Englische Philologie: I. Die lebende Sprache*, p. 42.

(ɵh)	V 21. Sw. gives E bird, where E. hears (ɵ). B. heard it only in Somerset sir and Cockney penny; the whole effect of the first appears to E. due to Somerset (R), the second he does not know.
(ə^1)	intermediate between (ə) and (*i*), written *ú* in Mr. Elworthy's West-Somerset grammar, a very common and characteristic sound in the dialect, but difficult and strange beyond it.
(*ə*)	V 31, T 17, F *feu*, *peu*. B. hears it in F *dú*, *bút* and in LS. E. hears it long in G hö*h*le. Sv. says the G sound is (œœ), not (*əə*), see (y).
(*ə*h)	V 35. B. hears it long in F *peur*, G schöne, etc., short in F *jeune*, G stöcke. E. hears (*əə*) in schöne and (œ) in the rest. See Sv. in (y).
(*ə*$_1$)	intermediate between (*ə*) and (œ), a common west Somerset sound; possibly Sv.'s "open G *ü*." See under (y).
(ɐ)	V 5, T 21. B. hears it in E d*o*ne, y*ou*ng, *u*p, *two*pence, where it sounds dialectal to E., who hears (ɵ), which see.
(ɐ'*ə*)	art. 7 ix, acute inchoant diphthong.

F. (f, ɟ).

(f)	S 1 *i*, C iii 11, E *f*eel, lower lip against upper teeth.
(ɟ)	a turned f, a modifier, laxly used; see mute and sonant (kɟ, gɟ), lateral flap (lɟ), nasals (nɟ, dɟ) and consonant diphthongs (tɟ dɟ, Tɟ Dɟ).

G. (g gɟ gh gj gjh grh g*w* g*w*h, G Gh).

(g)	S 7 *a*, C ii 3, art. 8, E *g*ape, e*gg*.
(gɟ)	S 7 *b*, C ii 5, SN ज, sonant of (kɟ), which see, and also (dɟ).
(gh)	S 5 *a*, C iv 3, mid G ta*g*e, buzz of (kh), which see, and also (gjh, g*w*h).
(gj)	C ii 4, IT la *gh*ianda, sonant of (kj), which see, formerly common in E before (a, æ), as *gu*ard, *g*arrison, now generally preserved in *g*irl, even in the vulgar form (gjæl).
(gjh)	C iv 4, mid G sie*g*e, buzz of (kjh), which see, confused by Germans themselves with (J), palatalized (gh).
(grh)	C vi 3, AR غ (grháin), or (gh) with the uvula slightly trilled, frequent Dutch *g*, MG *γ* before (a, o, u) in a mild form; Lepsius takes the AR sound to be (Gh), which see.
(g*w*)	art. 12, C ii 2, E *gu*ano, sonant of (k*w*), which see; the positions for (g) and (w) are assumed at the same time.
(g*w*h)	C iv 2, G au*g*e, fu*g*e, sonant of (k*w*h), which see; labialized (gh) after (*u*).
(G)	C ii 1, sonant of (K), which see, theoretical.
(Gh)	buzz of (G), see above under (grh).

H. (h ʻh ʼh ‡h, *h*, H, H[h).

(h)	when no letter, and, at most, some sign precedes, used for the unanalyzed physem, art. 5; after a letter very laxly used as a modifier of vowels (ah oh), and consonantal hisses or buzzes (th dh sh zh kh gh), etc.
(ʻh)	simple flatus, the (h) omitted when another letter precedes, as in the recoil (hæpʻ) hap, art. 8.
(ʼh)	the crudest voice producible, opposed to (ʻh), the (h) omitted in the voiced recoil (dedʼ) dead, art 8, and in (ʼl, ʼm, ʼn, ʼr) syllabic.
(‡h)	smack or click, art. 2, (1), the (h) is omitted after consonants showing the clicking parts, as (K‡, tj‡, tjᶞ‡, ˌt‡, T‡) guttural, palatal, unilateral, dental, and reverted click, see the turned numerals (8 ᔭ ⅂ ϛ Ƨ), which are used for brevity.
(*h*)	art. 5, physem (2), the AR ح (*h*aa), or "wheeze."
(H)	art. 5, physem (1), the "jerk" or unflated aspirate, used as post-aspirate after Indian sonants, as SN भ (bHə).
(H[h)	jerked flatus with gradual glottid, art. 5, physem (1), the usual aspirate of Scotland and Germany, and the Indian post-aspirate after mutes, thus SN ख थ फ are (kH[h, ˌtH[h, (pH[h), usually written *kh*, *th*, *ph*, but not to be confused with the palaeotype (kh, th, ph).

I. (i ĭa iiɹ, *ɨ* *ɨ*i, I).

(i)	V 25, T 1, short F fil (very different from E fill), long E f*ee*l.
(ĭa)	art. 7 iv, typical initial weak (i) diphthong, often confused with (Ja).
(iiɹ)	art. 7 vii, typical murmur diphthong with following permissive trill.
(ɨ)	V 26, T 2, E kn*i*t, almost peculiarly E and Icelandic, but often heard in Germany; long E (ii) is often replaced by (*ii*), especially before and after (r) and in singing.
(ɨi)	art. 7 ix, typical grave inchoant diphthong.
(I)	V 27. B. hears it in G *ü*ber, gl*ü*ck; Sw. in F l*u*ne, where B. hears (y); E. inclines to (I) in G, but Sv. thinks differently, see (y).

J. (j 'j ȷ, J Jh).

(j)	a modifier, symbol of palatalization, art. 12, but this simultaneous palatal action is constantly confused with successive (J, Ĭ).
('j)	art. 7 viii, used to express the vanish of (*ee*, *e*) towards (i), ending in an approach to the consonant (J), thus (*ee*'j, *e*'j).
(ȷ)	or (ȷ) without a dot, marks a semipalatalization, the tongue being only approximated to the palatalizing position, observed in several Uralic languages by LLB.
(J)	S 5 *b*, C iv 5, E *y*ea.
(Jh)	S 1 *b*, C iii 5, E *h*ew, *h*ue (JhĬu), hiss of (J) very close to flated (ʻii), art. 4.

K. (k kɟ kh kj kjh krh k*w* k*w*h, K Kh).

(k)	S 3 *a*, C i 3, E *c*ape, perfectly mute, art. 8.
(kɟ)	S 3 *b*, C i 5, SN च, the "back" and "front" of the tongue brought closely into the (k) and (J) positions, forming a complete stop; the "point" may rest against the lower gums, and had better do so to avoid the jump up to (tɟ) *ch*est, with which this mute is constantly confused; but (tɟ) is more like छ (kɟH[h) or post-aspirated (kɟ), which supplies the necessary hiss.
(kh)	S 1 *a*, C iii 3, G da*ch*, SP *j*, see (kjh k*w*h).
(kj)	C i 4, IT la *ch*iave, palatalized (k), art. 12. In the 17th and 18th centuries constantly used in E before (a, æ), it may be now constantly heard in London before *ou* in count, called (kjE'*u*nt), or finer (kjéunt) for (ka'unt).
(kjh)	C iii 4, G tei*ch*, palatalized (kh), confused with (Jh) by German theorists, but the back of the tongue is higher for (kjh). English people confuse it with concave (sh), which it ought never to approach, though it comes near convex (shj). Either (kjh) or (kɟh), the hiss of (kɟ), which was not distinguished from (Jh), was the original SN श, now called (sh) and confused with ष, properly (ʗh). see under C.
(krh)	C v 3, AR خ, a (kh) with the uvula slightly trilled, as in Dutch *ch*; Lepsius considers both to be (Kh).
(k*w*)	C i 2, art. 12, E *qu*een (k*w*iin), not (kwiin).
(k*w*h)	C iii 2, LS *quh*at (k*w*hat), G au*ch*, bu*ch*, art. 12 labialized (kh).
(K)	C i 1, AR ق (K*aaf*), the tongue greatly retracted and wedged against the uvula. Lepsius considers the proper sound of AR ق to be (G), the sonant of (K). By Syrian Mohammedans and often by Egyptians the ق is lost or rather becomes hamza (;), as (;aa'la) for (Kaa'la) said. "Emphatic" character attaches to AR ق خ غ ط ض ص ظ, here written (K krh grh *t d s z*), which Lepsius takes to have the values (G KH Gh .ˌd^1, .ˌl^1, .s^1, .dh^1) respectively; this "consists in a modification of the vowel by narrowing [the passage below] the soft palate;" these letters are called "high" by the Arabs because of this very high back of the tongue. They call the emphatic pronunciation "thick, rough, fatty." In fact (a) becomes (*a*), (o) remains, (e, i) become (E, i$_1$), (u) is scarcely changed. Europeans recognize the consonants mainly by this vowel change.
(Kh)	hiss of (K), considered by Lepsius to be the proper sound of what is here written as (krh).

L. (l lɟ lɟh lh lj lᶞ lᶞh, 'l, ˌl ˌlh *l* *l*h, L Lh, Ɪ Ɪj, [[h, T).

(l)	S 6 *c*, C viii 8, art. 10, E gu*ll*, tip of the tongue far behind the gums, replaced on the Continent by (ˌl).
(lɟ)	S 6 *b*. Sw. says "(l) formed in the place of (J)," and hears it in IT *gli*, SP *ll*, PR *lh*, where LLB. and E. hear (lj).
(lɟh)	S 2 *b*. B. says it is "a variety of defective *s*," theoretical.
(lh)	S 2 *c*, C vii 8, flated (l), not Welsh *ll*. B. hears it before (t) in fe*l*t, as (fElht). E. hears no trace of it, any more than he hears (ʻe) in (wet).

(lj)	C viii 6, art. 12, IT *gli*, SP *ll*, PR *lh*. LLB. and E. hear this as a palatalized E (l), not Continental (,l), the palatalization having retracted the (,l).
(lð)	C viii 8, voiced form or buzz of unilateral Welsh *ll*, see (lðh).
(lðh)	C vii 8, or more conveniently (lhh), Welsh *llall*; put tongue in position for (l), raise the left side to touch the palate, let flatus escape by the right side. The tongue is then in the position assumed *after* making the unilateral click (tjð‡), see (‡h) under H. This unilaterality is insisted on by Salesbury,[1] and E. was thus taught in Wales. Sw.[2] also insists on it. Some Welshmen do not.
('l)	E lit*tle*, syllabic (l), the voice of the lateral flap sufficing to form a syllable when final.
(,l)	S 6 *d*, C viii 9, F *l*ait, the tip of the tongue against the gums, as is usual out of England.
(,lh)	S 2 *d*, C vii 9, flated (,l), occ. F peup*le*.
(ł)	S 6 *a*, PL guttural or "barred" *ł*, that is, *l* with a slanting line drawn through it. The back of tongue is raised as high as for (ᴋ). St.[3] finds E *l* after a vowel in the same syllable half guttural; this is unknown to Englishmen.
(*l*h)	S 2 *a*. B. calls it "the hiss of a water-fowl," the hiss of (*l*), theoretical.
(ʟ)	C viii 7, reverted *l*, the underpart of the point of the tongue coming against the hard palate, used in conjunction with (ʀ) in southwest England, as wor*l*d (wɜʀᴅ'ʟ). Those who used retracted (r,) say (wɜr,d,'l,).
(ʟh)	C vii 7, flated form of (ʟ), theoretical.
(𝔩)	Irish Gaelic "broad" *ll*, as in a*l*t (the *l* being written singly because of the following *t*; at the end of a word it is always written *ll*), tongue in the same position as for (𝔡), which see, but with the lateral emission of the *l* class. [Lecky, MS. communication.]
(𝔩j)	Irish Gaelic "slender" *ll*, as in Irish Gaelic, mi*ll*; this bears the same relation to (𝔩) as (𝔱j) does to (𝔱), see (𝔱j). [Lecky, MS. communication.]
(ꞁ)	turned l, the gradual glottid, art. 5.
(ꞁh)	an exaggerated form of the gradual glottid, art. 5, and see (Hꞁh) under H.
(⅂)	turned L, DN *r*et, glottal *r*. Donders says "sing a note as deep as possible, and then try to sing a lower one, the voice will be replaced by a peculiar crackling noise," which is (⅂); it is the common form of DN *r*.

M. (m mh 'm ꟽ).

(m)	S 8 *g*, C x 13, art. 11, E *mumm*ing.
(mh)	S 4 *g*, C ix 13, flated form of (m). B. hears it before mutes in place of (m), as ca*m*p (kæmhp); E. does not, art. 11.
('m)	syllabic *m*, E chas*m* (kæz'm).
(ꟽ)	turned M, C vi 12, E defective *r* in ve*w*y (veꟽi) very, differing from (brh) by having tight and flat in place of loose and round lips, with minute instead of considerable excursions of the flap.

N. (n nɟ nh nj, ,n ,nh, 'n, ɴ, 𝔫 𝔫j).

(n)	S 8 *c*, C x 8, E *n*o, tongue as for (t), mouth open or closed indifferently, as the tongue is an effectual stop, art. 11.
(nɟ)	a nasalized (lɟ), which those take to be IT *gn* who assume IT *gl* to be (lɟ), see (nj, qɟ).
(nh)	S 4 *c*, C ix 8, flated (n), used in Cumberland for initial *kn*, in *kn*ow (nhoo). B. hears it before mutes, as in be*n*t (bᴇnht); E. does not, see art. 11.
(nj)	nasalized (dj), the tongue lies along the palate in the same way as for (dj), but the nasal passages are now open. LLB. and E. hear it as palatalized E (n), not (,n), IT *gn*, SP *ñ*, PR *nh*, F *gn*. St.[4] takes the F sound to be (qj). E. has not detected (qj) in native F speakers, after long-continued express observation.
(,n)	S 8 *d*, C x 9, F *n*ain, tongue on gums.
(,nh)	S 4 *d*, C ix 9, flated (,n), theoretical.
('n)	syllabic (n), E ope*n* (oop'n).
(ɴ)	C x 7, reverted (n), tongue as for (ᴛ), SN ण, southwest E *n* in connection with (ʀ), as (hɜʀɴ) ran.
(𝔫)	Irish Gaelic "broad" *nn*, as in dra*n*t (the *n* not doubled because of following *t*), tongue as for (𝔱, 𝔡), which see, but with nasal passages open. [Lecky, MS. communication.]
(𝔫j)	this bears the same relation to (𝔫) that (𝔱j) does to (𝔱), Irish Gaelic "slender" *nn*, as in bi*nn*. [Lecky, MS. communication.]

O. (o oh oᴬ 6y, *o* *o*h).

(o)	V 8, T 12, short IT open *o*, *nò*, long in E *o*re (ooɹ), which is fast degrading in London to (ᴀᴀ'ɐ).
(oh)	V 20. Sw. and Sv. hear (oh) and neither (o) nor (*o*h) in F h*o*mme, which E. hears as (om), very different from E (ɔm). B. hears (oh) in colloquial el*o*quence, phil*o*sophy, *o*pinion, and American wh*o*le, in all of which E. hears (*o*).
(oᴀ)	art. 11, F v*on*t, a conventional form, not to be confused with (aᴀ).
(6y)	art. 7 iii, theoretic form of G *eu*, see (a'y).
(*o*)	V 7, T 13. B. hears it short in E g*o*er, m*ow*er; E. in poetic, foll*ow*ing. B. hears it when long in E always and only with the vanish (*oo'w*), art. 6, art. 7 viii. E. hears (*oo'w*) in the pause, but otherwise generally (*oo*), and (*6ou*) is always erroneous.
(*o*h)	V. 19. B. says this is a mixture of (*o*) with (ɪ) or is (*o*) with advanced tongue, that is, (,*o*); he hears it in F homme (*o*hm), where E. hears (om), see (oh).

Œ. (œ œᴬ œ'y, *œ œ'*u, Œ, ꝏ Ꝏ).

(œ)	V 32, T 18, F v*eu*f, G b*ö*cke. See Sv. under (y).
(œᴀ)	art. 11, orinasal F *un*, chac*un*, conventional symbol.
(œ'y)	art. 7 iii.
(*œ*)	V 1. B. hears it in Scotch Gaelic l*ao*gh; it may be produced by saying (uu) and suddenly opening the mouth, see (*œ'*u.).
(*œ'*u)	acute inchoant diphthong, art. 7 ix, or (uu), begun with the mouth open and without internal rounding, very common in south Lancashire and Cheshire.
(Œ)	V 9. B. makes it the "narrow" form of (*a*), and the regular form of LS *u*p, c*o*me; Sw. occ. LS form.
(ꝏ)	V 22. B. hears it as the regular E sound of *er*, *ir*, *yr*. Sw. hears it in the first element of h*ow* (hꝏ'u), which E. finds dialectal.
(Ꝏ)	a dialectal southwest English sound of (ɜ) through which a sound of (ᴀ, ɔ) seems to run, and usually appreciated as the latter.

P. (p ph prh, p_1, ph_1, ᴘ).

(p)	S 3 *g*, C i 13, E *p*ee*p*ing, perfectly mute, art. 8.
(ph)	S 1 *g*, C iii 12, Hungarian *f*, MG *φ*, an (f) spoken by the lips only without the teeth, mouth in position for blowing to cool, flated form of (bh), which see.
(prh)	C v 13, flated form of (brh), common with babies before they can speak.
(p_1)	C i 12, mute of (ph), the lips closed flat to form a complete stop, theoretical.
(ph_1)	S 2 *g*, middle of lips in contact, flatus expelled from each corner of the mouth, theoretical.
(ᴘ)	C i 11, mute of (f) lower lip forming a complete stop with upper teeth, theoretical.

Q. (q qɟ qɟh qh qj).

(q)	S 8 *a*, C x 3, E si*ng*er, fi*n*ger, (g) with nasal passages open.
(qɟ)	S 8 *b*, C x 5, SN ञ, nasal of the palatal series, see (kɟ gɟ). Bopp considers it to be F *gn*, and Sw. hears it in F and IT *gn*, SP *ñ*, PR *nh*, in all of which LLB. and E. hear (nj) only.
(qɟh)	S 4 *b*, flated (qɟ), theoretical.
(qh)	S 4 *a*, C ix 3, flated (q). B. hears it before mutes, as si*n*k (siqhk); E. does not, art. 11.
(qj)	C x 4, palatalized (q), different from (qɟ).

R. (r rh rsh, $r_\circ$ $r_\circ$h, ,r ,rh ,$r_\circ$, *r* *r*h *rw*, *r*$_\circ$, ʀ ʀ$_\circ$, ɹ).

(r)	C vi 8, E *r*ing, tip of tongue far behind gums, flap weak in England, strong in Scotland and Italy.
(rh)	C v 8, flated form of (r).
(rsh)	PL *prz*ez, tongue in position for (sh) with point flapped.
($r_\circ$)	S 5 *c*, C ii 8, imperfect (d), the tongue not quite in contact, almost (zhj); imperfect (r), the flap being omitted, considered by B. and Sw. as normal (r), a sign for flapping being added where a trill is used. Sv. makes E *r* before a vowel regularly (,$r_\circ$). To E., a born Londoner ($r_\circ$), before a vowel is very difficult to utter.
($r_\circ$h)	S 1 *c*, flated ($r_\circ$), theoretical.
(,r)	C vi 9, SP *r*ey, IT *r*è, fully trilled *r* with the point of the tongue advanced to the gums.
(,rh)	C v 9, flated (,r), occ. F nô*tre*.
(,$r_\circ$)	alveolar unflapped (,r), see ($r_\circ$), possibly the "soft" SP *r* in ama*r*, a*r*ado, b*r*eve.
(*r*)	C vi 3, Parisian Pa*r*is, uvular *r*, art. 10 (3), resembling (grh).

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[1] *Welsh Pronunciation*, 1550.
[2] "Spoken North Welsh," in *Trans. Philol. Soc.*, 1882-84, p. 418.
[3] *Englische Philologie*: I. *Die lebende Sprache*, p. 74.
[4] *Ibid.*, p. 47.

(*r*h) C v 3, flated (*r*), common as a G final *r* in the pause, and then greatly resembling a faint (krh).

(*rw*) C vi 2, labialized uvular (*r*), regular in Northumberland.

(*r*$_\circ$) untrilled uvular (*r*), heard faintly between vowels in Northumberland, in ve*r*y, me*rr*y (va^1*r*$_\circ$*i*, ma^1*r*$_\circ$*i*), almost (v'a*i*, m'a*i*), like IT v*ai*, m*ai*.

(R) C vi 7, reverted or cerebral *r*, the underpart of the point of the tongue brought near the palate, and, according to E.'s observations, allowed to flap, but constantly asserted to be unflapped, see (R$_\circ$). Common in modern Indian, not in SN, and found in Norway and Sweden.[1] The characteristic of south of England dialectal speech, and parent of received E *r* and the vocal degeneration of *r*, art. 7 vii. By some considered as greatly retracted (r').

(R$_\circ$) C iv 7 unflapped variety of (R), supposed to prevail for (R), which see.

(ɹ) art. 7 vii, fully degenerated vocal (R), which may be followed permissively by a trilled or flapped (r), forming the murmur diphthongs.

S. (s sh shj sj, ˎs ˎsh, *s*, *s*j).

(s) S 1 *e*, C iii 9, E *s*eal, hissing, with a convex tongue forming a central strait, the sides being held firmly by the palate and teeth, point tense and unruffled, with many unconscious varieties.

(sh) S 1 *f*, C iii 7, E ru*sh*, tongue retracted in respect to (s), upper surface rather hollowed than convex, see (çh, shj) and occ. lips projected, as E hu*sh* (həsh^5).

(shj) C iii 8, (sh) with convex tongue, tip somewhat depressed, second element in (tɈ = tjshj), High G *s* initial before *p*, *t*, as *s*pielen, *s*tehen, where (sh) is not admissible.

(sj) C iii 6 PL ko*s*', palatalized (s), art. 12.

(ˎs) C iii 9, point of tongue advanced nearly to teeth. LLB. hears it in Tuscan sharp IT lo *s*io, usually taken as (ˎtˎsio).

(ˎsh) advanced (shj), tongue convex and nearer the palate. LLB. hears it in Tuscan pe*c*e (pè·ˎsh*e*), and considers it the only proper sound of IT *c* before *e* and *i*, which is usually assumed to be (ˎtˎsh) or (ˎtɈ); but an Englishman's (tɈ) is quite intelligible.

(*s*) AR. ص (*saa*d), according to Lepsius a close emphatic *s* or (.s^1), see (K) and (*d*, *t*, *z*).

(*s*j) Irish Gaelic ci*s*te (ˎkji*s*jtje,) treasure, *s* of the same series as (tj), which see. [Lecky, MS. communication.]

T. (t tɈ th tj, ˎt, th,, *t*, T TɈ, t tj).

(t) S 3 c, C i 8, E *t*oo, tip of the tongue far behind the gums, generated by reverted (T), with which it is confused by Indians, who use their cerebral ट ड for E (t, d).

(tɈ) E *ch*est = (tjshj), art. 12, not to be confounded with (kɈ), which see.

(th) S 1 *d*, C iii 10, E *th*in, Icelandic þ, MG *θ*, AR ث, point of tongue against back of front teeth, hiss produced by flatus escaping between tongue and teeth, not necessarily between the interstices of the teeth, as Sw. says.

(tj) C i 6, Hungarian *ty*, palatalized (t), art. 12, see (dj)

(ˎt) S 3 *d*, C i 9, F *t*as, usual Continental alveolar *t*, with the tongue against gums, SN त, found in some midland and northern E dialects before *r* or -*er*, see (ˎd).

(th,) C iii 10, SP *z* everywhere, and *c* before *e*, *i*, vo*z* *z*opo, *c*e*c*éo *c*into, lisped (s), tongue against gums, and hence a retracted (th), see (dh,). LLB. hears it in IT vi*z*io, where it is generally assumed to be (ˎtˎs).

(*t*) AR ط (*t*aad). which Lepsius describes as a close emphatic (.ˎd^1), see (K).

(T) C i 7, reverted or cerebral SN ट, with underpart of the point of the tongue against the palate, common in southwest E in connection with (R), parent of received E (t).

(TɈ) consonantal diphthong = (Tçh), heard in Wiltshire in connection with (R), as (ɜRTɈ) rich.

(t) Irish Gaelic "broad" post-aspirated mute, as in Irish Gaelic al*t*, *t*á, *t*ú. The place of the tip of the tongue is apparently unimportant, but it is generally assumed to be dental or interdental. The essential points are that the tongue is laterally expanded and slack, while the back is raised, leaving a hollow in the "front." It is followed by a slow flated glide, while the position changes to that of the vowel, resembling a greatly predominating (th) mixed with (kh). The voice is not put on till the vowel position is reached. This is constantly used for (th) by Irish speakers of English. [Lecky, MS. communication.]

(tj) Irish Gaelic "slender" form of post-aspirated mute, as in ail*t*, of a knuckle; the tongue is spreading and slack; the part nearest to the palate is about an inch on the inner side of the tip, being more towards the back than in the position for (s), the "front" being also raised; the tip is not turned up and its position is unimportant. The glide of the post-aspiration sounds like a predominating (Jh) mixed with (s), being tighter at first and looser afterwards than the E (Jh). [Lecky, MS. communication.]

U. (u ŭa, *u* *u*h, *ú*u, *u*$_1$, U).

(u) V 3, T 15, short E *t*o unemphatic, F p*ou*le, replaced by (*u*) in E; long E t*oo*. Some phonetists make the E long (uu) to be always (*ú*u) or (*u*w).

(ŭa) art. 7 vi, where (ŭ) replaces (w), F *oi*e (ŭa), *ou*i (ŭi), in s*oi*, d*oi*gt, etc. LLB. considers that (s, ˎd), etc., are labialized, art. 12.

(*u*) V 4, T 14, E f*u*ll, w*oo*d, w*o*man, c*ou*ld, "wide" form of (u).

(*u*h) V 16. B. hears it in the "colloquial" use of E awf*u*l, fiss*u*re, nat*u*re, fort*u*ne (which E. does not understand), but says also that it is (*u*) with a raised tongue, and hence = (*u*^{1}). Sw. hears it in SWD *u*pp, Sv. and St. in Norwegian h*u*ska.

(*ú*u) art. 7 ix. grave inchoant diphthong, possibly Sw.'s (*u*w), common dialectally in Cumberland and Westmoreland.

(*u*$_1$) midland E vowel replacing (ə, ɜ). E. feels it to be near (*o*^{1}), or to be a "thickened" (*u*); Mr. Hallam, to whom it is native, considers it to have the tongue intermediate to its position for (*o*, u), and the closure of the lips equal to that for (*o*), but made with flattened lips. In Yorkshire, Cumberland, and Westmoreland it is replaced by (*u*), with which most received speakers confound it.

(U) V 15. Sw. hears it long in Norwegian and SWD h*u*s, *u*t, and says it is not far from F l*u*ne, but see (y). St[2]. considers it intermediate between (u, y).

V. (v, ʌ).

(v) S 5 *i*, C iv 11, E *v*eal, voiced (f), easy for E, F, IT, hopeless to G, SP, AR, MG, and Hungarian. Indians use (v) with lower lip against upper teeth, but the dentality is not prominent; they read SN व in this fashion when not following a consonant; when it does, it reverts to (ŭ) rather than to (w), as (anusŭaara), not (anuswaara). In Bengali both व ब are called (b), which may be compared with SP (bh) for (b, v).

(ʌ) a turned *v*, regarded as an imperfect N, without the last upstroke, ɴ, after a vowel represents F nasality, art. 11, and used also for that of PR and modern Indian, in which the nasality seems much harsher, written like Greek *η*.

W. (w wh, *w* *w*j, '*w*).

(w) S 5 *h*, C iv 13, E *w*e (wii), with which compare F *v*ie (vii), *ou*i (ŭi) and G *w*ie (bhii); possibly AR و

(wh) S 1 *h*, C iii 13, E *wh*ey, *wh*ich, *wh*eel, *wh*ale, as distinct from *w*ay, *w*itch, *w*eal, *w*ail; the distinction, however, is nearly obliterated by received speakers, who use (w) for both (w, wh), which is like saying *v*eal, *v*ale, *v*ile for *f*eel, *f*ail, *f*ile; yet they laugh at the Somersetshire peasant for using initial (v) for (f). Some consider (wh) to be (hẇ), meaning (whw), and others to be (hŭ).

(*w*) a modifier to show labialization, art 12, see (k*w*).

(*w*j) art. 12, symbol of LLB.'s presumed palato-labialization, by attempting to pronounce (y) at the same time as a preceding consonant, as F *lu*i, *nu*it, which on this hypothesis are (ˎl*w*ji, ˎn*w*ji), and not (ˎlyí, ˎnyí).

('*w*) an indefinite vowel sound approaching to (u), towards which E (*oo*) vanishes, art. 6.

Y. (y yí, y$_1$, *y* Y).

(y) V 28, T 16. B. and E. hear this in F *u*ne. Sw. thinks the F sound to be (ɪ). Sv., speaking of the two series of vowels (ɪ ə əh) and (*y* œ œh), says what is equivalent to close G *ü* in *ü*ber = (ə), the lips being often pressed against the teeth; open G *ü* in h*ü*tte = (ə₁), somewhat more open than (ə); close G *ö* in sch*ö*n = (œ); open G *ö* in b*ö*cke = (æh). Sv. also makes F *u* in l*u*ne and DN *y* in l*y*s = (ɪ); F *eu* in p*eu* = (ə); SWD *ö* in f*ö*r = (əh), which last he believes to be the vowel nasalized in F *un*. Sw. also makes DN *y* in l*y*st = (y) and F *eu* in p*eu*ple = (œ).

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[1] *Englische Philologie: I. Die lebende Sprache*, p. 4.

[2] *Ibid.* p. 328.

(yi) art. 7 v, F h*ui*le, see also (*w*j).

(y₁) intermediate between (y, ə), frequent in west Somerset and Devon, where it replaces the received long (uu) and the received diphthong (ɪu).

(*y*) V 14. B. considers that E (i, *i*, *e* e) when unaccented tend to (*y*), as in r*e*turn, lim*i*t, S*ai*nt Paul's, capt*ai*n, th*e*re is, and regularly unaccented th*e*. Sw. hears it as occ. E in pr*e*tty. E. has not observed this change.

(ʏ) V 13. B. hears it long in American s*i*r. Sw.[1] says "the only Russian vowel which offers any special difficulty is the ЫI, first correctly identified by B. as (ʏ)." Lepsius[2] describes it as having (u)-tongue and (i)-lips, which would give (*œ*), and not (ʏ). Sw.[3] also identifies both North Welsh *u* and occ. *y*, as in s*u*t, t*y*, with (ʏ), replaced by (*i*) in South Wales. The PL and Bohemian *y* have the same sound.

Z. (z zh zhj zj, ˎz, ˎzh, *z*).

(z) S 5 *e*, C iv 9, E *z*eal, bu*zz*, not in SP or Indian.

(zh) S 5 *f*, C iv 7, E divi*si*on, F *j*. St.[4] says the E and F sounds are different, the F being more dental.

(zhj) C iv 8, voiced (shj), found in E (dʒ = djzhj).

(zj) C iv 6, PL le*ź*, voiced (sj), palatalized (z), art. 12.

(ˎz) C iv 9, IT lo *z*elo, according to LLB. Usually conceived as (ˎdˎz), voiced (ˎs), which see.

(ˎzh) voiced (ˎsh), which see, heard by LLB. in IT re*gi*o, usually accepted as (ˎdˎzh), for which the Englishman's (dʒ) is sufficiently intelligible.

(*z*) AR ظ (*zaa*). Lepsius considers this to be a close and emphatic (dh)—that is, (.dh^1), see (K)—but that in some places it is incorrectly pronounced as an emphatic (.z) and in others as an emphatic (.ˎd).

Numerals. (Ƨ Ɛ Ɛh Ч ƽ ⅃ 8, ^{1} $_1$ ^{4} ^{5}).

(Ƨ) Kaffre reverted click = (T‡), see (‡h) under H, Appleyard's *q*.

(Ɛ) AR ع (Ɛáin), see art. 5 (4).

(Ɛh) "trilled wheeze," differing from (*h*) solely by a rattle of mucus.

(Ч) Hottentot bilateral palatal click, Boyce's *qc* = (tj‡), see (‡h).

(ƽ) Kaffre dental click, Appleyard's *c* = (ˎt‡), see (‡h).

(⅃) Kaffre unilateral palatal click, Appleyard's *x* = (tjə‡), E click to start a horse, see (‡h) and (lәh).

(8) Waco (North-American Indian) guttural click = (K‡), see (‡h).

(^{1}) modifier, meaning properly "with raised tongue" used laxly, see (K).

($_1$) modifier, meaning properly "with lowered tongue," used very laxly, as in (ə₁), y₁, *u*₁, p₁, b₁, ph₁, bh₁), which see.

(^{4}) modifier, meaning "internally rounded" by compressing arches of palate, art. 4, as in a parrot's *puss* (p^4*u*^{4}s).

(^{5}) modifier, meaning "with projecting lips," compare (p*u*s, p^5*u*^{5}s, p^4*u*^{4}s), and Devon (œ'y₁^5), art. 7 iii.

Points. (, ; ! : . · ' ' " ˛).

(,) clear glottid, art. 5 (1).

(;) check glottid, AR hamza, art. 5 (3).

(!) suddenly stop, or absence of recoil in the pause, as (:sɐraɐ·wak!), not (:sɐraa·wak').

(:) (1) after a vowel shows that the syllable has a secondary stress, as (nɔ:min*ee*·shɐn) nomination; (2) before a whole word indicates the secondary emphasis usually shown by a capital, as (pAAl, :pAAl) pall, Paul.

(.) before a letter shows that it is especially strongly uttered, emphasis on a single element, as (.hæt, h.æt, hæ.t) *h*at, h*a*t, ha*t*, as distinct from "at, hot, had," see (K).

(·) (1) after a vowel shows that the syllable containing it has the principal stress; (2) prefixed to a word shows it to be emphatic, a substitute for italics, as (·wil)*i* kəm? wil ·hii kəm?) *will* he come? will *he* come? art. 14.

(') (1) before (h), see ('h) under H, crude voice; (2) before voiced letters, rendering the voice syllabically prominent, see ('l 'm 'n), etc.; (3) more laxly used in ('j, '*w*) for indefinite vowels near (i, u); (4) after sonants, voiced recoil, as (ded') dead, art. 8.

(') (1) abbreviation for ('h) flatus, which see under H; (2) before voiced letters indicates whisper, art. 4; (3) after mutes, flated recoil, as (det') debt, not written unless it is necessary to call attention to it.

(") before voiced letters, reduces them to flated, as ("ii), art. 4.

(˛) after a vowel or consonant nasalized by partial opening of nasal passages, in Gaelic, south G, occ. American.

Accents. (′ ″ ˏ ˏˏ ˋ ˎ ˎˎ ˎˎˎ).

(′) (1) mark of diphthongization, placed over or after stressed element, art. 7; (2) after (a) and not over it, as (a′i), distinct from (ái), mark of unanalyzed diphthong, art. 7.

(″) in place of (′), mark of slurred diphthongs, art. 7.

(ˏ) (1) after a letter shows retraction, as (dˏ, dhˏ), etc.; (2) (ˏˏ) more retraction.

(ˋ) (1) over or after a vowel denotes medial length, often united with diphthongal (′) forming a circumflex, as (âi, ə′ˋi): (2) after a consonant shows that it is held, the position being maintained throughout even when mute, as (detˋ); used for the north of England definite article (tˋman) the man, distinctly different from (tman, tɐman, ɐtman). (ˎ) prefixed to a letter means "with tongue advanced towards the teeth," see (ˎt ˎd ˎn): (3, 4) (ˎˎ ˎˎˎ) more advanced, as (t) tongue point some way behind gums, (ˎt) tongue point on gums, (ˎˎt) tongue point on teeth, (ˎˎˎt) tongue point on upper lip.

Signs. (‡ ¿ ¡ + ⁾) [ ).

(‡) abridgment of (‡h), which see under H.

(¿) mark of trill or flap, used in transliterating B. and Sw., thus their equivalent of (r₀¿) = (r).

(¡) symbol of inspiration, art. 2 (2).

(+) symbol of glide or speech-sound with changing position, when simple juxtaposition is insufficient, arts. 2, 8.

(⁾) the second half of a parenthesis ()) cut at the height of a non-ascending letter, symbol of "break," showing that there is no glide between the letters juxtaposed. Thus (s + ii) is usually written (sii), but (s⁾ii) are the two letters and their sounds (s, ii) without any glide, of great use in theoretical discussions.

()) the second half of a parenthesis placed between two letters shows that, though they belong to different words, they run on with a glide as if they belonged to the same word, very convenient in dialect writing, as (*oo*lˋ⁾d)ɪ·mɐn) old woman, usually written *ole dumman* by dialect writers; here (ˋ) shows that (l) is held, but (⁾) marks that it does not run on to the (d), which, however, is shown by ( )) to belong to the same word with (l), but to run on to (ɪ) in the next word.

(⌊) is [cut at the height of a non-ascending letter and shows that the letter it precedes is scarcely perceptible in speech, as (:màdhˏri⌊dhˏ) Madrid.

There are many more palaeotype letters and signs, here omitted for brevity, but found necessary for phonetical discussions.

21. *Practical Alphabets.*—The above alphabetical list comprises 243 symbols, made up of 192 elements, 14 vowel diphthongs, 4 consonant diphthongs. 19 modifiers, and 11 other signs. It has been reduced to the smallest possible number suitable for giving a notion of the kind of symbolization required for universal alphabets. The list from which it was extracted contained double the number and was still incomplete, even so far as the writer's investigations had extended. A universal alphabet would probably require a thousand cases to be provided for. It would be difficult for even the inventors to use such an alphabet, and absurd to present it for practical use. Inventors have therefore had recourse to *radical* signs symbolizing what they consider the principal relations and modifiers of these radicals. Some, as Brücke, Merkel, Bell, and Sweet, use entirely new characters, of which Bell's and Sweet's are intended by their shape to recall the positions of the organs of speech in uttering the sounds represented. But these writers are not agreed either as to the shape or value of the radicals themselves. The modifiers are very various, and when more than one modifier is required the characters

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[1] "Russian Pronunciation," in *Trans. Philol. Soc.*, 1877–79, p. 544.

[2] "Die Arabischen Sprachlaute und Sclavisches *y*," in *Trans. Berlin Acad. Sci.*, 1861, p. 150.

[3] "Spoken North Welsh," in *Trans. Philol. Soc.*, 1882–84.

[4] *Ibid.*, p. 43.

become too complicated for the eye and hand to deal with them rapidly. Universal writing is still a philosopher's stone, though much has been learned in its pursuit. Palaeotype is of course a mere typographical makeshift.

Fortunately writing long preceded phonetic knowledge. The number of distinct sounds in any one language seldom exceeds fifty, and practically fewer still are needed, for a native needs only a broad hint of the sound to reproduce it. The signs for English in art. 1 are rather superabundant than deficient, and the small additions of foreign signs suffice for French, German, and Italian practically, though very deficient scientifically. In fact, the modes of combining sounds in those three languages and English are so different that the alphabet has to be differently conceived for each. This is the final breakdown of universal writing. An English, German, French, and Italian reader, each requires an alphabet founded on his own linguistic habits, and very insufficiently comprehends any other. But even a rough appreciation for linguistic purposes is better than the thoroughly false appreciations now current. To obtain a scientific foundation for erecting an alphabet of any language which shall have scientific value, five stages are needed: (1) the perfect acquisition of a series of words containing every sound used; (2) variation of each word by involving its sounds in different combinations to appreciate the effects of gliding juxtaposition; (3) the perfect acquisition of short sentences of different characters to understand the effects of construction and emotion; (4) the study of unrestrained conversation between natives from the phonetic point of view; (5) frequent writing from the dictation of natives and teaching others to read by the signs adopted after the first four stages are passed. How far the characters should indicate the positions of the organs of speech is another point, which need not be considered at first, and can only be accomplished with extreme roughness even at last. Thus Bell's capitally conceived and executed "visible speech" requires much explanation to be intelligible and after all tells but little. Any signs easy to write and distinct to read without wearying the eye will suffice, provided each be furnished with a full explanation (much longer and more explicit than the greatly condensed explanations of art. 20) not only of its separate but its combined power, and the requisite knowledge for furnishing these cannot be obtained without much and long-continued labor. Mr. Sweet's studies of Danish, Swedish, Russian, Portuguese, and North Welsh pronunciation are models in their way, especially the last, but suffer from extreme conciseness.

The use of such phonetic studies is principally philological, a much smaller amount of precision sufficing for all the purposes of ordinary life,—understanding speech and speaking intelligibly, writing speech from dictation and reading what is written. Our scientific knowledge of speech-sounds has really only just commenced, and is therefore extremely incomplete and confined to very few people. But what has as yet been learned is of great practical value in the reduction of unwritten dialects and languages to writing, in exhibiting the actual speaking habits of existent written tongues, in divining the intention of systems of writing employed in extinct languages, and hence in historically tracing the cognation and filiation of one language to another and the successive forms assumed in the gradual development of a single form of speech. These great applications of the study of speech-sounds, as well as the practical introduction of systems of spelling easier to read and write than those now found in most of Europe (including European America) and Asia, lie beyond the scope of this article, which only aims at showing in extremely condensed terms the foundations of the theory of their combinations and some of their most important and best known forms.

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SPEKE, John Canning[1] (1827–1864), an eminent African explorer, who was the first European to cross Central Africa from north to south and to determine the existence and position of the great water basin from which the Nile proper issues full formed. He was born on 4th May, 1827, at Jordans near Ilchester, in Somersetshire. Entering the Indian army in 1844, he served in Sir Colin Campbell's division in the Punjab campaigns, and gradually acquired no small repute both as a military officer and as a sportsman and naturalist. When on furlough Captain Speke often advanced into unexplored portions of the Himalayas, and even crossed the frontier into Tibet; but his attention was at an early date turned to the great problems not of Asiatic but of African geography, and in 1854 he commenced his brief and brilliant African career by an expedition along with Captain Burton into Somali land, the incidents of which are narrated in *What led to the Discovery of the Source of the Nile* (London, 1864). It was along with the same explorer that the expedition of 1857–59 was undertaken, in the course of which Captain Speke, leaving Captain R. F. Burton, unfortunately invalided, at Kazé, struck northwards and reached the shores of Lake Victoria Nyanza in the neighborhood of a nullah, which he named Jordans after his birthplace. Convinced though he was that this lake belonged to the Nile system, he had no absolute proof to offer to the skepticism of his fellow-traveller and many stay-at-home geographers, until in 1863 he returned from another expedition along with Captain James Augustus Grant, in which he struck the Nile at its exit from the lake, and proved its identity with the river of Egypt by following it most of the way down. Captain Speke was expected to hold a public discussion with Captain Burton as to certain disputed points in the history of his discoveries at the British Association in Bath (1864); but on the very morning (15th September) fixed for the tournament he was killed by the accidental discharge of his own gun as he was crossing a fence while out shooting.

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[1] [His name is given John Hanning on the title page of his *Journal*.—Am. Ed.]

See Speke, *Journal of the Discovery of the Source of the Nile*, 2 vols., 1863; J. A. Grant, *A Walk across Africa*, 1864.

SPENCER, John Charles Spencer, third Earl (1782–1845), better known by his courtesy title of Lord Althorp, had the good fortune to be acquainted, through his father's official position in the ministries of Pitt and Grenville, with both Pitt and Fox, and to be the confidential ally, through his own sound judgment and political honesty, of the leaders of the Whig party immediately before and after the Reform Bill of 1832. His father, the second earl, was well versed in books. His mother, the eldest daughter of Lord Lucan, was conspicuous in London society for her gayety and brightness. Their eldest son, John Charles, was born at Spencer House, London, on 30th May, 1782, and sent to Harrow for his education when less than eight years old. At school he was chiefly remarkable for his love of sports and for a shyness which accompanied him throughout life, but fortunately did not prevent him whilst at Harrow from forming two or three acquaintances which proved useful in parliamentary life. In January, 1800, he took up his residence at Trinity College, Cambridge, and for some time applied himself energetically to mathematical studies; but during the last year of his life at college he surrendered himself a captive to the pleasures of hunting and racing. Almost immediately after taking the degree of M.A., in June, 1802, he set out on a Continental tour, which was cut short, after he had passed some months in the chief cities of Italy, by the renewal of war. Through the influence of Pitt's Government he was returned to parliament for the borough of Okehampton in Devonshire in April, 1804, and, although he vacated his seat in February, 1806, to contest the university of Cambridge against Lord Henry Petty and Lord Palmerston (when he was hopelessly beaten), he was re-elected in the same month for Okehampton, and rewarded with the emoluments of a lord of the treasury. At the general election in November, 1806, the freeholders of Northamptonshire selected him as their representative, and he continued to sit for the county until he succeeded to the peerage. His tastes were then, as ever, for country life, but his indignation at the duke of York's conduct at the Horse Guards led him to move a resolution of the House of Commons in 1809 for the duke's removal from his post. For the next few years after this speech Lord Althorp occasionally spoke in debate and always on the side of Liberalism, but from 1813 to 1818 he rarely entered the doors of the House of Commons. His absence was partly due to a feeling that it was hopeless to struggle against the will of the Tory ministry, but more particularly to his marriage on 14th April, 1814, to Esther, only daughter of Richard Acklon of Wiseton Hall, Nottinghamshire. In 1819, on his return to political life after the death of his wife, and for many years after that date, he pressed upon the attention of the House the necessity of establishing a more efficient bankruptcy court, and of expediting the recovery of small debts: and, although his name is not associated with the attainment of either of these objects, he saw both accomplished before 1825. During the greater part of the reign of George IV. the Whigs lost their legitimate influence in the state from their want of cohesion, but this defect was soon remedied when Lord Althorp was chosen their leader in the Lower House, and his capacity for the position was proved by experience. When Lord Grey's administration was formed at the close of 1830 the chancellorship of the exchequer combined with the leadership of the House of Commons was naturally entrusted to Lord Althorp, and to him more than to any other man, with the exception of the prime minister and the lord chancellor, may be attributed the success of the Government measures. The budget, it is true, was a failure, but this misfortune was soon forgotten in the struggles over the Reform Bill. The consideration of the preliminaries of this measure was assigned to four ministers, two in the cabinet and two outside that body; but their proposals were, after careful examination, approved or rejected by Lord Grey and Lord Althorp before they were brought under the notice of the cabinet. When the Bill was ready for introduction to the House of Commons its principles were expounded by Lord John Russell; but from the commencement of the protracted discussion over its details he had the assistance of Lord Althorp, and after some weeks of incessant toil, which the physique of Lord John Russell could not sustain any longer, the whole responsibility was cast on Lord Althorp. To combat the objections of three such pertinacious opponents as Croker, Sugden, and Wetherell required both skill and courage, and in Lord Althorp these qualities were found. He was constantly on his legs, and on one evening he made as many as twenty speeches. The Reform Bill was carried at last, and popular instinct was right in assigning to the leader of the House a credit only second to that earned by Lord John Russell. After the dissolution the Whigs returned to power with augmented numbers; but differences soon showed themselves among both leaders and followers, and their majority crumbled away. Their position was strengthened for a time by triumphantly carrying a new poor law Bill; and even their keenest critics would now allow that, had the Whig propositions on tithes and church-rates been carried into effect, many years of passionate controversy would have been spared. The ministry of Lord Grey was shattered to pieces by difficulties over an Irish coercion Bill, in which O'Connell thought that he had been unfairly treated. Although Lord Melbourne became premier (14th July, 1834), the fortunes of the ministry rested on Lord Althorp's presence in the House of Commons. The death of Lord Spencer on 10th November, 1834, called his son to the Upper House, and William IV. took advantage of this event to summon a Tory cabinet to his side. The new Lord Spencer abandoned the cares of office and returned to country life with unalloyed delight. Often as he was urged by his political friends to come to their assistance, he rarely quitted the peaceful pleasures which he loved. He died at Wiseton on 1st October, 1845. The Whigs required, to carry the Reform Bill, a leader of unstained character, one to whom party spirit could not attach the suspicion of greed of office, and against Lord Althorp malevolence was powerless. No stronger proof of his pre-eminence could be given than the oft-quoted saying of Lord Hardinge that one of Croker's ablest speeches was demolished by the simple statement of Lord Althorp that he had collected some figures which entirely refuted it, but had lost them. The trust which the House put in him then was never wanting.

SPENER, Philipp Jakob (1635–1705), "the father of Pietism," was born 13th January, 1635, at Rappoltsweiler in Upper Alsace. He received his earliest education from his subsequent brother-in-law, Joachim Stoll, chaplain to the count of Rappoltstein, whose wife was Spener's godmother. After a brief stay in the grammar-school of Colmar he entered the university of Strasburg in 1651 as a student of theology,—living there with an uncle, and holding quite aloof from the student-life of the place. He devoted himself to philology, history, and philosophy, and won his degree of master (1653) by a disputation against the philosophy of Hobbes. He then became private tutor to the princes Christian and Charles of the Palatinate, and lectured in the university on philology and history. From 1659 to 1662 he visited the universities of Basel, Tübingen, and Geneva, and commenced the study of heraldry, which he pursued throughout his life. In Geneva especially his religious views and tendencies were turned in the direction of his subsequent Pietism. He returned to Strasburg in 1663, where he was appointed preacher without pastoral duties, with the right of holding lectures in the university. Three years afterwards he was invited to become the chief pastor in the Lutheran church at Frankfort-on-the-Main. He had previously married a lady of his mother's choice, who made him an excellent wife and bore him eleven children. Immediately after his removal to Frankfort he commenced that line of pastoral work which issued in the movement called PIETISM (*q.v.*). In 1686 he accepted the invitation to the first court chaplaincy at Dresden. But the elector John George III., at whose personal desire the post had been offered to him, was soon offended at the fearless conscientiousness with which his chaplain sought to discharge his pastoral duties; and the opposition of the Saxon university of Leipsic to the Pietistic movement and to Spener personally served to render the chaplain more decidedly a *persona ingrata* to the elector. Spener refused to resign his post, and the Saxon Government hesitated to dismiss him. But in 1691 the Saxon representative at Berlin induced the court of Brandenburg to offer him the rectorship of St. Nicolas in Berlin with the title of "consistorialrath." In Berlin Spener was held in high honor, though the tendencies of the court and the Government officials were rather rationalistic than pietistic. One of the most important works of this period of his life was the foundation of the university of Halle (1691), which he directed. All his life long Spener had been exposed to the incessant attacks and abuse of the orthodox Lutheran theologians, who generally charged him with the errors in doctrine and extravagances in practice of followers who had borrowed from him everything rather than his wisdom and caution. With his years his opponents multiplied, and the movement which he had inaugurated presented increasingly matter for hostile criticism. In 1695 the theological faculty of Wittenberg formally laid to his charge 283 errors, and only his death (5th February, 1705) released him from these fierce conflicts.

Though Spener has been justly called "the father of Pietism," hardly any of the errors and none of the extravagances of the movement can be ascribed to him personally. So far was he from sharing them that Ritschl maintains (ii. p. 163) that "he was himself not a Pietist," as he did not advocate the quietistic, legalistic, and semi-separatist practices of Pietism, though they were more or less involved in the positions he assumed or the practices which he encouraged or connived at. The only two points on which he departed from the orthodox Lutheran faith of his day were the requirement of regeneration as the *sine qua non* of the true theologian, and the expectation of the conversion of the Jews and the fall of Papacy as the prelude of the triumph of the church. He did not, like the later Pietists, insist on the necessity of a conscious crisis of conversion, nor did he encourage a complete breach between the Christian and the secular life.

Spener was a voluminous writer. The list of his published works comprises 7 vols. folio, 63 quarto, 7 octavo, 46 duodecimo; and in one year he had answered 622 and had still to answer 300 letters. The most important of his works for their bearing on his history are *Theologische Bedenken*, in 4 parts, Halle, 1700–1702; *Letzte theologische Bedenken*, with a life of Spener by Canstein, Halle, 1711; *Concilia et judicia theologica Latina* (posthumous), Frankfort, 1709.

See Hossbach, *Philipp Jakob Spener und seine Zeit* (Berlin, 1828, 2d ed. 1858, 3d ed. 1861); Tholuck, in Herzog-Plitt's *Real-Encyklopädie* (2d ed., vol. xiv.); Gass, *Protestantische Dogmatik* (Berlin, 1857); Ritschl, *Gesch. des Pietismus*, ii. p. 97, *sq.* (Bonn, 1884); and Sachsse, *Ursprung und Wesen des Pietismus* (Wiesbaden, 1884).

SPENNYMOOR, a market town of Durham, England, is situated on the Ferryhill and Bishop Auckland branch of the North-Eastern Railway, 3½ miles northwest of Ferryhill and 6 south of Durham by road. Within recent years it has increased with great rapidity owing to the production of coal and iron, and in 1865 it was formed into a market town under a local board of health. It possesses a town hall, a mechanics' institute and reading room, and two market halls. A school board was formed in 1875. The population of the urban sanitary district (area 176 acres) in 1871 was 4627, and in 1881 it was 5917.

SPENSER, EDMUND (*c.* 1552–1599), Elizabethan poet, was born in London about the year 1552. The received date of his birth rests on a passage in sonnet lx. of the *Amoretti.* He speaks there of having lived forty-one years; the *Amoretti* was published in 1595, and described on the title-page as "written not long since"; this would make the year of his birth 1552 or 1553. We know from the *Prothalamion* that London was his birthplace. This at least seems the most natural interpretation of the words:

> "Merry London, my most kindly nurse,
> That to me gave this life's first native source."

It would appear from a recent discovery by Mr. R. B. Knowles[1] that the relationship of the poet to the noble family of Spencer, if it existed at all—and official names such as Spenser (Dispenser) or Stewart (Steward) carry no proof of consanguinity—was remote, and that the poet's kinsmen must be sought among the humbler Spensers of northeast Lancashire. Robert Nowell, a London citizen, left a sum of money to be distributed in various charities, and in the account books of his executors Mr. Knowles has discovered among the names of other beneficiaries "Edmund Spensore, scholar of the Merchant Taylor School, at his going to Pembroke Hall in Cambridge." The date of this benefaction is 28th April, 1569. As the poet is known to have been a sizar of Pembroke, the identification is beyond dispute. Till this discovery it was not known where Spenser received his school education. The speculations as to the poet's parentage started by the Nowell MS. are naturally more uncertain. Mr. Knowles found three Spensers in the books of the Merchant Taylors, and concluded that the poorest of them, John Spenser, a "free journeyman" in the "art or mystery of clothmaking," might have been the poet's father, but he afterwards abandoned this theory. Mr. Grosart, however, adheres to it, and gives a confident solution of Mr. Knowles's difficulties. Nothing approaching certainty can be reached on the point, which is not itself of much importance. The connection of Spenser with Lancashire is also supported by the Nowell MS. Several Spensers of that county appear among the "poor kinsfolk" who profited by Nowell's bounty.

It is natural that a poet so steeped in poetry as Spenser should show his faculty at a very early age; and there is strong reason to believe that verses from his pen were published just as he left school at the age of sixteen or seventeen. Certain pieces, translations from Du Bellay and Petrarch, afterwards included in a volume of poems by Spenser published in 1591, are found in a miscellany, *Theatre for Worldings*, issued by a Flemish Protestant refugee, John van der Noodt, on the 25th of May, 1569. The translations from Du Bellay appear in blank verse in the miscellany, and are rhymed in sonnet form in the later publication, but the diction is substantially the same; the translations from Petrarch are republished with slight variations. Poets were so careless of their rights in those days and publishers took such liberties that we cannot draw for certain the conclusion that would be inevitable if the facts were of more modern date; but the probabilities are that these passages in Van der Noodt's *Theatre*, although the editor makes no acknowledgment, were contributed by the schoolboy Spenser. As the exercises of a schoolboy writing before our poetic diction was enriched by the great Elizabethans, they are remarkable for a sustained command of expression which many schoolboys might exhibit in translation now, but which was a rarer and more significant accomplishment when Surrey and Sackville were the highest models in post-Chaucerian English.

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[1] See *The Spending of the Money of Robert Nowell*, privately printed, 1877.

Little is known of Spenser's Cambridge career, except that he was a sizar of Pembroke Hall, took his bachelor's degree in 1572, his master's in 1576, and left Cambridge without having obtained a fellowship. Mr. Grosart's inquiries have elicited the fact that his health was not good,—college allowances while he was in residence being often paid "Spenser ægrotanti." One of the fellows of Pembroke strongly influenced his destiny. This was Gabriel Harvey, a prominent figure in the university life of the time, an enthusiastic educationist, vigorous, versatile, not a little vain of his own culture and literary powers, which had gained him a certain standing in London society. The revival and advancement of English literature was a passion of the time, and Harvey was fully possessed by it. His fancy for reforming English verse by discarding rhyme and substituting unrhymed classical metres, and the tone of his controversy with Thomas Nash, have caused him to be regarded as merely an obstreperous and pragmatic pedant; but it is clear that Spenser, who had sense enough not to be led astray by his eccentricities, received active and generous help from him and probably not a little literary stimulus. Harvey's letters to Spenser[1] throw a very kindly light on his character.

Three years after leaving Cambridge, in 1579, Spenser issued his first volume of poetry, the *Shepherd's Calendar*. Where and how he spent the interval have formed subjects for elaborate speculation. That most of it was spent in the study of his art we may take for granted. That he lived for a time in the "north parts" of England; that there or elsewhere he fell in love with a lady whom he celebrates under the anagram of "Rosalind"; that his friend Harvey urged him to return south, and introduced him to Sir Philip Sidney; that Sidney took to him, discussed poetry with him, introduced him at court, put him in the way of preferment,—are ascertained facts in his personal history. Mr. Grosart conjectures with considerable plausibility that he was in Ireland in 1577 in the service of Sir Henry Sidney, Philip's father, and returned to England with that administrator in 1578.

The interest of the *Shepherd's Calendar* is mainly personal to Spenser. Its twelve poems continue to be read chiefly because they were the first published essays of the author of the *Faery Queen*, the poems in which he tried and disciplined his powers. They mark no stage in the history of pastoral poetry. Spenser had too strong a genius not to make his own individuality felt in any form that he attempted, and his buoyant dexterity in handling various schemes of verse must always afford delight to the connoisseur in such things. But a reader not already interested in Spenser, or not already familiar with the artificial eclogue, would find little to attract him in the *Shepherd's Calendar*. The poems need a special education; given this, they are felt to be full of charm and power, a fresh and vivid spring to the splendid summer of the *Faery Queen*. The diction is a studiously archaic artificial compound, partly Chaucerian, partly North Anglian, partly factitious; and the pastoral scenery is such as may be found in any country where there are sheep, hills, trees, shrubs, toadstools, and running streams. That Spenser, having been in the north of England, should have introduced here and there a touch of north country color is natural enough, but it is not sufficient to give a character to the poems as pastoral poems. As such they follow continuously and do not violently break away from Latin, Italian, and French predecessors, and Mr. George Saintsbury is undoubtedly right in indicating Marot as the most immediate model. At the same time one can quite understand on historical grounds why the *Shepherd's Calendar* was hailed with enthusiasm as the advent of a "new poet." Not only was it a complete work in a form then new to English literature, but the execution showed the hand of a master. There had been nothing so finished, so sustained, so masterful in grasp, so brilliant in metre and phrase, since Chaucer. It was felt at once that the poet for whom the age had been waiting had come. The little coterie of friends whose admiration the young poet had won in private were evidently concerned lest the wider public should be bewildered and repelled by the unfamiliar pastoral form and rustic diction. To put the public at the right point of view the poems were published with a commentary by "E. K.,"—supposed to be one Edward Kirke, who was an undergraduate with Spenser at Pembroke. This so-called "glosse" explained the archaic words, revealed the poet's intentions, and boasted that, as in the case of Virgil, the pastoral poetry of the "new poet" was but "a proving of the wings for higher and wider flights." The "new poet's" name was withheld; and the identification of the various "shepherds"—of Cuddie and Rofly and Diggon Davie, and the beauteous golden-haired "widow's daughter of the glen"—was fortunately reserved to yield delight to the ingenious curiosity of a later age.[2]

The *Shepherd's Calendar* was published at Gabriel Harvey's instance, and was dedicated to Sir Philip Sidney. It was one out of many poetical schemes on which the young poet was busy in the flush of conscious power and high hopes excited by the admiration of the literary authorities whose approval was then most to be coveted. His letters to Harvey and Harvey's letters to him furnish hints for a very engaging fancy picture of Spenser at this stage of his life,—looking at the world through rose-colored spectacles, high in favor with Sidney and Leicester, dating his letters from Leicester House, gayly and energetically discussing the technicalities of his art, with some provision from his powerful friends—certain, but the form of it delightfully uncertain,—going to court in the train of Leicester, growing pointed beard and mustachios of fashionable shape, and frightening his ever-vigilant friend and mentor Harvey by the light courtier-like tone of his references to women. The studious pastoral poet from "north parts" had blossomed with surprising rapidity in the image of the gay fortune-seeking adventurers who crowded the court of the virgin queen in those stirring times. Some of the poems which he mentions to Harvey as then completed or on the anvil—his *Dreams*, his *Nine Comedies*, his *Dying Pelican*, and his *Stemmata Dudleiana* (singing the praises of the noble family which was befriending him)—have not been preserved, at least in any form that can be certainly identified. He had sent Harvey a portion of the *Faery Queen*, which he was eager to continue; but Harvey did not think much of it—a judgment for which Harvey is often ridiculed as a dull pedant, as if we knew for certain that what was submitted to him was identical with what was published ten years later.

Spenser was appointed secretary to the lord-deputy of Ireland in 1580, and was one of the band of adventurers who, with mixed motives of love of excitement, patriotism, piety, and hopes of forfeited estates, accompanied Lord Arthur Grey of Wilton to Ireland to aid in the suppression of Desmond's rebellion. Regret is sometimes expressed that the author of the *Faery Queen*, who ought to have been dreamy, meditative, gentle, and refined, should have been found in such company, and should have taken part in the violent and bloody scenes of Lord Grey's two years' attempt at "pacification." But such things must be judged with reference to the circumstances and the spirit of the time, and it must be remembered that England was then engaged in a fierce struggle for existence against the Catholic powers of the Continent. Of Lord Grey's character, his secretary was an enthusiastic admirer, exhibiting him in the *Faery Queen* as Arthegal, the personification of justice; and we know exactly what were his own views of Irish policy, and how strongly he deplored that Lord Grey was not permitted to carry them out. Spenser's *View of the State of Ireland*, drawn up after fourteen years' experience, is not the work of a gentle dreamer, but of an energetic and shrewd public official.

The *View* is not a descriptive work; there is nothing in the style to indicate that it was written by a poet; it is an elaborate state paper, the exposition in the form of a dialogue of a minutely considered plan for the pacification of Ireland, written out of zeal for the public service for the eyes of the Government of the day. A very thoroughgoing plan it is. After passing in review the history and character of the Irish, their laws, customs, religion, habits of life, armor, dress, social institutions, and finding "evil usages" in every department, he propounds his plan of "reformation." Reformation can be effected only by the sword, by the strong hand. The interlocutor in the dialogue holds up his hands in horror. Does he propose extermination? By no means; but he would give the Irish a choice between submission and extermination. The Government had vacillated too long, and, fearing the cost of a thorough operation, had spent twice as much without in any way mending matters. Let them send into Ireland 10,000 foot and 1000 horse, disperse them in garrisons—a complete scheme of localities is submitted—give the Irish twenty days to come in; if they did not come in then, give no quarter afterwards, but hunt them down like wild beasts in the winter time when the covert is thin; "if they be well followed one winter ye shall have little work to do with them the next summer"; famine would complete the work of the sword; and in eighteen months' time peace would be restored and the ground cleared for plantation by English colonists. There must be no flinching in the execution of this plan,—"no remorse or drawing back for the sight of any such rueful object as must thereupon follow, nor for compassion of their calamities, seeing that by no other means it is possible to recover them, and that these are not of will but of very urgent necessity." The Government had out of foolish compassion drawn back before when Lord Grey had brought the recalcitrant Irish to the necessary extremity of famine; the gentle poet warns them earnestly against a repetition of the blunder.

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[1] *Letter-Book of Gabriel Harvey*, Camden Society.

[2] See Mr. Grosart's *Complete Works of Spenser*, vol. I.

Such was Spenser's plan for the pacification of Ireland, propounded not on his own authority, but as having support in "the consultations and actions of very wise governors and counsellors, whom he had sometimes heard treat thereof." He knew that it was "bloody and cruel"; but he contended passionately that it was necessary for the maintenance of English power and the Protestant religion. Commentary on the plan, which has been so much and so warmly discussed, would be out of place here. The method was repugnant to the kindly nature of average Englishmen; from the time of Lord Grey no English authority had the heart to go through with it till another remorseless zealot appeared in the person of Cromwell. That Cromwell knew the treatise of "the sage and serious Spenser," perhaps through Milton, is probable from the fact that the poet's Irish estates were secured to his grandson by the Protector's intervention in 1657. These estates had been granted to Spenser as his share in the redistribution of Munster,—3000 acres of land and Kilcolman castle, an ancient seat of the Desmonds, in the north of the county of Cork. The elaborate and business-like character of the *View* shows that the poet was no sinecurist, but received his reward for substantial political services. He ceased to be secretary to the lord-deputy when Lord Grey was recalled in 1582; but he continued in the public service, and in 1586 was promoted to the onerous position of clerk to the council of Munster.

Amidst all the distractions of his public life in Ireland, Spenser seems to have proceeded steadily with the composition of the *Faery Queen*, translating his varied experience of men and affairs into the picturesque forms of his allegory, and expressing through them his conception of the immutable principles that ought to regulate human conduct. He had, as we have seen, conceived a work of the kind and made a beginning before he left England. The conception must have been very much deepened and widened and in every way enriched by his intimate daily contact with the actual struggle of conflicting individuals and interests and policies in a great crisis. Some four or five years later, being asked in a mixed company of English officials in Ireland (as recorded in Lodowick Bryskett's *Discourse of Civil Life*) to give off hand a short sketch of "the ethical part of moral philosophy" and the practical uses of the study, Spenser explained to these simple-minded men that the subject was too intricate for an impromptu exposition, but that he had in hand a work called the *Faery Queen* in which an ethical system would be exhibited in action. The respect paid by his official brethren to Spenser as a man, "not only perfect in the Greek tongue, but also very well read in philosophy, both moral and natural," is an interesting item in his biography. Some years later still, when Spenser was settled at Kilcolman castle, Sir Walter Raleigh found him with three books of the *Faery Queen* completed, and urged him to come with them to London. London accordingly he revisited in 1589, after nine years' absence. There is a very pretty record of this visit in *Colin Clout's Come Home Again*, published in 1595, but written in 1591, immediately after his return to Kilcolman. The incidents of the visit, by that time matters of wistful memory, are imaged as a shepherd's excursion from his quiet pastoral life into the great world. Colin Clout calls round him once again the masked figures of the *Shepherd's Calendar*, and describes to them what he saw, how he fared, and whom he met at the court of Cynthia, and how through the influence of "the Shepherd of the Ocean" he was admitted at timely hours to play on his oaten pipe in the great queen's presence.

How much is pure fiction and how much veiled fact in this picture cannot now be distinguished, but it is undoubted that Spenser, though his chief patrons Leicester and Sidney were now dead, was very graciously received by the great world on his return to London. Not only did the queen grant him an audience, but many ladies of the court, several of whom he afterwards honored with dedications, honored him with their patronage. The first three books of the *Faery Queen*, which were entered at Stationers' Hall on the 1st December, 1589, were published in 1590, and he was proclaimed at once with remarkable unanimity by all the writers of the time as the first of living poets.

From the first week of its publication the literary world has continued unanimous about the *Faery Queen*, except on minor points. None of our great poets has been welcomed with such universal acclaim and upheld without loss of favor through so many changes of fashion. When romanticism was at its lowest ebb Pope read Spenser in his old age with as much delight as in his boyhood. He speaks himself of having had his detractors, of having suffered from the venomous tooth of the Blatant Beast, and he seems to have had in more than ordinary share the poet's sensitiveness to criticism; but the detractors or indifferentists have generally been found among men who, like the lord high treasurer Burghley, have no liking for poetry of any kind. The secret of Spenser's enduring popularity with poets and lovers of poetry lies specially in this that he excels in the poet's peculiar gift, the instinct for verbal music. Shakespeare, or the author of the sonnet usually assigned to him, felt and expressed this when he drew the parallel between "music and sweet poetry"—

> "Thou lovest to hear the sweet melodious sound
> That Phœbus' lute, the queen of music, makes;
> And I in deep delight am chiefly drowned
> Whenas himself to singing he betakes."

This is an early word in criticism of Spenser, and it is the last word about his prime and unquestionable excellence,—a word in which all critics must agree. Whether he had imagination in the highest degree or only luxuriant fancy, and whether he could tell a story in the highest epic manner or only put together a richly varied series of picturesque incidents, are disputable points; but about the enchantment of his verse there can be no difference of opinion. It matters not in the least that he gains his melody often by archaic affectations, licenses of diction that should make Dr. Richard Morris "stare and gasp"; there, however purchased, the marvellously rich music is. In judging of the structure of the *Faery Queen* we must always remember that, long and diffuse as it is, what we have is but a fragment of the poet's design, and that the narrative is regulated by an allegorical purpose; but, however intricate, however confused, the reader may feel the succession of incidents to be, when he studies the succession of incidents, it is only at the call of duty that he is likely to occupy himself with such a study in reading Spenser.

The ethical value of the allegory has been very variously estimated. The world would probably never have divined that there was any allegory if he had not himself drawn attention to it in a prose dedication and in doggerel headings to the cantos. It was apparently at his friend Raleigh's suggestion that the poet condescended to explain his ethical purpose; otherwise it would have been as problematical as the similar intention in the case of the *Idylls of the King* before that intention was expressly declared. It is almost to be regretted, as far as the allegory is concerned, that the friendly "E. K." was not employed to furnish a "glosse" to the *Faery Queen* as he had done to the *Shepherd's Calendar*. Undoubtedly the peculiar "poetic luxury" of the *Faery Queen* can be enjoyed without any reference to the allegory; even Professor Dowden, the most eloquent champion of Spenser's claims as a "teacher," admits that it is a mistake to look for minute correspondence between outward symbol and underlying sense, and that the poet is least enjoyable where he is most ingenious. Still the allegory governs the structure of the poem, and Spenser himself attached great importance to it as determining his position among poets. The ethical purpose is distinctive of the poem as a whole; it was foremost in Spenser's mind when he conceived the scheme of the poem, and present with him as he built up and articulated the skeleton; it was in this respect that he claimed to have "overpassed" his avowed models Ariosto and Tasso. If we wish to get an idea of Spenser's imaginative force and abundance, or to see his creations as he saw them, we must not neglect the allegory. It is obvious from all that he says of his own work that in his eyes the ethical meaning not only heightened the interest of the marvellously rich pageant of heroes and heroines, enchanters and monsters, but was the one thing that redeemed it from romantic commonplace. For the right appreciation of many of the characters and incidents a knowledge of the allegory is indispensable. For example, the slaughter of Error by the Red Cross knight would be merely disgusting but for its symbolic character; the iron Talus and his iron flail is a revolting and brutally cruel monster if he is not regarded as an image of the executioner of righteous law; the Blatant Beast, a purely grotesque and ridiculous monster to outward view, acquires a serious interest when he is known to be an impersonation of malignant detraction.

After the publication of the *Faery Queen* Spenser seems to have remained in London for more than a year, to enjoy his triumph. It might be supposed, from what he makes the Shepherd of the Ocean say in urging Colin Clout to quit his banishment in Ireland, that Raleigh had encouraged him to expect some permanent provision in London. If he had any such hopes they were disappointed. The thrifty queen granted him a pension of £50 [$243], which was paid in February, 1591, but nothing further was done for him. Colin Clout's explanation that the selfish scrambling and intriguing of court life were not suited to a lowly shepherd swain, and that he returned to country life with relief, may be pastoral convention, or it may have been an expression of the poet's real feelings on his return to Kilcolman, although as a matter of fact there seems to have been as much scrambling for good things in Munster as in London. Certain it is that he did return to Kilcolman in the course of the year 1591, having probably first arranged for the publication of *Daphnaida* and *Complaints*. *Daphnaida* is a pastoral elegy on the death of the niece of the mistress of the robes. The fact implied in the dedication that he was not personally known to the lady has more than once provoked the solemn remark that the poet's grief was assumed. Of course it was assumed; and it is hardly less obvious that sincerity of personal emotion, so far from being a merit in the artificial forms of pastoral poetry, the essence of which lies in its dreamy remoteness from real life, would be a blemish and a discord. Any suggestion of the poet's real personality breaks the charm; once raise the question of the poet's personal sincerity and the pastoral poem may at once be thrown aside. The remark applies to all Spenser's minor poetry, including his love-sonnets; the reader who raises the question whether Spenser really loved his mistress may have a talent for disputation but none for the full enjoyment of hyperbolical poetry. *Complaints*, also published in 1591, is a miscellaneous collection of poems written at different periods. The volume contained *The Ruins of Time; The Tears of the Muses; Virgil's Gnat; Mother Hubbard's Tale; The Ruins of Rome; Muiopotmos; Visions of the World's Vanity; Bellay's Visions; Petrarch's Visions.* Some of these pieces are translations already alluded to and interesting only as the exercises of one of our greatest masters of melodious verse; but two of them, *The Tears of the Muses* and *Mother Hubbard's Tale*, have greater intrinsic interest. The first is the complaint of the decay of learning alluded to in *Midsummer Night's Dream*, v. 1, 52—

> "The thrice three Muses mourning for the death
> Of Learning late deceased in beggary."

The lament, at a time when the Elizabethan drama was "mewing its mighty youth," was not so happy as some of Spenser's political prophecies in his *View of Ireland;* but it is idle work to try to trace the undercurrents and personal allusions in such an occasional pamphlet. *Mother Hubbard's Tale*, a fable in Chaucerian couplets, shows a keenness of satiric force not to be paralleled in any other of Spenser's writings, and suggests that he left the court in a mood very different from Colin Clout's.

Spenser returned to London probably in 1595. He had married in the interval a lady whose Christian name was Elizabeth—Mr. Grosart says Elizabeth Boyle. The marriage, celebrated on the 11th of June, 1594, was followed by a rapid succession of publications. The first was a volume (entered at Stationers' Hall, 19th November, 1594, published 1595) containing the *Amoretti*, a series of exquisite sonnets commemorative of the moods and incidents of his courtship, and the magnificent *Epithalamion*, incomparably the finest of his minor poems. As in the case of the *Complaints*, the publisher for obvious reasons issued this volume nominally without his authority. *Colin Clout's Come Home Again* was published in the same year, with a dedication to Sir Walter Raleigh, dated 1591. Early in 1596 the second three books of the *Faery Queen* were entered in the register of Stationers' Hall; and in the course of the same year were published his *Four Hymns*, his *Prothalamion*, and his *Astrophel*, a pastoral lament for Sir Philip Sidney, which he dedicated to the countess of Essex.

That Spenser wrote more of the *Faery Queen* during the last two years of his life, and that the MS. perished in the sack of Kilcolman castle by the rebels, may plausibly be conjectured, but cannot be ascertained. During those years he would seem to have been largely occupied with political and personal cares. He describes himself in the *Prothalamion* as a disappointed suitor at court. He drew up his *View of Ireland* in 1596 when he was in London, and from various circumstances it is evident that he had hopes of some kind from the favor of Essex. The *View*, with its urgent entreaty that Essex should be sent to Ireland, was entered at Stationers' Hall in April, 1598, but he did not obtain leave to publish it.[1] Burghley, who had long stood in his way, died in August of that year, and next month Spenser was appointed sheriff of Cork. In October Tyrone's rebellion broke out, and Spenser's house was sacked and burned. The poet himself escaped, and in December was sent to London with despatches. Again he ventured to urge upon the queen his plan for the thorough "reformation" of Ireland. But his own end was near. On 16th January, 1599, he died at Westminster, ruined in fortune, if not heart-broken, and was buried in Westminster Abbey, near his master Chaucer.

There have been many editions of Spenser's works. The most available and complete is the Globe edition, with a carefully edited text by Dr. R. Morris, and a memoir by Professor J. W. Hales. Mr. Grosart's edition, with its keenly argumentative biography and copious collection of variorum researches and critical opinions, is printed for private circulation. (W. M.)

SPERMACETI is a solid waxy body found in special cavities in the head of the sperm whale (*Physeter macrocephalus*), where it is held in solution by sperm oil while the creature is in life. At a temperature of about 6° C. the solid matter separates in a crystalline condition, and when purified by pressure and treatment with weak solution of caustic alkali it forms brilliant white crystalline scales or plates, hard but unctuous to the touch, and destitute of taste or smell. It is quite insoluble in water, very slightly affected by boiling alcohol, but easily dissolved in ether, chloroform, and carbon bisulphide. Spermaceti consists principally of cetin or cetyl palmitate, $\left.\begin{matrix}C_{16}H_{31}O\\C_{16}H_{33}\end{matrix}\right\}O$,—an ether composed of cetyl alcohol combined with palmitic acid. Spermaceti candles of definite size are employed as a standard for illuminants on account of the uniform steady light they afford. The substance is further used in the dressing of fabrics and in medicine and surgery, especially in cerates, bougies, ointments, and in cosmetic preparations. For sperm oil, see WHALE OILS.

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[1] [This work was first published in 1633, as a part of a *Chronicle of Ireland*, having lain in MSS. for thirty-seven years.—AM. ED.]

SPEUSIPPUS, son of Eurymedon and Potone, is supposed to have been born about 407 B.C. He was bred in the school of Isocrates; but, when his maternal uncle, Plato, returned to Athens about 387, he yielded to his influence and became a member of the Academy. In 361, when Plato undertook his third and last journey to Sicily, Speusippus accompanied him. In 347 the dying philosopher nominated his nephew to succeed him as scholarch, and the choice was ratified by the school. Speusippus held the office for eight years, and died in 339 after a paralytic seizure. According to some authorities he committed suicide. There is a story that his youth was riotous, until Plato's example led him to reform his ways. In later life he was conspicuously temperate and amiable. He was succeeded by Xenocrates.

Of Speusippus's many philosophical writings nothing survives except a fragment of a treatise *On Pythagorean Numbers*. Nor have secondary authorities preserved to us any general statement or conspectus of his system. Incidentally, however, we learn the following details. (A) In regard to his theory of being,—(1) whereas Plato postulated as the basis of his system a cause which should be at once Unity, Good, and Mind, Speusippus distinguished Unity, the origin of things, from Good, their end, and both Unity and Good from controlling Mind or Reason; (2) whereas Plato recognized three kinds of numbers—firstly, ideal numbers, the formal causes of the ideas; secondly, mathematical numbers, the abstractions of mathematics; and thirdly, sensible numbers, numbers embodied in things—Speusippus rejected the ideal numbers, and consequently the ideas; (3) Speusippus traced number, magnitude, and soul each to a distinct principle of its own. (B) In regard to his theory of knowledge,—(4) he held that a thing cannot be known apart from the knowledge of all things besides; for, that we may know what a thing is, we must know how it differs from other things, which other things must, therefore, be known; (5) accordingly, in the ten books of a work called Ὅμοια, he attempted a classification of plants and animals; (6) the results thus obtained he distinguished at once from "knowledge" (ἐπιστήμη) and from "sensation" (αἴσθησις), holding that "scientific observation" (ἐπιστημονικὴ αἴσθησις), though it cannot attain to truth, may nevertheless, in virtue of a certain acquired tact, frame "definitions" (λόγοι). (C) In regard to his theory of ethics,—(7) he denied that pleasure was a good, but seemingly was not prepared to account it an evil.

In default of direct evidence, it remains for us to compare these scattered notices of Speusippus's teaching with what we know of its original, the teaching of Plato, in the hope of obtaining at least a general notion, firstly, of Speusippus's system, and, secondly, of its relations to the systems of Plato, of contemporary Platonists, such as Aristotle, and of the later Academy.

It has been suggested elsewhere (SOCRATES, p. 250 *supra*) that the crude and unqualified "realism" of Plato's early manhood gave place in his later years to a theory of natural kinds founded upon a "thoroughgoing idealism," and that in this way he was led to recognize and to value the classificatory sciences of zoology and botany. More exactly, it may be said that the Platonism of Plato's maturity included the following principal doctrines: (i.) the supreme cause of all existence is the One, the Good, Mind, which evolves itself as the universe under certain eternal immutable forms called "ideas"; (ii.) the ideas are apprehended by finite minds as particulars in space and time, and are then called "things"; (iii.) consequently the particulars which have in a given idea at once their origin, their being, and their perfection may be regarded, for the purposes of scientific study, as members of a natural kind; (iv.) the finite mind, though it cannot directly apprehend the idea, may, by the study of the particulars in which the idea is revealed, attain to an approximate notion of it.

Now when Speusippus (1) discriminated the One, the Good, and Mind, (2) denied the ideas, and (3) abandoned the attempt to unify the plurality of things, he explicitly rejected the theory of being expressed in (i.) and (ii.); and the rejection of the theory of being, *i.e.*, of the conception of the One evolving itself as a plurality of ideas, entailed consequential modifications in the theory of knowledge conveyed in (iii.) and (iv.). For, if the members of a natural kind had no common idea to unite them, scientific research, having nothing objective in view, could at best afford a λόγος or definition of the appropriate particulars; and, as the discrimination of the One and the Good implied the progression of particulars towards perfection, such a λόγος or definition could have only a temporary value. Hence, though, like Plato, Speusippus (4) studied the differences of natural products (5) with a view to classification, he did not agree with Plato in his conception of the significance of the results thus obtained; that is to say, while to Plato the definition derived from the study of the particulars included in a natural kind was an approximate definition of the idea in which the natural kind originated, to Speusippus the definition was a definition of the particulars studied, and, strictly speaking, of nothing else. Thus, while Plato hoped to ascend through classificatory science to the knowledge of eternal and immutable laws of thought and being, Speusippus, abandoning ontological speculation, was content to regard classificatory science not as a means but as an end, and (6) to rest in the results of scientific observation. In a word, Speusippus turned from philosophy to science.

It may seem strange that, differing thus widely from his master, Speusippus should have regarded himself and should have been regarded by others as a Platonist, and still more strange that Plato should have chosen him to be his successor. It is to be observed, however, firstly, that the scientific element occupied a larger place in Plato's later system than is generally supposed,[1] and, secondly, that the only Academics who came into competition with Speusippus agreed with him in his rejection of the theory of ideas. Hence, Plato, finding in the school no capable representative of his ontological theory, might well choose to succeed him a favorite pupil whose scientific enthusiasm and attainment were beyond question; and Speusippus's rivals, having themselves abandoned the theory of ideas, would not be in a position to tax him with his philosophical apostasy.

In abandoning the theory of ideas—that is to say, the theory of figures and numbers, the possessions of universal mind, eternally existent out of space and time, which figures and numbers when they pass into space and time as the heritage of finite minds are regarded as things—Speusippus had the approval, as of the Platonists generally, so also of Aristotle. But, whereas the new scholarch, confining himself to the detailed examination of natural kinds, attempted no comprehensive explanation of the universe, Aristotle held that a theory of its origin, its motions, and its order was a necessary adjunct to the classificatory sciences; and in nearly all his references to Speusippus he insists upon this fundamental difference of procedure. Conceiving that the motions of the universe and its parts are due to the desire which it and they feel towards the supreme external mind, so that the cosmical order is initial in the divine mind, final in the phenomenal universe, Aristotle supposes himself thus to secure the requisite unification of the variety of things. Contrariwise, when Speusippus distinguishes One, Good, and Mind, so that Mind, not as yet endowed with an orderly scheme, adapts the initial One to a variety of particular Goods, his theory of nature appears to his rival "episodical," *i.e.*, to consist of a series of tableaux wanting in dramatic unity, so that it reminds him of Homer's line—*οὐκ ἀγαθὸν πολυκοιρανίη· εἷς κοίρανος ἔστω.* The theory propounded by Aristotle himself is not perhaps impeccable in this respect, but at any rate he does not, like Speusippus, despair of a solution of the traditional problem of the One and the Many.

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[1] That Plato did not neglect, but rather encouraged, classificatory science is shown, not only by a well-known fragment of the comic poet Epicrates, which describes a party of Academics engaged in investigating, under the eye of Plato, the affinities of the common pumpkin, but also by the *Timæus*, which, while it carefully discriminates science from ontology, plainly recognizes the importance of the study of natural kinds.

Speusippus and his contemporaries in the school exercised an important and far-reaching influence upon Academic doctrine. When they, the immediate successors of Plato, rejected their master's ontology and proposed to themselves as ends mere classificatory sciences which with him had been means, they bartered their hope of philosophic certainty for the tentative and provisional results of scientific experience. Xenocrates indeed, identifying ideal and mathematical numbers, sought to shelter himself under the authority of Plato; but, as the Xenocratean numbers, though professedly ideal as well as mathematical, were in fact mathematical only, this return to the Platonic terminology was no more than an empty form. It would seem, then, that Academic skepticism began with those who had been reared by Plato himself, having its origin in their acceptance of the scientific element of his teaching apart from the ontology which had been its basis. In this way, and, so far as the present writer can see, in this way only, it is possible to understand the extraordinary revolution which converted Platonism, philosophical and dogmatic, into Academicism, scientific and skeptical. It is as the official representative of this scientific and skeptical departure that Speusippus is entitled to a place in the history of philosophy.

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SPEY, a river in the north of Scotland, rises in the southeast of Inverness-shire from a small tarn called Loch Spey, 5 miles east of the Caledonian Canal, and flows northeastwards by Kingussie to Grantown in Elginshire, 10 miles below which it reaches Banffshire. After forming for about 15 miles the boundary between Elginshire and Banffshire, it again enters the former county, through which it flows for about 10 miles past Fochabers to the Moray Firth. In the earlier part of its course it is fed by a large number of mountain streams, its principal tributaries being, in Inverness-shire, the Tromie and the Feshie from the right and the Dulnain from the left, and on the boundaries of Banff and Elgin the Avon (Aven) and the Fiddich from the right. Its entire length is 96 miles, and it drains an area of about 1200 square miles. The flow of the river is very rapid, and, being fed largely by mountain streams, it is subject to sudden freshets, which sometimes occasion extensive floods, the greatest being that of 1829. The Spey is, next to the Tay and the Tweed, the most important salmon river in Scotland. The scenery in its upper courses is occasionally bare and bleak, but sometimes finely picturesque, especially where, as in Elginshire and Banffshire, its bold and rocky banks are clothed by forests of birch and pine.

See L. Shaw, *History of the Province of Moray* (1st ed. 1775, 3d ed. 1882), and Sir Thomas Dick Lauder, *Account of the Moray Floods* (1st ed. 1830, 4th ed. 1873).

SPEZIA, a city of Italy, in the province of Genoa, 56 miles southeast of Genoa by the railway to Pisa, which has become since the unification of the kingdom one of the principal Italian ports and the seat of a great Government arsenal. It is situated at the northwest angle of the Gulf of Spezia, formerly known as Lunæ Portus, the western side of which is formed by a rocky promontory about 4 miles long, terminating in the picturesque little town of Portovenere and the islands of Palmaria and Tino. A great breakwater, constructed about 1860, stretches across the gulf from Santo Maria Point to Santa Teresa Point for a distance of 7220 feet; and the outer harbor to the southwest of the town, excavated in 1865 to a depth of 32 feet, has an area of 247 acres. The arsenal has a length of 3937 feet and an average breadth of 2460 feet. The first dock covers an area of 20 acres and the second 17 acres; and there are besides two careening basins, 433 and 354 feet long. Farther south lie the extensive military establishments of San Vito, with storehouses, reservoir, etc.; and almost right opposite, on the other side of the gulf, are the dock (1½ acres), shipbuilding yards, and repairing docks of San Bartolomeo. Some of the largest vessels of the Italian navy have been constructed at Spezia. As a commercial centre Spezia suffers from the lack of railway communication with the interior,—the range of the Apennines lying between it and the more productive regions of northern Italy. The whole movement of the port in 1884 was represented by 38 vessels engaged in foreign trade (tonnage, 29,251) and 1333 engaged in the coasting trade (tonnage, 198,447). Though the town itself, with the barracks and military hospital as its principal buildings, presents little to attract the foreign visitor, the beauty of the gulf and of the neighboring country has brought Spezia into some repute as a watering-place, and there are several excellent hotels in the Corso. The walls and gates of the old city are for the most part destroyed. In one of the public squares is a statue of Admiral Chiodo, the founder of the arsenal. The population of the city was 6105 in 1861 (commune 11,556) and 19,864 in 1881 (commune 30,732).

The origin of Spezia is doubtful; but it probably rose after the destruction of Luna. Sold by one of the Fieschi in 1276 to Genoa, the town was fortified by its new possessors and made the seat of a governor of some importance. It became a city in the 16th century. The idea of making the Gulf of Spezia a great naval centre was first broached by Napoleon I.

SPHEROMETER, an instrument for the precise measurement of the radius of a sphere or the thickness of a thin plate. The usual form consists of a fine screw moving in a nut carried on the centre of a small three-legged table. The lower end of the screw and those of the table legs are finely tapered and terminate in hemispheres, so that each rests on a point. If the screw has two turns of the thread to the millimètre, the head is usually divided into 500 equal parts, so that differences of 0.001 millimètre may be measured without using a vernier. A vertical scale fastened to the table indicates the number of whole turns of the screw and serves as a fixed point for reading the divisions on the head. In order to measure the thickness of a plate the instrument is placed on a level plane surface and the screw turned until the point just touches; the exact instant when it does so is defined by a sudden diminution of resistance succeeded by a considerable increase. The divided head and scale are read; the screw is raised; the thin plate slipped under it; and the process is repeated. The difference between the two readings gives the required thickness. A contact-lever, delicate level, or electric contact arrangement may be attached to the spherometer in order to indicate the moment of touching more precisely than is possible by the sense of touch. To measure the radius of a sphere—*e.g.*, the curvature of a lens—the spherometer is levelled and read, then placed on the sphere, adjusted until the four points exert equal pressure, and read again. The difference gives the thickness of that portion of the sphere cut off by a plane passing through the three feet; and, since the feet are equidistant, this distance (a) being known gives the value (R) of the radius from the formula $2R = \frac{a^2}{3h} + h$, where h is the thickness of the lenticular segment. The *well spherometer*[1] is adapted for measuring small spherical lenses. The true plane on which the instrument stands is perforated by a cylindrical well of known diameter. A plate applied to the lower edge of the well by a spring is adjusted to be parallel to the large plane, and the spherometer screw, being centred over the well, is run down until it touches the plate, and then read. The plate is removed; the lens put in its place; the point—still accurately centred—is brought down; and the screw is read again. The difference between these readings gives the height of the section of the lens above the lower edge of the well. Calling this height h and the radius of the cylindrical well r, the radius R of the sphere is got by the formula $2R = \frac{r^2}{h} + h$. The spherometer can be applied to test the sphericity of a globe, and may be used on either a convex or a concave surface.

SPHINX, a hybrid creature of Egyptian and Greek art and mythology. In Egypt the sphinxes are colossal images of granite or porphyry, with a human head and breast and the body of a lion (wingless) lying down. The largest and most famous is that of Gizeh, described in vol. vii. p. 670. The head of the sphinx is usually that of a man, but female heads are said to occur occasionally. From Egypt the figure of the sphinx passed to Assyria, where it appears with a bearded male head on cylinders; the female sphinx, lying down and furnished with wings, is first found in the palace of Esarhaddon (7th century B.C.). Sphinxes have been found in Phœnicia, one at least being winged and another bearded. In Asia Minor an ancient female sphinx, but wingless, stands on the sacred road near Miletus. Sphinxes of the usual Greek type (female heads with bodies of winged lions) are represented seated on each side of two doorways in an ancient frieze found by Sir Charles Fellowes at Xanthus in Lycia, and now in the British Museum. The same type appears on the early sculptures of the temple at Assus. In the early art of Cyprus—that half-way house between Asia and Greece—sphinxes of this type are not uncommon. On the other hand, on a gem of Phœnician style found at Curium in Cyprus, there appear two male (bearded) sphinxes, with the tree of life between them. With regard to Greece proper, in the third tomb on the acropolis of Mycenæ were found six small golden sphinxes; they are beardless, but the sex is doubtful. In the ancient tomb, discovered in 1877, at Spata near Athens (which represents a kindred but somewhat later art than the tombs at Mycenæ) were found female winged sphinxes carved in ivory or bone. Sphinxes on glass plates have been found in graves at Camirus in Rhodes, and on gold plates in Crimean graves. Sphinxes were represented on the throne of Apollo at Amyclæ; in the best period of Greek art a sphinx was sculptured on the helmet of the statue of Athene in the Parthenon at Athens; and sphinxes carrying off children were sculptured on the front feet of the throne of Zeus at Olympia.

In Greek mythology the most famous sphinx was that of Thebes in Bœotia. She is first mentioned by Hesiod (*Theog.*, 326), who calls her the daughter of Orthus and Chimæra. According to Apollonius (iii. 5, 8), she was the daughter of Typhon and Echidna, and had the face of a woman, the feet and tail of a lion, and the wings of a bird. She dwelt on a bald rocky mountain at the southeast corner of the Copaic lake; the name of the mountain was Phicium (now Fagas), which was derived from Phix, the Æolic form of sphinx. The Muses taught her a riddle and the Thebans had to guess it. Whenever they failed she carried one of them off and devoured him. The riddle was this: What is that which is four-footed, three-footed, and two-footed? At last Œdipus guessed correctly that it was man; for the child crawls on hands and feet, the adult walks upright, and the old man supports his steps with a stick. Then the sphinx threw herself down from the mountain.

The story of the sphinx's riddle first occurs in the Greek tragedians Milchhöfer believes that the story was a mere invention of Greek fancy, an attempt to interpret the mysterious figure which Greek art had borrowed from the East. On the other hand, he holds that the destroying nature of the sphinx was much older, and he refers to instances in both Egyptian and Greek art where a sphinx is seen seizing and standing upon a man. And whereas the Theban legend is but sparingly illustrated in Greek art, the figure of the sphinx appears more commonly on tombs, sculptured either in the round or in relief. From this Milchhöfer seems to infer that the sphinx was a symbol of death. The word "sphinx" is Greek, being derived from σφίγγειν, "to draw tight."

See Brugsch, *History of Egypt*, vol. i. pp. 79 *sq.*, 414 *sq.*; Cesnola, *Cyprus*, pp. 110, 114 *sq.*, 263 *sq.*, and plate xxxvii. No. 13; Schliemann, *Mycenæ*, pp. xlv., 184; and especially Milchhöfer, in *Mitth. d. deutsch. archäol. Instit. in Athen*, 1879, p. 46 *sq.*

SPHYGMOGRAPH. See VASCULAR SYSTEM.

SPICE ISLANDS. See MOLUCCAS, vol. xvi. p. 723.

SPIDER. See ARACHNIDA, vol. ii. p. 237 *sq.*

SPIKENARD, or NARD (Hebrew *nĕrd*, Gr. νάρδος, from Sanskrit *naladwitha*, the change from "r" to "l" seeming to indicate that the word came through Persia),[2] a celebrated perfume which seems to have formed one of the most durable aromatic ingredients in the costly unguents used by the Romans and Eastern nations. The ointment prepared from it ("ointment of pistic nard"[3]) is mentioned in the New Testament (Mark, xiv. 3–5; John, xii. 3–5) as being "very costly," a pound of it being valued at more than 300 denarii (over £10 [$48.60]). This appears to represent the prices then current for the best quality of nard, since Pliny (*H. N.*, xii. 26) mentions that nard spikes reached as much as 100 denarii [$16.20] per ℔, and, although he does not mention the price of nard ointment, he states (xiii. 2) that the "unguentum cinnamominum," a similar preparation, ranged from 25 [$4.05] to 300 denarii [$48.60], according to its quality. Nard ointment also varied considerably in price from its liability to sophistication (*Id.* xii. 26, 27; xiii. 2). The ingredients of the genuine ointment (*unguentum nardinum sive foliatum*), Pliny tells us (xiii. 2), were Indian nard, juncus (the leaves of *Andropogon Schœnanthus*, L.), costus (the root of *Aplotaxis auriculata*, DC.), amomum (the fruits of *Amomum Cardamomum*, L.), myrrh (the gum-resin of *Balsamodendron Myrrha*, Nees), balm (the oleo-resin of *Balsamodendron Opobalsamum*), omphacium or oleum omphacinum (the oil expressed from unripe olives), and balaninum (derived from *Balanites ægyptiaca?*). Dioscorides (i. 75) also remarks that malabathrum

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[1] A. M. Mayer, in *American Journal of Science*, 1886, xxxii. p. 61.

[2] See Fick, in *Orient u. Occident*, iii. p. 364. The Syrians and Arabs simply call it "spike" (*shebāltā*, *sunbul*) or "the Indian spike."

[3] The meaning of the word "pistic" is uncertain, some rendering it "genuine," others "liquid," and others taking it for a local name.

(the leaf of *Cinnamomum Tamala*, Nees) was sometimes added. Of these ingredients costus and amomum were most relied upon for increasing the fragrance and the nard for the stimulating and other virtues of the unguent.[1]

The exact botanical source of the true or Indian nard was long a matter of uncertainty, the descriptions given by ancient authors being somewhat vague. Theophrastus (*De Odor.*, 28) classes nard amongst roots, and states that it came from India (*Hist. Plant.*, ix. 7, 2), had a biting and hot taste, and resembled iris root in perfuming the air near it (*De Odor.*, 12, 56). He also remarks (*l.c.*, 42) that the ointment was one of the most durable of perfumes. Pliny (*H.N.*, xii. 26, 27) gives a somewhat confused account, from which it appears that both "spike" and leaf were in use, although it is not clear whether the spike (*spica*) consisted of the flower-head or the fibrous lower portion of the stem. The only definite statement he makes concerning it is that the "sincere" nard is known by its red color, sweet smell, and especially taste, "for it drieth the tongue and leaveth a pleasant relish behind it." Dioscorides (i. 6) states that the true nard came from India and was collected on mountains beside which the river Ganges flowed. He describes it as blackish with short spikes, smelling something like cyperus. Linnæus, Blane, Hatchett, and other writers have supposed that spikenard was an Indian grass of the genus *Andropogon* (*A. Nardus*, L.); but Sir W. Jones (*As. Res.*, ii. 416, iv. 97) has given convincing reasons for identifying it with *Nardostachys Jatamansi*,[2] a plant of the Valerian order, the fibrous root-stocks or "spikes" of which are still collected in the mountains of Bhotan and Nepal. Further evidence is afforded by Lambert (*Illustr. of the Genus Cinchona*, App., p. 177), who found the root under the name of "spikenard" in one of the oldest chemist's shops in London, also by Dymock (*Mat. Med. W. India*, 2d ed., p. 347), who states that the principal use of the drug at the present time is for making hair washes and ointments, the popular opinion being that it promotes the growth and blackness of the hair. The name of "spike" applied to the Indian nard appears to be derived from its resemblance in shape to a spike or ear of bearded corn. The root is crowned by the bases of several stems, each about 2 inches or more in length and as thick as the finger. To these the fibrous tissue of former leaves adheres and gives them a peculiar bristly appearance. It is this portion that is chiefly collected.

Other and inferior varieties of nard are mentioned by Dioscorides and subsequent writers. Celtic nard, obtained from the Ligurian Alps and Istria, consisted of the roots of plants also belonging to the Valerian order (*Valeriana celtica* and *V. salicina*). This was exported to the East and thence to Egypt, and was used in the preparation of baths. Mountain nard was collected in Cilicia and Syria, and is supposed to have consisted of the root of *Valeriana tuberosa*. The false nard of Dauphiné used in later times, and still employed as a charm in Switzerland, is the root-stock of *Allium Victorialis*. It presents a singular resemblance to the spikes of Indian nard, but is devoid of fragrance. It is remarkable that all the nards belong to the natural order *Valerianaceæ*, the odor of valerian being considered disagreeable at the present day; that of *Nardostachys Jatamansi* is intermediate between valerian and patchouli, although more agreeable than either.

The name "spikenard" has also been applied in later times to several plants. The spikenard of the United States is *Aralia racemosa*, and another species of the same genus, *A. nudicaulis*, is known as "false spikenard." In the West Indies *Hyptis suaveolens* is called "spikenard," and in Great Britain the name "ploughman's spikenard" is given to *Inula Conyza*. (E. M. H.)

SPINACH. See HORTICULTURE, vol. xii. pp. 297, 300–1.

SPINAL CORD. See PHYSIOLOGY, vol. xix. p. 39 *sq.* For the diseases affecting the spinal cord, see ATAXY (LOCOMOTOR), PARALYSIS, PATHOLOGY (vol. xviii. p. 401–2), and SURGERY.

SPINEL. See MINERALOGY, vol. xvi. p. 402, and RUBY.

SPINELLO ARETINO (*c.* 1330-*c.* 1410), painter, the son of a Florentine named Luca, who had taken refuge in Arezzo in 1310 when exiled with the rest of the Ghibelline party, was born at Arezzo about 1330. Spinello was a pupil of Jacopo di Casentino, a follower of Giotto, and his own style was a sort of link between the school of Giotto and that of Siena. In the early part of his life he worked in Florence as an assistant to his master Jacopo while painting frescos in the church of the Carmine and in Sta. Maria Novella. Between 1360 and 1384 he was occupied in painting many frescos in and near Arezzo, almost all of which have now perished.[3] After the sack of Arezzo in 1384 Spinello returned to Florence, and in 1387–88 with some assistants covered the walls and vaults of the sacristy of S. Miniato near Florence with a series of frescos, the chief of which represent scenes from the life of St. Benedict. These still exist, though in a sadly restored condition; they are very Giotto-like in composition, but have some of the Siena decorative brilliance of color. In 1391–92 Spinello was painting six frescos, which still remain on the south wall of the Pisan Campo Santo, representing miracles of St. Potitus and St. Ephesus. For these he received 270 gold florins [$686.34]. Among his later works the chief are the very fine series of frescos painted in 1407–8 on the walls and vault of a chapel in the municipal buildings of Siena; these also have suffered much from repainting, but still are the finest of Spinello's existing frescos. Sixteen of these represent the war of Frederick Barbarossa against the republic of Venice. Spinello died at Arezzo about 1410.

Spinello's frescos are all strong and highly decorative works, drawn with much spirit, and are very superior in style to his panel pictures, many of which appear to be mere *bottega* productions. The academy of Florence possesses a panel of the Madonna and Saints, which is chiefly interesting for its signature—"Hoc opus pinxit Spinellus Luce Aritio D. I. A. 1391." The easel pictures which are to be found in the various galleries of Europe give little or no notion of Spinello's power as a painter.

SPINET. See PIANOFORTE, vol. xix. p. 75 *sq.*

SPINNING. See YARN.

SPINOLA, AMBROGIO SPINOLA, MARCHESE DI (*c.* 1571–1630), a celebrated general, belonged to a noble and wealthy Italian family, and was born at Genoa about 1571. After the siege of Ostend had languished for more than two years under the direction of the archduke Albert, Spinola, who, though not a soldier by profession, had seen something of campaigning during a season or two, came upon the scene as a condottiere and received charge of the works. He entered upon his task in October, 1603, and his courage and vigor were rewarded by the surrender of the place on 20th September, 1604. During the next five years, until the conclusion of the armistice of 1609, he frequently encountered Maurice of Orange, but on the whole with undecisive results. In 1620 he was sent by Spain into the Palatinate of the Rhine, and took many places; in the following year, on the renewal of the war with Holland, he returned to the scenes of his earlier campaigns, where his principal exploits were the capture of Jülich in February, 1622, and of Breda after a ten months' siege in June, 1625. His health now began to give way; and his spirits are said to have been further depressed by Philip's disregard of his pecuniary claims. He died at Castel-Nuovo di Scrivia on 25th September, 1630.

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[1] The use of alabaster vessels for preserving these fragrant unguents was customary at a very early period. Theophrastus (*c.* 314 B.C.) states that vessels of lead and alabaster were best for the purpose, on account of their density and coolness, and their power of resisting the penetration of the ointment into their substance. Pliny also recommends alabaster for ointment vases. For small quantities onyx vessels seem to have been used (Horace, *Carm.* iv., 12, ll. 10, 17).

[2] The plant figured by Sir W. Jones is *Valeriana Hardwickii* (probably the inferior Gangetic nard of Dioscorides and the ozænitis of Pliny); the true plant is figured by Royle and Lambert.

[3] The fine fresco of an Apocalyptic scene which still exists in S. Maria degli Angeli at Arezzo belongs to about 1400.

SPINOZA, Baruch (1632–1677), or, as he afterwards signed himself, Benedict de Spinoza, philosopher, was born at Amsterdam on 24th November, 1632. His parents belonged to the community of Jewish emigrants from Portugal and Spain who, fleeing from Catholic persecution in the Peninsula, had sought refuge in the nearly emancipated Netherlands. The name, variously written De Spinoza, D'Espinoza, and Despinoza, probably points to the province of Leon as the previous home of the family; there are no fewer than five townships so called in the neighborhood of Burgos. Of the philosopher's parents nothing is known. His father is said to have been a tradesman in fair circumstances, and the house is still shown upon the Burgwal where his son Baruch was born; two sisters, Rebekah and Miriam, formed the remainder of the family. Spinoza received his first training under the senior rabbi, Saul Levi Morteira, whose most promising pupil he soon became. Under Morteira he became familiar with the Talmud and, what was probably more important for his own development, with the philosophical writings of Ibn Ezra and Maimonides, Levi ben Gerson, Chasdai Creskas, and other representatives of Jewish mediæval thought, who aim at combining the traditional theology with ideas got from Aristotle and his Neoplatonic commentators. Latin, still the universal language of learning, formed no part of Jewish education; and Spinoza, after learning the elements from a German master, resorted for further instruction to a physician named Franz van den Ende, who eked out an income by taking pupils. Van den Ende appears to have been distinctly a man of parts, though of a somewhat indiscreet and erratic character. He was eventually hanged in Paris as a conspirator in 1674. His enthusiasm for the natural sciences may have been the only ground for the reputation he had acquired of instilling atheistic notions into the minds of his pupils along with the Latin which he taught them. But it is quite possible that his scientific studies had bred in him, as in many others at that time, a materialistic, or at least a naturalistic, turn of mind; indeed we should expect as much in a man of Van den Ende's somewhat rebellious temperament. We do not know whether his influence was brought to bear in this sense upon Spinoza; but it has been suggested that the writings of Bruno, whose spirit of enthusiastic naturalism and fervid revolt against the church would be especially dear to a man of Van den Ende's leanings, may have been put into the pupil's hand by the master. Latin, at all events, Spinoza learned from Van den Ende to use with correctness, freedom, and force, though his language does not, of course, conform to classical canons. The only romance of Spinoza's life is connected with Van den Ende's household. The physician had an only daughter, Clara Maria by name, who, besides being a proficient in music, understood Latin, it is said, so perfectly that she was able to teach her father's pupils in his absence. Spinoza, the story goes, fell in love with his fair instructress; but a fellow-student, called Kerkering, supplanted him in his mistress's affections by the help of a valuable necklace of pearls which he presented to the young lady. Chronology unfortunately forbids us to accept this little episode as true. Recent investigation has proved that, while the marriage with Kerkering, or rather Kerckkrink, is a fact, it did not take place till 1671, in which year the bride, as appears by the register, was twenty-seven years of age. She cannot, therefore, have been more than eleven or twelve in 1656, the year in which Spinoza left Amsterdam; and as Kerckkrink was seven years younger than Spinoza, they cannot well have been simultaneous pupils of Van den Ende and simultaneous suitors for his daughter's hand. But, though the details of the story thus fall to pieces, it is still possible that in the five years which followed his retirement from Amsterdam Spinoza, who was living within easy distance and paid visits to the city from time to time, may have kept up his connection with Van den Ende, and that the attachment may have dated from this later period. This would at least be some explanation for the existence of the story; for Colerus expressly says that Spinoza "often confessed that he meant to marry her." But beyond possibility we cannot go in the matter. There is no mention of the Van den Endes in Spinoza's correspondence; and in the whole tenor of his life and character there is nothing on which to fasten the probability of a romantic attachment.

The mastery of Latin which he acquired from Van den Ende opened up to Spinoza the whole world of modern philosophy and science, both represented at that time by the writings of Descartes. He read him greedily, says Colerus, and afterwards often declared that he had all his philosophical knowledge from him. The impulse towards natural science which he had received from Van den Ende would be strengthened by the reading of Descartes; he gave over divinity, we are told, to devote himself entirely to these new studies. His inward break with Jewish orthodoxy dated, no doubt, farther back,—from his acquaintance with the philosophical theologians and commentators of the Middle Ages; but these new interests combined to estrange him still further from the traditions of the synagogue. He was seldomer seen at its services,—soon not at all. The jealousy of the heads of the synagogue was easily roused. An attempt seems to have been made to draw from him his real opinions on certain prominent points of divinity. Two so-called friends endeavored, on the plea of doubts of their own, to lead him into a theological discussion; and, some of Spinoza's expressions being repeated to the Jewish authorities, he was summoned to give an account of himself. Anxious to retain so promising an adherent, and probably desirous at the same time to avoid public scandal, the chiefs of the community offered him a yearly pension of 1000 florins [$388.03] if he would outwardly conform and appear now and then in the synagogue. But such deliberate hypocrisy was abhorrent to Spinoza's nature. Threats were equally unavailing, and accordingly on the 27th of July, 1656, Spinoza was solemnly cut off from the commonwealth of Israel. The curses pronounced against him may be read in most of the biographies. While negotiations were still pending, he had been set upon one evening by a fanatical ruffian, who thought to expedite matters with the dagger. Warned by this that Amsterdam was hardly a safe place of residence for him any longer, Spinoza had already left the city before the sentence of excommunication was pronounced. He did not go far, but took up his abode with a friend who lived some miles out on the Old Church road. His host belonged to the Collegiants or Rhijnsburgers, a religious society which had sprung up among the proscribed Arminians of Holland. The pure morality and simple-minded piety of this community seem early to have attracted Spinoza, and to have won his unfeigned respect. Several of his friends were Collegiants, or belonged to the similarly-minded community of the Mennonites, in which the Collegiants were afterwards merged.[1] In this quiet retreat Spinoza spent nearly five years. He drew up a protest against the decree of excommunication, but otherwise it left him unmoved. From this time forward he disused his Hebrew name of Baruch, adopting instead the Latin equivalent, Benedictus. Like every Jew, Spinoza had learned a handicraft; he was a grinder of lenses for optical instruments, and was thus enabled to earn an income sufficient for his modest wants. His skill, indeed, was such that lenses of his making were much sought after, and those found in his cabinet after his death fetched a high price. It was as an optician that he was first brought into connection with Huygens and Leibnitz; and an optical *Treatise on the Rainbow*, written by him and long supposed to be lost, has been recently discovered and reprinted by Dr. Van Vloten. He was also fond of drawing as an amusement in his leisure hours; and Colerus had seen a sketch-book full of such drawings representing persons of Spinoza's acquaintance, one of them being a likeness of himself in the character of Masaniello.

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[1] [Blunt's *Dictionary of Sects, Heresies*, etc. (Philadelphia, 1874), p. 110, says the Collegiants "at the present time form a considerable body in Holland and Hanover." On the death of the Spinozist Bredenburg and his opponent Couper about the end of the 18th century, the parties which they led reunited.—Am. Ed.]

The five years which followed the excommunication must have been devoted to concentrated thought and study. Before their conclusion Spinoza had parted company from Descartes, and the leading positions of his own system were already clearly determined in his mind. A number of the younger men in Amsterdam—many of them students of medicine or medical practitioners—had also come to regard him as their intellectual leader. A kind of philosophical club had been formed, including among its members Simon de Vries, John Bresser, Louis Meyer, and others who appear in Spinoza's correspondence. Originally meeting in all probability for more thoroughgoing study of the Cartesian philosophy, they looked naturally to Spinoza for guidance, and by-and-by we find him communicating systematic drafts of his own views to the little band of friends and students. The manuscript was read out and discussed at their meetings, and any points remaining obscure were referred to Spinoza for further explanation. An interesting specimen of such difficulties, propounded by Simon de Vries and resolved by Spinoza in accordance with his own principles, is preserved for us in Spinoza's correspondence. This Simon de Vries was a youth of generous impulses and of much promise. Being in good circumstances, he was anxious to show his gratitude to Spinoza by a gift of 2000 florins [$776.06], which the philosopher half-jestingly excused himself from accepting. De Vries died young, and would fain have left his fortune to Spinoza; but the latter refused to stand in the way of his brother, the natural heir, to whom the property was accordingly left, with the condition that he should pay to Spinoza an annuity sufficient for his maintenance. The heir offered to fix the amount at 500 florins [$194.02], but Spinoza accepted only 300 [$116.41], a sum which was regularly paid till his death. The written communications of his own doctrine referred to above belong to a period after Spinoza had removed from the neighborhood of Amsterdam; but it has been conjectured that the *Short Treatise on God, on Man, and his Wellbeing*, which represents his thoughts in their earliest systematic form, was left by him as a parting legacy to this group of friends. It is at least certain, from a reference in Spinoza's first letter to Oldenburg, that such a systematic exposition was in existence before September, 1661.[1] There are two dialogues somewhat loosely incorporated with the work which probably belong to a still earlier period. The short appendix, in which the attempt is made to present the chief points of the argument in geometrical form, is a forerunner of the *Ethics*, and was probably written somewhat later than the rest of the book. The term "Nature" is put more into the foreground in the *Treatise*, a point which might be urged as evidence of Bruno's influence,—the dialogues, moreover, being specially concerned to establish the unity, infinity, and self-containedness of Nature;[2] but the two opposed Cartesian attributes, thought and extension, and the absolutely infinite substance whose attributes they are—substance constituted by infinite attributes—appear here as in the *Ethics*. The latter notion—of substance—is said to correspond exactly to "the essence of the only glorious and blessed God." The earlier differs from the later exposition in allowing an objective causal relation between thought and extension, for which there is substituted in the *Ethics* the idea of a thoroughgoing parallelism.

Early in 1661 Spinoza's host removed to Rhijnsburg near Leyden, the headquarters of the Collegiant brotherhood, and Spinoza removed with him. The house where they lived at Rhijnsburg is still standing, and the road bears the name of Spinoza Lane. Very soon after his settlement in his new quarters he was sought out by Henry Oldenburg, the first secretary of the Royal Society.[3] Oldenburg became Spinoza's most regular correspondent,—a third of the letters preserved to us are to or from him; and it appears from his first letter that their talk on this occasion was "on God, on infinite extension and thought, on the difference and the agreement of these attributes, on the nature of the union of the human soul with the body, as well as concerning the principles of the Cartesian and Baconian philosophies." Spinoza must therefore have unbosomed himself pretty freely to his visitor on the main points of his system. Oldenburg, however, was a man of no speculative capacity, and, to judge from his subsequent correspondence, must have quite failed to grasp the real import and scope of the thoughts communicated to him. From one of Oldenburg's early letters we learn that the treatise *De Intellectus Emendatione* was probably Spinoza's first occupation at Rhijnsburg. The nature of the work also bears out the supposition that it was first undertaken. It is, in a manner, Spinoza's "organon,"—the doctrine of method which he would substitute for the corresponding doctrines of Bacon and Descartes, as alone consonant with the thoughts which were shaping themselves or had shaped themselves in his mind. It is a theory of philosophical truth and error, involving an account of the course of philosophical inquiry and of the supreme object of knowledge. It was apparently intended by the author as an analytical introduction to the constructive exposition of his system, which he presently essayed in the *Ethics*. But he must have found as he proceeded that the two treatises would cover to a large extent the same ground, the account of the true method merging almost inevitably in a statement of the truth reached by its means. The *Amendment of the Understanding* was therefore put aside unfinished, and was first published in the *Opera Posthuma*. Spinoza meanwhile concentrated his attention upon the *Ethics*, and we learn from the correspondence with his Amsterdam friends that a considerable part of book i. had been communicated to the philosophical club there before February, 1663. It formed his main occupation for two or three years after this date. Though thus giving his friends freely of his best, Spinoza did not cast his thoughts broadcast upon any soil. He had a pupil living with him at Rhijnsburg whose character seemed to him lacking in solidity and discretion. This pupil (probably Albert Burgh, who afterwards joined the Church of Rome and penned a foolishly insolent epistle to his former teacher) was the occasion of Spinoza's first publication,—the only publication indeed to which his name was attached. Not deeming it prudent to initiate the young man into his own system, he took for a text-book the second and third parts of Descartes's *Principles*, which deal in the main with natural philosophy. As he proceeded he put Descartes's matter in his own language and cast the whole argument into a geometric form. At the request of his friends he devoted a fortnight to applying the same method to the first or metaphysical part of Descartes's philosophy, and the sketch was published in 1663, with an appendix entitled *Cogitata Metaphysica*, still written from a Cartesian standpoint (defending, for example, the freedom of the will), but containing hints of his own doctrine. The book was revised by Dr. Meyer for publication and furnished by him, at Spinoza's request, with a preface, in which it is expressly stated that the author speaks throughout not in his own person but simply as the exponent of Descartes. A Dutch translation appeared in the following year.[1]

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[1] Various manuscript copies were apparently made of the treatise in question, but it was not printed, and dropped entirely out of knowledge till 1852, when Edward Böhmer of Halle lighted upon an abstract of it attached to a copy of Colerus's *Life*, and shortly afterwards upon a Dutch MS. purporting to be a translation of the treatise from the Latin original. This was published in 1862 by Van Vloten with a re-translation into Latin. Since then a superior Dutch translation has been discovered, which has been edited by Professor Schaarschmidt and translated into German. Another German version with introduction and notes has been published by Sigwart based on a comparison of the two Dutch MSS.

[2] The fact that Spinoza nowhere mentions Bruno would not imply, according to the literary habits of those days, that he was not acquainted with his speculations and even indebted to them. There is no mention, for example, of Hobbes throughout Spinoza's political writing, and only one casual reference to him in a letter, although the obligation of the Dutch to the English thinker lies on the surface. Accordingly full weight must be allowed to the internal evidence brought forward by Sigwart and others to prove Spinoza's acquaintance with Bruno's writings. But in regard to this question, and in regard to the elaborate researches directed to prove that the main determinations of Spinoza's thought are anticipated in the mediæval philosophers of his own race, it must be said that these investigations are of comparatively little vital interest. Doubtless Spinoza's thought was colored by his Hebraic origin and his Hebraic studies; from these sources, above all, he may have brought with him to the study of the dualistically expressed philosophy of Descartes the need, and the profound conviction, of unity. But the main strain of Spinoza's thought is sufficiently explained by reference to the Cartesian philosophy itself, the intellectual *milieu* of the time. Descartes's metaphysics can be shown to lead us to the very threshold of Spinoza's system; not only the general form, but the very terminology—substance, attributes, and modes—lay waiting to be appropriated by an independent student.

[3] Henry Oldenburg (*c.* 1626–1678) was a native of Bremen, but had settled in England in the time of the Commonwealth. Though hardly a scientific man himself, he had a genuine interest in science, and must have possessed social gifts. He was the friend of Boyle, and acquainted with most of the leaders of science in England as well as with many on the Continent. He delighted to keep himself in this way *au courant* with the latest developments, and lost no opportunity of establishing relations with men of scientific reputation. It was probably at the suggestion of Huygens that he bent his steps towards Spinoza's lodging.

In 1663 Spinoza removed from Rhijnsburg to Voorburg, a suburban village about 2 miles from The Hague. His reputation had continued to spread. From Rhijnsburg he had paid frequent visits to The Hague, and it was probably the desire to be within reach of some of the friends he had made in these visits—among others the De Witts—that prompted his change of residence. He had works in hand, moreover, which he wished in due time to publish; and in that connection the friendly patronage of the De Witts might be of essential service to him. The first years at Voorburg continued to be occupied by the composition [illegible] the *Ethics*, which was probably finished, however, by the summer of 1665. A journey made to Amsterdam in that year is conjectured to have had reference to its publication. But, finding that it would be impossible to keep the authorship secret, owing to the numerous hands through which parts of the book had already passed, Spinoza determined to keep his manuscript in his desk for the present. In September, 1665, we find Oldenburg twitting him with having turned from philosophy to theology and busying himself with angels, prophecy, and miracles. This is the first reference to the *Tractatus Theologico-Politicus*, which formed his chief occupation for the next four years. The aim of this treatise may be best understood from the full title with which it was furnished—*Tractatus Theologico-Politicus, continens dissertationes aliquot, quibus ostenditur libertatem philosophandi non tantum salva pietate et reipublicæ pace posse concedi sed eandem nisi cum pace reipublicæ ipsaque pietate tolli non posse.* It is, in fact, an eloquently reasoned defence of liberty of thought and speech in speculative matters. The external side of religion—its rites and observances—must of necessity be subject to a certain control on the part of the state, whose business it is to see to the preservation of decency and order. But, with such obvious exceptions, Spinoza claims complete freedom of expression for thought and belief; and he claims it in the interests alike of true piety and of the state itself. The thesis is less interesting to a modern reader—because now generally acknowledged—than the argument by which it is supported. Spinoza's position is based upon the thoroughgoing distinction drawn in the book between philosophy, which has to do with knowledge and opinion, and theology, or, as we should now say, religion, which has to do exclusively with obedience and conduct. The ægis of religion, therefore, cannot be employed to cover with its authority any speculative doctrine; nor, on the other hand, can any speculative or scientific investigation be regarded as putting religion in jeopardy. Spinoza undertakes to prove his case by the instances of the Hebrew Scriptures. Scripture deals, he maintains, in none but the simplest precepts, nor does it aim at anything beyond the obedient mind; it tells us nought of the divine nature, but what men may profitably apply to their lives. The greater part of the treatise is devoted to working out this line of thought; and in so doing Spinoza consistently applies to the interpretation of the Old Testament those canons of historical exegesis which are often regarded as of comparatively recent growth. The treatise thus constitutes the first document in the modern science of Biblical criticism. It was published in 1670, anonymously, printer and place of publication being likewise disguised (*Hamburgi apud Heinricum Künraht*). The storm of opposition which it encountered showed that these precautions were not out of place. It was synodically condemned along with Hobbes's *Leviathan* and other books as early as April, 1671, and was consequently interdicted by the states-general of Holland in 1674; before long it was also placed on the Index by the Catholic authorities. But that it was widely read appears from its frequent re-issue with false title-pages representing it now as an historical work and again as a medical treatise. Controversialists also crowded into the lists against it. A translation into Dutch appears to have been proposed; but Spinoza, who foresaw that such a step would only increase the commotion which was so distasteful to him, steadily set his face against it. No Dutch translation appeared till 1693.

The same year in which the *Treatise* was published Spinoza removed from his suburban lodging at Voorburg into The Hague itself. He took rooms first on the Veerkay with the widow Van de Velde, who in her youth had assisted Grotius to escape from his captivity at Loewenstein. This was the house afterwards occupied by Colerus, the worthy Lutheran minister who became Spinoza's biographer. But the widow insisted on boarding her lodger, and Spinoza presently found the expense too great for his slender purse. He accordingly removed to a house on the Pavelioen Gracht near at hand, occupied by a painter called Van der Spijck. Here he spent the remaining years of his life in the frugal independence which he prized. Colerus gives particulars which enable us to realize the almost incredible simplicity and economy of his mode of life. He would say sometimes to the people of the house that he was like the serpent who forms a circle with his tail in his mouth, meaning thereby that he had nothing left at the year's end. His friends came to visit him in his lodgings, as well as others attracted by his reputation—Leibnitz among the rest—and were courteously entertained, but Spinoza preferred not to accept their offers of hospitality. He spent the greater part of his time quietly in his own chamber, often having his meals brought there and sometimes not leaving it for two or three days together when absorbed in his studies. On one occasion he did not leave the house for three months. "When he happened to be tired by having applied himself too much to his philosophical meditations, he would go downstairs to refresh himself, and discoursed with the Van der Spijcks about anything that might afford matter for an ordinary conversation, and even about trifles. He also took pleasure in smoking a pipe of tobacco; or, when he had a mind to divert himself somewhat longer, he looked for some spiders and made them fight together, or he threw some flies into the cobweb, and was so well pleased with the result of that battle that he would sometimes break into laughter" (Colerus). He also conversed at times on more serious topics with the simple people with whom he lodged, often, for example, talking over the sermon with them when they came from church. He occasionally went himself to hear the Lutheran pastor preach—the predecessor of Colerus—and would advise the Van der Spijcks not to miss any sermon of so excellent a preacher. The children, too, he put in mind of going often to church, and taught them to be obedient and dutiful to their parents. One day his landlady, who may have heard strange stories of her solitary lodger, came to him in some trouble to ask him whether he believed she could be saved in the religion she possessed. "Your religion is a good one," said Spinoza; "you need not look for another, nor doubt that you will be saved in it, provided that, while you apply yourself to piety, you live at the same time a peaceable and quiet life." Only once, it is recorded, did Spinoza's admirable self-control give way, and that was when he received the news of the murder of the De Witts by a frantic mob in the streets of The Hague. It was in the year 1672, when the sudden invasion of the Low Countries by Louis XIV. raised an irresistible clamor for a military leader and overthrew the republican constitution for which the De Witts had struggled. John De Witt had been Spinoza's friend, and had bestowed a small pension upon him; he had Spinoza's full sympathy in his political aims. On receiving the news of the brutal murder of the two brothers, Spinoza burst into tears, and his indignation was so roused that he was bent upon publicly denouncing the crime upon the spot where it had been committed. But the timely caution of his host prevented his issuing forth to almost certain death. Not long after Spinoza was himself in danger from the mob, in consequence of a visit which he paid to the French camp. He had been in correspondence with one Colonel Stoüpe, a Swiss theologian and soldier, then serving with the prince of Condé, the commander of the French army at Utrecht. From him Spinoza received a communication inclosing a passport from the French commander, who wished to make his acquaintance and promised him a pension from the French king at the easy price of a dedication to his majesty. Spinoza went to Utrecht, but returned without seeing Condé, who had in the meantime been called elsewhere; the pension he civilly declined. There may have been nothing more in the visit than is contained in this narrative; but on his return Spinoza found that the populace of The Hague regarded him as no better than a spy. The town was full of angry murmurs, and the landlord feared that the mob would storm his house and drag Spinoza out. Spinoza quieted his fears as well as he could, assuring him that as soon as the crowd made any threatening movement he would go out to meet them, "though they should serve me as they did the poor De Witts. I am a good republican and have never had any aim but the honor and welfare of the state." Happily the danger passed off without calling for such an ordeal.

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[1] The title of the Latin original ran—*Renati des Cartes Principiorum Philosophiæ pars* i. *et* ii. *more geometrico demonstratæ per Benedictum de Spinoza Amstelodamensem. Accesserunt ejusdem Cogitata Metaphysica.*

In 1673 Spinoza received an invitation from the elector palatine to quit his retirement and become professor of philosophy in the university of Heidelberg. The offer was couched in flattering terms, and conveyed an express assurance of "the largest freedom of speech in philosophy, which the prince is confident that you will not misuse to disturb the established religion." But Spinoza's experience of theological sensitiveness led him to doubt the possibility of keeping on friendly terms with the established religion, if he were placed in a public capacity. Moreover, he was not strong; he had had no experience of public teaching; and he foresaw that the duties of a chair would put an end to private research. For all these reasons he courteously declined the offer made to him. There is little more to tell of his life of solitary meditation. In 1675 we learn from his correspondence that he entertained the idea of publishing the *Ethics*, and made a journey to Amsterdam to arrange matters with the printer. "But, whilst I was busy with this," he writes, "the report was spread everywhere that a certain book of mine was in the press, wherein I endeavored to show that there was no God; and this report found credence with many. Whereupon certain theologians (themselves perhaps the authors of it) took occasion to complain of me to the prince and the magistrates; moreover, the stupid Cartesians, because they are commonly supposed to side with me, desiring to free themselves from that suspicion, were diligent without ceasing in their execrations of my doctrines and writings, and are as diligent still." As the commotion seemed to grow worse instead of subsiding, Spinoza consigned the manuscript once more to his desk, from which it was not to issue till after his death. His last literary work was the unfinished *Tractatus Politicus* and the preparation of notes for a new edition of the *Tractatus Theologico-Politicus*, in which he hoped to remove some of the misunderstandings which the book had met with. The *Tractatus Politicus* develops his philosophy of law and government on the lines indicated in his other works, and connects itself closely with the theory enunciated by Hobbes a generation before. Consumption had been making its insidious inroads upon Spinoza for many years, and early in 1677 he must have been conscious that he was seriously ill. On Saturday the 20th of February he sent to Amsterdam for his friend Dr. Meyer. On the following day the Van der Spijcks, having no thought of immediate danger, went to the afternoon service. When they came back Spinoza was no more; he had died about three in the afternoon with Meyer for the only witness of his last moments. Spinoza was buried on the 25th of February "in the new church upon the Spuy, being attended," Colerus tell us, "by many illustrious persons and followed by six coaches." He was little more than forty-four years of age.

Spinoza's effects were few and realized little more than was required for the payment of charges and outstanding debts. "One need only cast one's eyes upon the account," says his biographer, "to perceive that it was the inventory of a true philosopher. It contains only some small books, some engravings, a few lenses, and the instruments to polish them." His desk, containing his letters and his unpublished works, Spinoza had previously charged his landlord to convey to Jan Rieuwertz, a publisher in Amsterdam. This was done, and the *Opera Posthuma* appeared in the same year, without the author's name, but with his initials upon the title-page. They were furnished with a preface written in Dutch by Jarig Jellis, a Mennonite friend of Spinoza's and translated into Latin by Dr. Meyer. Next year the book was proscribed in a violently worded edict by the states of Holland and West Friesland. The obloquy which thus gathered round Spinoza in the later years of his life remained settled upon his memory for a full hundred years after his death. Hume's casual allusion to "this famous atheist" and his "hideous hypothesis" is a fair specimen of the tone in which he is usually referred to; people talked about Spinoza, Lessing said, "as if he were a dead dog." The change of opinion in this respect may be dated from Lessing's famous conversation with Jacobi in 1780. Lessing, Goethe, Herder, Novalis, and Schleiermacher, not to mention philosophers like Schelling and Hegel, united in recognizing the unique strength and sincerity of Spinoza's thought, and in setting him in his rightful place among the speculative leaders of mankind. Transfused into their writings, his spirit has had a large share in moulding the philosophic thought of the 19th century, and it has also been widely influential beyond the schools. Instead of his atheism Hegel speaks of his acosmism, and Novalis dubs him a God-intoxicated man. Schleiermacher's fine apostrophe is well known, in which he calls upon us to "offer a lock of hair to the manes of the holy and excommunicated Spinoza."

Spinoza's personal appearance is described by Colerus from the accounts given him by many people at The Hague who knew him familiarly. "He was of a middle size, and had good features in his face, the skin somewhat dark, black curled hair, and the long eyebrows of the same color, so that one might easily know from his looks that he was descended from the Portuguese Jews." Leibnitz also gives a similar description: "The celebrated Jew Spinoza had an olive complexion and something Spanish in his face." These characteristics are preserved in a portrait in oil in the Wolfenbüttel library, which was probably the original of the (in that case unsuccessfully rendered) engraving prefixed to the *Opera Posthuma* of 1677. This portrait has recently been photographed for Dr. Martineau's *Study of Spinoza*. In 1880 a statue was erected to Spinoza at The Hague by international subscription among his admirers.

Spinoza's philosophy is a thoroughgoing pantheism, which has both a naturalistic and a mystical side. The foundation of the system is the doctrine of one infinite substance, of which all finite existences are modes or limitations (modes of thought or modes of extension). God is thus the immanent cause of the universe; but of creation or will there can be no question in Spinoza's system. God is used throughout as equivalent to nature (*Deus sive natura*). The philosophical standpoint comprehends the necessity of all that is—a necessity that is none other than the necessity of the divine nature itself. To view things thus is to view them, according to Spinoza's favorite phrase, *sub specie æternitatis*. Spinoza's philosophy is fully considered in the article CARTESIANISM (see vol. v. p. 152 *sq.*).

Literature.—The contents of the *Opera Posthuma* included the *Ethics*, the *Tractatus Politicus*, and the *De Intellectus Emendatione* (the last two unfinished), a selection from Spinoza's correspondence, and a *Compendium of Hebrew Grammar*. The *Treatise on the Rainbow*, supposed to be lost, was published anonymously in Dutch in 1687. The first collected edition of Spinoza's works was made by Paulus in 1802; there is another by Gfrörer (1830), and a third by Bruder (1843–46) in three volumes. Van Vloten's volume, published in 1862, *Ad Benedicti de Spinoza opera quæ supersunt omnia supplementum*, is uniform with Bruder's edition so as to complete it by a supplementary volume. It contained the early treatise *De Deo et homine*, the *Treatise on the Rainbow*, and several fresh letters. A complete and authoritative edition has only recently been achieved by Dr. Van Vloten and Professor J. P. N. Land. The work was undertaken by them for the Spinoza Memorial Committee formed in Holland to celebrate the bicentenary of the philosopher's death; the funds remaining after the erection of the statue mentioned above were devoted to the publication of this handsome edition (2 vols., 1882–83). An English translation of *The Chief Works of Spinoza*, by R. H. M. Elwes, appeared in 1883, and a separate translation of the *Ethics*, by W. H. White was published in the same year; previous translations were unscholarly in execution. The main authority for Spinoza's life is the sketch published in 1705, in Dutch, with a controversial sermon against Spinozism, by Johannes Colerus. The French version of this *Life* (1706) has been several times reprinted as well as translated into English and German. The English version, also dating from 1706, has been reprinted by Mr. Frederick Pollock at the end of his work, *Spinoza, his Life and Philosophy* (1880). Mr. Pollock's book and Dr. Martineau's *Study of Spinoza* (1882), both admirable pieces of work, are in a manner complementary, and may with advantage be studied together. In his introduction Mr. Pollock gives a list of the biographical sources, and also some account of the early literature relating to Spinoza. The Spinoza literature in more recent times has become so extensive as to forbid quotation. A. van der Linde's *Benedictus Spinoza: Bibliografie* (The Hague, 1871) is a classified catalogue as nearly as possible complete down to that date. (A. SE.)

SPIRES (Germ. *Speyer* or *Speier*), the chief town of the Rhenish palatinate, Bavaria, and formerly a free imperial city, is situated on the left bank of the Rhine, at the mouth of the Speyerbach, 21 miles to the south of Worms. The principal streets are broad but irregular, and the general appearance of the town little corresponds to its high antiquity, owing to the fact that it was burned by the French in 1689. The only important ancient building that has survived the flames is the cathedral, a very large and imposing basilica of red sandstone, and one of the noblest examples of Romanesque architecture now extant. Beyond the general interest attaching to it as one of the old Romanesque churches of the Rhineland, Spires cathedral has a peculiar importance in the history of architecture as probably the earliest Romanesque basilica in which the nave as well as the side arcades was vaulted from the first. Built in 1030–61 by Conrad II. and his successor, this church has had a chequered history, its disasters culminating in 1689, when the soldiers of Louis XIV. burned it to the bare walls and scattered the ashes of the eight German emperors who had been interred in the kings' choir. Restored in 1772–84 and provided with a vestibule and façade, it was again desecrated by the French in 1794; but in 1846–53 it was once more thoroughly restored and adorned in the interior with gorgeous frescos at the expense of the king of Bavaria. The large cathedral bowl (Domnapf) in front of the west façade formerly marked the boundary between the episcopal and municipal territories. Each new bishop on his election had to fill the bowl with wine, while the burghers emptied it to his health. The heathen tower to the east of the church, on foundations supposed to be Roman, was probably part of the town wall built in 1080 by Bishop Rudger. Of the Retscher, or imperial palace, so called because built after the model of the Hradschin at Prague, only a mouldering fragment of wall remains. It was in this palace that the famous diet of Spires met in 1529, at which the Reformers first received the name of Protestants. The Altpörtel (alta porta), a fine old gateway of 1246, is a relic of the free imperial city. Among the modern buildings are several churches and schools, a museum and picture gallery, etc. Spires, although rebuilt in 1697, has never recovered from the cruel injuries inflicted by the French in 1689. Its trade is insignificant, although it still has a free harbor on the Rhine. Its manufactures include paper, tobacco and cigars, sugar, sugar of lead, vinegar, beer, and leather. Vines and tobacco are grown in the neighborhood. The population in 1880 was 15,589 and in 1885 16,228.

Spires, known to the Romans as *Augusta Nemetum* or *Nemetæ*, and to the Gauls as *Naviomagus*, is one of the oldest towns on the Rhine. The modern name appears first, under the form Spira, about the 7th century. Captured by Julius Cæsar in 47 B.C., it was repeatedly destroyed by the barbarian hordes in the first few centuries of the Christian era. The town had become an episcopal seat in the 4th century; but heathenism supervened, and the present bishopric dates from 610. In 830 Spira became part of the Frankish empire, the emperors having a "palatium" here; and it was especially favored by the Salic imperial house. The contentions between the bishops and the citizens were as obstinate and severe as in any other city of Germany. The situation of the town opposite the mouths of several roads through the Rhine valley early fostered its trade; in 1294 it rose to be a free imperial city, although it owned no territory beyond its walls and had a population of less than 30,000. It enjoyed great renown as the seat of the imperial supreme court from 1527 till 1689; it was fifth among the free cities of the Rhine, and had a vote in the Upper Rhenish diet. Numerous imperial diets assembled here. From 1801 till 1814 it was the capital of a department of France; but it was restored to Bavaria in the latter year. By the peace of Spires in 1544[1] the Hapsburgs renounced their claims to the crown of Sardinia.

SPIRITUALISM. The term "spiritualism" is used by philosophical writers to denote the opposite of materialism. It is also used in a narrower sense to describe the belief that the spiritual world manifests itself by producing in the physical world effects inexplicable by the known laws of nature. The belief in such occasional manifestations has probably existed as long as the belief in the existence of spirits apart from human bodies, and a complete examination into it would involve a discussion of the religions of all ages and nations. In 1848, however, a peculiar form of it, believed to be based on abundant experimental evidence, arose in America and spread there with great rapidity and thence over the civilized world. To this movement, which has been called "modern spiritualism," the discussion in the present article is confined. The movement began in a single family. In 1848 a Mr. and Mrs. Fox and their two daughters, living at Hydeville (Wayne), New York, were much disturbed by unexplained knockings. At length Kate Fox discovered that the cause of the sounds was intelligent and would make raps as requested, and, communication being established, the rapper professed to be the spirit of a murdered peddler. An investigation into the matter seemed to show that none of the Fox family were concerned in producing the rappings; but the evidence that they were not concerned is insufficient, although similar noises had been noticed occasionally in the house before they lived there. It was, however, at Rochester, where the two Fox girls soon afterwards went to live with a married sister (Mrs. Fish) that modern spiritualism assumed its present form, and that communication was, as it was believed, established with lost relatives and deceased eminent men. The presence of certain "mediums" was required to form the link between the worlds of the living and of the dead, and Kate Fox and her sister were the first mediums. Spiritualists do not as yet claim to know what special qualities in mediums enable spirits thus to make use of them. The earliest communications were carried on by means of "raps," or, as Mr. Crookes calls them, "percussive sounds." It was agreed that one rap should mean "no" and three "yes," while more complicated messages were —and are—obtained in other ways, such as calling over or pointing to letters of the alphabet, when raps occur at the required letters.

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[1] [The diet of Spires in 1544 affirmed the title of the duke of Savoy to certain parts of the Genevan shore; *v. Maison de Savoie*, by Belgiojoso (Paris, 1878). Austria ceded the island of Sardinia to duke Victor Amadeus II. of Savoy in 1720 (*v.* vol. xxi. p. 324), and in the same year the Kingdom of Sardinia was established by the treaty of Madrid (*v.* vol. xxi. p. 357.—AM. ED.]

The idea of communicating with the departed was naturally attractive even to the merely curious, still more to those who were mourning for lost friends, and most of all to those who believed that this was the commencement of a new revelation. The first two causes have attracted many inquirers; but it is the last that chiefly gives to modern spiritualism its religious aspect. Many came to witness the new wonder, and the excitement and interest spread rapidly. "Spirit-circles" were formed in several families, and other mediums discovered, exhibiting phenomena of various kinds (see below). The interest in mesmerism and the phenomena of hypnotic trance, which was widely diffused at this time both in America and Europe (see MAGNETISM, ANIMAL, vol. xv. p. 279 *sq.*), was favorable to the new idea. Information about other worlds and from higher intelligences was thought to be obtained from persons who could be put into the sleep-waking state, of whom Andrew Jackson Davis was in America the most prominent example. His work, *Nature's Divine Revelations* (New York, 1847), was alleged to have been dictated in "clairvoyant" trance. Many reputed "clairvoyants" developed into mediums. The movement spread like an epidemic. There is very little evidence to show that it rose anywhere spontaneously;[1] but those who sat with the Foxs' were often found to become mediums themselves and then in their turn develop mediumship in others. The mere reading of accounts of seances seemed to develop the peculiar susceptibility in some persons, while others, who became mediums ultimately, did so only after prolonged and patient waiting.

There seems to have been little practical interest in spiritualism in Europe till Mrs. Hayden, a professional medium from Boston, came over in 1852. It spread like wildfire within a few months of her arrival, —its first development being in the form of a mania for table-turning, which seems to have prevailed all over Europe in 1853. Daniel Dunglas Home, the next medium of importance who appeared in London, came over from America in 1855. But it was at Keighley in Yorkshire that spiritualism as a religious movement first made any mark in England, and it was there that the first English spiritualistic periodical, the *Yorkshire Spiritual Telegraph*, was started in 1855. The extent to which the movement has spread and the present number of spiritualists are very difficult to estimate. Vague calculations have from time to time been attempted: in 1867 one spiritualist estimated the number in America at 11,000,000 or two-fifths of the population, and another has held 3,000,000 to be an extreme estimate (see *Spiritual Magazine* for 1867). The periodicals devoted to spiritualism may perhaps be taken to indicate the present state of the movement. There are in England two weekly newspapers, *Light* and *The Medium and Daybreak*; one of these has advertisements of Sunday meetings in sixty different towns and in eighty different rooms. The spiritualistic journals outside Great Britain number about 100, though probably only about a quarter of these are of any importance. Of these 30 are in English (26 published in America and 4 in the Australian colonies), 15 to 20 in French, and 6 in German. But nearly 40 are published in Spanish in Spain and South America. Private circles which meet regularly are believed to be numerous in England; and there are numerous public and semi-public trance-speaking and clairvoyant mediums, especially among the miners in the north.

In the present article it is impossible to give an exhaustive catalogue of the phenomena and modes of communication of modern spiritualism. Many have not now appeared for the first time in history, though it is difficult to suppose any historical connection between the new developments and the old. Perhaps the most striking parallelism is that between the proceedings at modern seances and those connected with the later Greek oracles.[2] The greater part of the phenomena may be divided into two classes. To the first and earliest developed class belong what may be called the physical phenomena of spiritualism,—those, namely, which, if correctly observed and due neither to conscious or unconscious trickery nor to hallucination on the part of the observers, exhibit a force hitherto unknown to science, acting in the physical world otherwise than through the brain or muscles of the medium. The earliest of these phenomena were the raps already spoken of and other sounds occurring without apparent physical cause, and the similarly mysterious movements of furniture and other objects; and these were shortly followed by the ringing of bells and playing of musical instruments. Later followed the appearance of lights; quasi-human voices; musical sounds, produced, it is supposed, without instruments; the "materialization" or presence in material form of what seem to be human hands and faces, and ultimately of complete figures, alleged to be not those of any person present, and sometimes claimed by witnesses as deceased relatives; "psychography," or "direct writing and drawing," asserted to be done without human intervention; "spirit-photography," or photographing of human and other forms invisible to all but specially endowed seers; unfastening of cords and bonds; elongation of the medium's body; handling of red-hot coals; and the apparent passage of solids through solids without disintegration. The phenomena observed at Tedworth belong to this class. Somewhat similar was the Cock Lane ghost in 1762.[3] A practice of causing heavily loaded tables to rise by "magic" seems to have existed among the German Jews in the 17th century.[4] Kerner records movements of objects in connection with Madame Hauffe in 1825—

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[1] It is possible that the family of Dr. Phelps were unaware of the "Rochester knockings" when the disturbances began in his house at Stratford, Connecticut, in 1850 (see Capron's *Modern Spiritualism, its Facts*, etc.); but these disturbances, as recorded, have a closer resemblance to the ordinary occurrences at a spiritualistic seance than those which took place at Tedworth in 1661 (see Glanvill's *Sadducismus Triumphatus*) and at Slawensik in 1806 (see Kerner's *Seherin von Prevorst*), and others too numerous to mention.

[2] See *Essays Classical*, by F. W. H. Myers, 1883.

[3] See *Gentleman's Magazine*, 1762.

[4] Von Harless, *Aegyptische Mysterien*, 1856, pp. 130-132.

28,[1] and such movements also occurred in presence of the so-called electric girl in 1846.[2] The second class of phenomena, which we may call the automatic, consists in table-tilting and turning with contact; writing, drawing, etc., through the medium's hand; convulsive movements and involuntary dancing; entrancement, trance-speaking, and personation by the medium of deceased persons, attributed to temporary "possession"; seeing spirits and visions and hearing phantom voices. This class bears affinity to some of the phenomena of hypnotism and of certain nervous complaints, to certain epidemics of the Middle Ages,[3] and to phenomena that have occurred at some religious revivals. According to quotations given by Chevreul,[4] the divining-rod was used at the end of the 17th century for obtaining answers to questions as table-tilting now is. In a third class must be placed the cure of disease by healing mediums. This cannot well be treated apart from mesmeric healing and "faith cures" and "mind cures," and belongs to medical psychology.

The class of automatic phenomena are much the commonest. The investigations of Carpenter on unconscious cerebration and of Faraday on unconscious muscular action[5] have shown that it is not necessary to look outside the medium's own brain and organism for the explanation of such things as automatic writing and table turning. It is about the matter communicated by these means that the controversy now turns. Spiritualists maintain that true information is thus given, probably unknown to the medium or other persons present, or at least expressed in a way obviously beyond their powers to originate. Another view, which is now gaining ground, is that the information in some exceptional cases does not come from the mind of the medium, but is due to the influence wrought on his mind by that of other persons, and more than this is not proved.[6]

At no period of the spiritualistic movement has the class of physical phenomena been accepted altogether without criticism. Most spiritualists know that much fraud in connection with them has been discovered—frequently by spiritualists themselves—and that the conditions favorable to obtaining them are often such as favor fraud. It is with a full knowledge of these difficulties in the way of investigation that they maintain that unmistakably genuine phenomena are of constant occurrence. Many volumes containing accounts of such phenomena have been printed, and appeal is often made to the mass of evidence so accumulated. "No physical science can array a tithe of the mass of evidence by which psychism" (*i.e.*, what is usually called spiritualism) "is supported," says Serjeant Cox.[7] But the majority of these accounts have scarcely any scientific value. Spiritualists have, as a rule, sought to convince not by testimony but by ocular demonstration. Yet, if there is not a mass of scientific evidence, there are a number of witnesses—among them distinguished men of science and others of undoubted intelligence—who have convinced themselves by observation of the genuineness of the phenomena,—a fact of undeniable importance, even without careful records, when the witnesses are otherwise known to be competent and trustworthy observers. Mr. Maskelyne has affirmed[8] that he has witnessed table-turning where he was satisfied that there was neither trickery nor unconscious muscular action. Moreover, if the phenomena are not genuine, we have to assume a large amount of apparently aimless fraud.

Amongst the proposed explanations of these phenomena that of hallucination need not detain us long. Sensory hallucination of several persons together who are not in a hypnotic state is a rare phenomenon, and therefore not a probable explanation. Moreover, it cannot be regarded as being generally applicable, partly because material traces of what occurs often remain, and partly because of the general agreement not only of all the witnesses but of all the senses as to what is perceived, as distinguished from what is inferred. Nevertheless something of the kind may occasionally have happened, especially at some of the seances of Home.[9] If collective hallucination really occurs at seances, it is a very interesting fact, and deserves to be carefully studied.

What may broadly be called conjuring is, however, a much more probable explanation of most of the recorded phenomena; and in the vast majority of cases the witnesses do not seem to have duly appreciated the possibilities of conjuring, nor to have taken sufficient precautions to exclude it. Besides, not even a conjuror knows all the possibilities of his art and can describe in detail all the accidental circumstances which may on any particular occasion favor deception, and perhaps never exactly recur. We require, therefore, to know not only that the witness is careful and accurate but that he has allowed a sufficiently wide margin for the possibilities of conjuring; and some leading spiritualists do not allow this. It is often urged that mediums are not conjurors because they frequently fail, whereas "imposture can be reproduced at will." and because they can produce the phenomena in private rooms, and under conditions which exclude the possibility of conjuring. But the phenomena produced by mediums in private rooms would generally be uninteresting and unsuited to public performance, so that it would not pay a professional conjuror to practice them. Amateur conjurors might do something in this way, and the present writer has seen one imitate successfully some of the phenomena of professional mediums for "direct writing"; but to compete with mediums on really equal terms the conjuror must have the same conditions throughout, and this is difficult to arrange, since it involves securing witnesses who are doubtful as to whether what they see is conjuring or not. Still more important to the conjuror is that very privilege of failing whenever he pleases, so largely used by mediums, that he may avail himself of accidental opportunities for trickery, which would be interfered with by a settled programme. The extent to which the absence of programme obtains at seances appears from the following statement by a leading spiritualist who writes under the *nom de plume* of "M.A. (Oxon.)": "In 99 out of every 100 cases people do *not* get what they want or expect. Test after test, cunningly devised, on which the investigator has set his mind, is put aside, and another substituted."[10] In other words, the evidence is rarely strictly experimental, and this not only gives facilities for fraud but makes it necessary to allow a much larger margin for accidents, mistakes, and mal-observation. It must be borne in mind that the most excellent moral character in the medium is no guarantee against trickery, unless it can be proved that he was in no abnormal mental condition when the phenomena occurred; for extraordinary deceptions have been carried on by hysterical patients and others with no apparent motive but a desire to secure attention.

One of the possibilities to be allowed for is that of unusual muscular endowment in the medium. For instance, in 1851, the remarkable loud double raps occurring in the presence of the Fox girls, which in

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[1] *Seherin von Prevorst.*

[2] Tanchou, *Enquête sur l'authenticité des phénomènes électriques d'Angélique Cottin*, Paris, 1846.

[3] See Hecker, *Epidemics of the Middle Ages*, 1859.

[4] *De la baguette divinatoire*, etc., 1854.

[5] *Athenæum*, 2d July, 1853; see also on this subject Chevreul, *op. cit.*

[6] See Ch. Richet, "La Suggestion Mentale," in *Revue Philosophique*, December, 1884, and *Proc. Soc. for Psychical Research*, vols. ii. and iii.

[7] *Mechanism of Man: What am I?* vol. ii. p. 313, 1879.

[8] See *Pall Mall Gazette*, 18th, 20th and 23d April, 1885.

[9] See, *e.g.*, *Report on Spiritualism of the Committee of the London Dialectical Society*, 1871, pp. 367–369, 207. See also Guldenstubbe, *De la réalité des esprits*, 1857, p. 66.

[10] *Human Nature*, 1876, p. 267.

1849 had puzzled several investigating committees at Rochester, were explained by Professors Flint, Lee, and Coventry of Buffalo as produced by rapidly partially dislocating and restoring the knee and other joints. They stated that they had experimented with another lady who could do the same; and, challenged by Mrs. Fish, they tried some experiments with her and Margaretta Fox which strongly supported their view.

Besides the general arguments for supposing that the physical phenomena of spiritualism may be due to conjuring, there are two special reasons which gain in force as time goes on. (1) Almost every medium who has been prominently before the public has at some time or other been detected in fraud, or what cannot be distinguished from fraud except on some violently improbable hypothesis; and (2), although it is easy to devise experiments of various kinds which would place certain phenomena above the suspicion of conjuring, by eliminating the necessity for continuous observation on the part of the investigators, there is no good evidence that such experiments have ever succeeded. Nevertheless there does exist evidence for the genuineness of the physical phenomena which deserves consideration. Count Agénor de Gasparin[a] in his *Tables Tournantes* (Paris, 1854), gives an account of what seem to have been careful experiments with his own family and friends, which convinced him that by some unknown force tables could be got to move without contact. He did not believe that spirits had anything to do with it. His experiments were conducted in broad daylight and with skeptical witnesses (whose testimony, however, he does not give) looking on outside the circle. The minutes of the sub-committee No. 1 of the committee of the Dialectical Society (*op. cit.*, pp. 373–391) report that tables moved without contact, whilst all the persons present knelt on chairs (the backs of which were turned to the table), with their hands on the backs. The report, however, would be of greater value if the names of the medium and of the working members of the committee were given—we only know that of Sergeant Cox—and if they had written independent accounts of what they witnessed. The conditions of some of Mr. Crookes's experiments with D. D. Home on alterations in the weight of a partially suspended board[1] appear to have been so simple that it is difficult to imagine how the witnesses can have been deceived. Some very remarkable evidence is contained in "Researches in Spiritualism during the Year 1872–3," by "M.A. (Oxon.)," published in a spiritualistic periodical called *Human Nature*, March and August, 1874. The papers give accounts of phenomena obtained through the writer's own mediumship, generally in the presence of one or two friends, and extending over almost the whole range of spiritualistic manifestations.

But what chiefly interests spiritualists is the assurance of life and progress after death, and the moral and religious teaching, which they obtain through automatic writing and trance-speaking. It was discovered very early in the movement that the accuracy of these communications could not always be relied on; but it is maintained by spiritualists that by the exercise of the reason and judgment, by prolonged acquaintance with particular communicating intelligences, and by proofs of identity with persons known to have been trustworthy on earth, it is possible to obtain valuable information from beings not infallible, but with the knowledge of spirit life superadded to their earthly experience. Still the agreement between communications so received has not been sufficiently great for anything like a universal spiritualistic creed to have been arrived at. In France the doctrine of successive reincarnations with intervals of spirit life promulgated by Allan Kardec (Léon Hippolyte Denisart Rivail) forms a prominent element of spiritualistic belief. This view has, however, made but little way in England and America, where the opinions of the great majority of spiritualists vary from orthodox Christianity to Unitarianism of an extreme kind. Probably it would be impossible to unite spiritualists in any creed, which, besides the generally accepted belief in God and immortality, should postulate more than the progress of the spirit after death, and the power of some of the dead to communicate with the living by means of mediums.

Spiritualism has been accused of a strong tendency to produce insanity; the charge, however, seems to be in the main a mistaken inference from the fact that the delusions of the insane not unfrequently take the form of supposed converse with invisible beings. It is, however, probable that the spiritualistic theories of possession and obsession sometimes injure persons with incipient insane impulses, by weakening their sense of responsibility for these and their efforts to control them. Spiritualism has also been accused of fostering free love and other doctrines subversive of society. But this charge too has been made without adequate grounds; for, though certain spiritualistic bodies have at times taught such doctrines, they have always been repudiated by the mass of spiritualists. The great scandal of spiritualism is undoubtedly the encouragement it gives to the immoral trade of fraudulent mediumship.[b]

In addition to the works already mentioned, the student, for a general idea of the whole subject, should consult the following: E. W. Capron, *Modern Spiritualism, its Facts*, etc., Boston, 1855, for the early history of the movement in America, Edmonds and Dexter, *Spiritualism*, New York, 1854–55; R. Hare, *Experimental Investigations of the Spirit Manifestations*, New York, 1856; Allan Kardec, *Livre des Esprits*, 1st ed. 1853; Mrs. De Morgan, *From Matter to Spirit*, London, 1863, with preface by Professor De Morgan; Alfred Russel Wallace, *Miracles and Modern Spiritualism*, 1876; M.A. (Oxon.), *Spirit Identity* and *Spirit Teaching*; Zöllner, *Wissenschaftliche Abhandlungen* (the part relating to spiritualism has been translated into English under the title *Transcendental Physics* by C. C. Massey).[2] A succinct account of typical frauds of spiritualism is contained in D. D. Home's *Lights and Shadows of Spiritualism*, 2d. ed., 1877–78. (E. M. S.)

SPITZBERGEN.

Situation.

SPITZBERGEN. This group of rocky, barren, and snow-clad islands, lost in the solitudes of the Arctic Ocean, 400 miles north-northwest of the North Cape of Norway (see vol. xix. pl. II.), but nevertheless well known for at least four centuries to European whalers and seal-hunters, has of late acquired new interest from the scientific expeditions by which it has been selected either as a base for attempts to reach the north pole or as a field in which to inaugurate a new era of scientific exploration in the arctic regions. From Spitzbergen Parry started in 1827 on the sledge journey which brought him within 480 miles of the pole; it was the starting-point of the investigations which led Charles Martins to his brilliant generalizations of the flora, present and past, of the earth; and numerous Swedish expeditions from 1858 onwards have accumulated an amount of knowledge, so vast and so important, as to be comparable only with the results of the great equatorial and arctic journeys of the first years of the 19th century.

Islands.

The Spitzbergen archipelago, lying between 76° 30′ and 80° 30′ N. lat. and 10° and 30° E. long.—half-way between Greenland and Nova Zembla—consists of six large and a great number of smaller islands. The chief, that of West Spitzbergen, shaped like a wedge pointed towards the south, and deeply indented on the west and north by long branching fjords, has an area of nearly 15,200 square miles. High mountains, reaching 4560 feet in the Horn Sound Tind, cover its southern parts; while a wide plateau, with an altitude of from 1500 to 2000 feet and covered by a thick ice-sheet, occupies the north. Several fjords —Horn Sound, Bel Sound, Ice Fjord (15 miles wide and 80 long), and the double fjord of King's Bay and Cross Bay on the west, and Liefde, Wiide and Lomme Bays on the north—deeply penetrate the island. One of the ramifications (Dickson Bay) of the beautiful Ice Fjord, 150 fathoms deep, nearly reaches the head of Wiide Bay, so as almost to divide the island. A long narrow island, Prince Charles's Foreland, with peaks of nearly 5000 feet high, runs parallel to part of the west coast of West Spitzbergen, from which it is separated by a narrow strait. The broad Stor (Great) Fjord, or Wiide Jans Water, separates the main island from two others to the east,—Stans Foreland (2500 square miles) and Barents Land (580 square miles). Formerly these were considered as one, and named Edge Island, until the narrow Walter Thymen Strait which parts them was discovered. A few peaks, estimated at from 1600 to 2000 feet high, protrude above the snow and ice by which these two imperfectly explored islands are covered. To the northeast of West Spitzbergen, separated from it by Hinlopen Strait (7 to 60 miles in breadth) lies North-East Land, with an area of about 6200 square miles. Its western and northern coasts are indented by several bays and fjords; the southern and eastern shores, on account of the masses of ice by which they are constantly girt, remain unexplored. This island appears like a broad plateau covered by an ice-sheet 2000 to 3000 feet in thickness, from which a few peaks protrude. Slowly moving towards the east, this immense sheet of ice discharges into the sea by a huge ice-wall, unbroken by promontories for 150 miles, thus forming the broadest glacier known,—Dickson's glacier. Eastwards from this group of islands, 100 miles to the northeast of Stans Foreland, rises another island, measuring 90 miles from west to east. Marked either Gillis's Land or Wiche's Land in earlier maps,[1] it was seen from Spitzbergen as a snow-clad mass mingling with the fogs of the sea by a Swedish expedition, and later on by Heuglin and Zeil; but it was not until 1872 that the Norwegian whalers Altman, Johnsen, and Nilsen reached it from the east and nearly circumnavigated it. After some discussion about its name, it has received from Professor Mohn the name of King Charles Land, which is now generally accepted. The wide strait which separates it from Spitzbergen is called Olga Strait. It is now established that Gillis saw Gillis's Land to the northeast of the archipelago, and this land, which may perhaps be a link between the Spitzbergen archipelago and that of Franz-Joseph, has been again sighted by Norwegian seal-hunters. Numerous small islands lie around the larger: the Danes and Norwegians Islands on the northwest, the seven islands on the north, Outger Reps, Brock, and Charles XII. Island on the northeast, Waygat Islands and William I. Island in Hinlopen Strait, the Ryk Yse Archipelago, Hope Island, and the Thousand Islands (about a hundred small rocks) to the east and south of Stans Foreland, and many other smaller ones. Many of these small islands rise to a height of 1500 to 1700 feet.[2]

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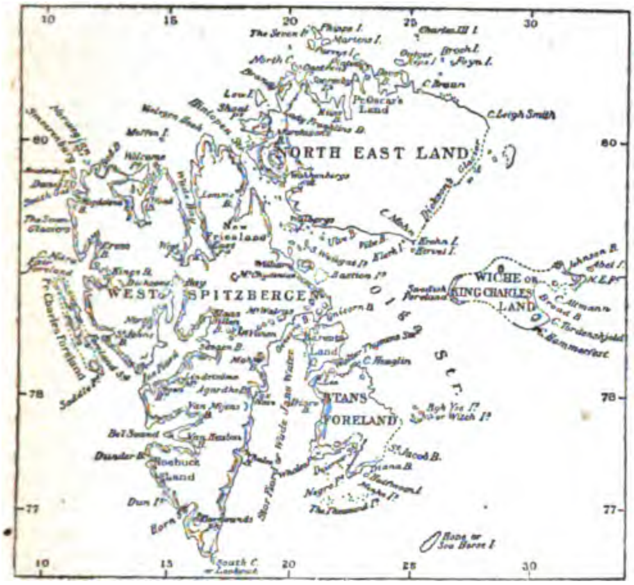
[1] *Quart. Journ. of Science*, July and October 1871; republished, with other papers by Mr. Crookes, under the title of *Researches on the Phenomena of Spiritualism*, 1874–76.

[2] [See also *Preliminary Report of the Commission appointed to investigate modern Spiritualism in accordance with the request of the late Henry Seybert* (Phila., 1887).—AM. ED.]

[a] [French Protestant apologist, born at Orange, 1810, sought with Monod the doctrinal unity of the Reformed Church, settled in Switzerland (1848), defended the American Union in a work translated as *The Uprising of a Great People*. Died at Geneva (1871). His wife wrote *The Near and Heavenly Horizons*.—AM. ED.]

[b] [For a Chinese form of this superstition, see LAO-TSZE, Vol. XIV. p. 298.—AM. ED.]



Map of Spitzbergen.

Seas round Spitzbergen.

The archipelago, which has the Greenland Sea to the west and Barents Sea to the east, rises from a submarine platform that extends from Bear Island northeastwards to Franz Joseph Land, and probably was an immense arctic continent connected with Greenland during the middle of the Tertiary period. The sea around Spitzbergen has a depth of less than 100 fathoms. Owing to this circumstance the ice readily accumulates round the shores; and, although the glaciers of Spitzbergen do not give origin to icebergs so huge as those of Greenland, the smaller icebergs and the pack-ice are thick enough to prevent access to the shores except for a few months in the year. Happily the Gulf Stream, which washes the shores of Norway, after sending a branch to the east, flows north to the western shores of Spitzbergen, moderating its climate, and leaving an open passage which permits whalers to approach the western coast even under the most unfavorable conditions of ice in the arctic regions. Driftwood brought from lower latitudes, glass-floats of the Norwegian fishermen, and even the large seeds of the *Entada Gigalobium*, carried by the Gulf Stream from the Gulf of Mexico, are found at the northern extremity of Spitzbergen. On the other hand, a cold current charged with ice descends from higher latitudes along the eastern coast, rendering approach extremely difficult. On this account King Charles Land remained unknown until 1872, and the eastern coast of North-East Land still continues unexplored.

Climate.

Owing to the warm current, the climate of Spitzbergen is less severe than in the corresponding latitudes of Greenland and Smith Sound. The isotherm of 23° Fahr. (— 5° C.), which crosses the middle of Eastern Siberia, touches its southern extremity, and only the northeast coasts of West Spitzbergen and North-East Land have an average yearly temperature so low as 14° to 10.5° (— 10° to — 11.9° C.). At Mussel Bay (79° 53′) the average yearly temperature is 16° (January 14.1°, July 39.3°). Bear Island, notwithstanding its more southerly position, has a lower temperature, as the Gulf Stream does not touch it. Even in the coldest months of the winter a thaw may set in for a few days; but, on the other hand, snow sometimes falls in July and August. Spring comes in June; the snow becomes saturated with water and disappears in places, and scurvy grass and the polar willow open their buds. By the end of June the thermometer has ceased to sink below the freezing-point at night; July, August, and September are the best months. In September, however, autumn sets in on shore, though the whalers continue cruising until the end of the month and even reach the highest latitudes. By the end of September the pack-ice rapidly freezes into one solid mass. To move on this mass, however, is exceedingly difficult, for the ice, owing to its contraction and expansion, is either intersected by large fissures or broken up and piled into heaps, which puts insuperable difficulties in the way of sledge expeditions.

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[1] [On old Dutch charts this "land is marked 'Commandeur Giles's Land entdekt, 1707.'" See Nordenskiöld's Arctic Voyages, London, 1879. p. 244.—AM. ED.]

[2] Bear Island, half-way between the North Cape and Spitzbergen, can hardly be reckoned to the Spitzbergen archipelago. It was formerly renowned for its hunting grounds, but is very seldom visited now. Lying outside the course of the Gulf Stream, it is almost entirely ice-bound.

Glaciers.

Glaciers are largely developed. On the high grounds the snow under a level of from 1200 to 1500 feet disappears every year; but on the plateaus it continually accumulates, so as to cover them with an immense ice-sheet, like that of Greenland, which slowly discharges by the valleys towards the sea in the form of immense glaciers. All North-East Land and the interior of West Spitzbergen are covered with such ice-sheets, which descend to King's Bay by a glacier 15 miles wide, or by that already alluded to in North-East Land, where the ice-cliffs are from 200 to 400 feet high. These glaciers, however, discharging into comparatively shallow waters, do not produce such icebergs as those of Greenland. The glaciers of the present epoch are but trifling in comparison with what they were during the Glacial period, when the entire country was buried under an ice-sheet, which probably connected all the archipelago into one ice-bound continent and spread far beyond to northern Europe.

Geology.

The backbone of the islands consists of thick layers of granite, gneiss, and other archaic schists. But more recent formations bearing witness to a much more genial climate are not wanting. The Carboniferous period is represented by extensive coal-bearing strata, the lowest of which are intermediate with the Devonian (Liefde Bay strata). The Trias, also containing a rich fossil flora, is represented by black clay slate. The Jurassic deposits are widely spread; they mostly belong to the Kelloway, and many of them are coal-bearing. To the same period belong the frequently occurring layers of what was formerly called hypersthenite, but has now been proved to be (according to Zirkel's classification) diabase and dolorite. The most interesting formation is, however, the Miocene. At a period close, geologically speaking, to the subsequent Glacial period, and even to our own, Spitzbergen was covered with a luxuriant vegetation the like of which is now found only in the 60th parallel in Scandinavia. The shores of Bel Sound, Ice Fjord, and Cape Starostine in 78° N. lat. were covered with extensive peat bogs, on the edges of which the marsh cypress flowered, dropping its leaves and blossoms into the marshes. *Sequoiæ*, poplars, birches, planes, and large oaks also grew there. while ivy and thick underwood freely developed under their shadow, and thousands of insects swarmed in the thicket. The most striking feature of this Miocene vegetation—a feature conclusively established by the researches of Oswald Heer—is that Spitzbergen, Greenland, Franz-Josef Land, and Nova Zembla were at that time parts of one immense continent, thus realizing the very conditions for the coldest climate, if climate had to depend on telluric causes only. Heer has shown, moreover, in a manner that hardly admits of doubt that the luxuriant vegetation so unmistakably borne witness to by the Miocene strata of the arctic regions could not have developed had it been condemned to endure the long arctic night it now undergoes. This feature of the arctic Miocene flora is unexplained, and will remain so until higher cosmical laws are formulated to explain changes of climate. A change in the position of the earth's axis of rotation (recently the subject of a serious discussion in England and on the Continent) would seem to be the only adequate hypothesis by which to account for the warm vegetation of the period in question in such proximity to the pole; but this hypothesis would be so much at variance with the present state of our knowledge that we may well hesitate to advance it. A brief recurrence of a warmer climate —not nearly so warm as the Miocene, yet somewhat warmer than the present—was also experienced by Spitzbergen after the long period of glaciation as is proved by the occurrence of beds with mussels, which are now found only in much warmer latitudes. This warmer Post-Glacial period—traces of which have been met with throughout the arctic and subarctic regions—was followed by a period of slow upheaval, which still continues.

Flora.

The flora is of course poor. The only tree is the polar willow, which does not exceed 2 inches in height and bears a few leaves not larger than a man's finger-nail; and the only bush is the crowberry (*Empetrum nigrum*), to which the recently discovered cloudberry (*Rubus Chamæmorus*) may be added. But at the foot of the warmer cliffs some loam has been formed notwithstanding the slowness of putrefaction, and there, in contrast with the brownish lichens that cover the hills, grows a carpet of mosses of the brightest green, variegated with the golden-yellow flowers of the ranunculus (*R. sulphureus* and *hyperboreus*), the *Sileneæ*, the reddish heads of the *Pedicularis*, the *Oxyria reniformis* (a foot high), the large-leaved scurvy grass (*Cochlearia fenestrata*), several saxifrages, *Cerastium alpinum*, *Potentilla emarginata*, fox-tail grass (*Alopecurus alpinus*), *Dupontia Fischeri*, *Poa cenisia*, *pratensis*, and *stricta*, with a few large-flowered *Polygona Andromedæ;* while on the driest spots yellow poppies and whitlow grasses (*Drabæ*), *Cardamine bellidifolia*, several *Dryadeæ*, etc., are found. Even on the higher slopes, 1500 feet above the sea, the poppy, *Luzula hyperborea*, and *Stellaria Edwardsii* are occasionally met with. Mosses, mostly European acquaintances, cover all places where peat has accumulated. The slopes of the crags and the blocks of stone on the beach are sometimes entirely covered with a luxuriant moss and lichen vegetation, among the last being the so-called "famine bread" (*Umbilicaria arctica*), which has maintained the life of so many arctic travellers. Flowering plants are represented by as many as ninety-six species, of which eighty-one grow in Greenland and sixty-nine in Scandinavia; forty-three species are alpine cosmopolites, and have been met with on the Himalayas. The ferns are represented by two species.[1] Although thus limited in number, the flora is suggestive in its distribution. The vegetation of the south has a decidedly Lappish or European alpine character, while that of the north coast is decidedly American, and recalls that of Melville Island. Many flowering plants which are common in northwest Spitzbergen are absent from the east coast, where the cold current is inimical to both flora and fauna; but, on the other hand, one moss (*Pottia hyperborea*) and one lichen (*Usnea melaxantha*) are found there which are of American origin and grow both in North America and on the Cordilleras. *Algæ* are most numerous, many, like the brown *Laminaria* and *Nostoc commune*, which fill all pools and are the chief food of many birds, being familiar in Europe. *Protococcus nivalis* covers the snow with its reddish powder.

Fauna.

The fauna, although not very rich in species, is exceedingly rich in individuals. It includes fifteen mammals, only two of which are terrestrial—the reindeer and the ice-fox—besides the usual inhabitant of the arctic regions, the polar bear.[2] The number of reindeer is really puzzling. In a single summer, or rather in the course of a few weeks, no fewer than from 1500 to 2000 reindeer were killed by hunters for several consecutive years previous to 1868. Much emaciated in June, they grow very fat towards the end of the autumn, after feeding on the mosses. Great numbers are "marked" (that is, have both ears cut at the same height), and the hunters are persuaded that these individuals come from an unknown continent in the northeast, where they have been marked by the hand of man. However strange this hypothesis, it must be acknowledged that the objections urged against it by the Swedish explorers are not conclusive, and that frost-bite attacking young calves could hardly account for the symmetrical markings on both ears. The immense numbers of the reindeer strongly support the idea of their migration, and the only question is whether they came from Siberia *via* Nova Zembla, or whether they did not really come from the unknown archipelagoes on the northeast, the existence of which is supported by so many other data (immobility of the ice to the east of Spitzbergen, dirty ice, birds met with off North-East Land, as well as several other considerations of a more general character).

Eight Cetaceans are met with in the seas off Spitzbergen, viz.: *Balænoptera boops*, 80 to 110 feet long; *B. gigas* and *B. rostrata*, 30 feet long; the white whale (*Beluga catodon*), three species of seals (*Phoca barbata*, *grœnlandica*, and *hispida*), and the walrus (*Trichechus* or *Odobænus rosmarus*). The Greenland whale has completely disappeared in consequence of the great havoc made during the last two centuries; according to Scoresby, no less than 57,590 individuals were killed between 1669 and 1775. A perfectly reckless extermination of seals is still going on. Numberless walruses tumble about in the water, or lie in crowds on the floating ice; and their number further increases when the flocks of Greenland seals arrive in August.

Birds visit the archipelago in such vast flocks that the cliffs are literally covered with them. The fulmar petrel (*Procellaria glacialis*)—a herald of polar regions—meets the ships approaching Spitzbergen far away from the coasts. Its colonies cover the cliffs, as also do those of the glaucous gull (*Larus glaucus*), or the "burgomaster." Rotches (*Mergulus alba*), black guillemots (*Uria grylla*), ivory gulls (*Larus eburneus*), auks, and kittiwake gulls (*Larus tridactylus*) breed extensively on the cliffs, while geese, looms, and snipe swarm on and about the lagoons and small freshwater ponds. The bernacle goose (*Anser bernicla*) is only a bird of passage, as it goes farther northeast to nest. The eider breeds in large colonies on the islands, where its young are safe from the ice-fox, only the glaucous gull and the brent goose (*Bernicla brenta*) being admitted to keep them company, while the lumme (*Mormon arcticus*) and the tern confine themselves to separate cliffs. These birds, however, are only guests in Spitzbergen, the snow-bunting (*Emberiza nivalis*) being the only species which stays permanently; twenty-three species breed regularly on Spitzbergen, and four others (the falcon, snowy owl, swan, and skua) come occasionally.

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[1] According to Mr. Naathorst's researches in 1882 (*Sv. Vetenskaps Akad. Handlingar*, xx.; *Botanisches Jahrbuch*, iv.), the flora of Spitzbergen is composed as follows: *Rosaceæ*, 7 species; *Saxifrageæ*, 10; *Cruciferæ*, 15; *Ranunculaceæ*, 8; *Sileneæ* and *Alsineæ*, 12; *Salix*, 2; *Compositæ*, 5; *Scrophulariaceæ*, 2; *Ericaceæ*, 2; *Gramineæ*, 23; *Cyperaceæ*, 12; *Juncaceæ*, 6; *Filices* (Ferns), 2; *Lycopodiaceæ*, 1. The whole of this flora immigrated during the Post-Glacial period, which was warmer than the present.

[2] The existence of the *Arvicola hudsonia* is not quite proved.

There are twenty-three species of fishes, but no reptiles. Insects are few: *Lepidoptera* (one species), *Neuroptera* (one), *Hymenoptera* (four), and *Diptera* (twenty) have been met with by the Swedish expeditions. Arachnids, and especially Pantopods, on the other hand, are very common. Molluscs are also very numerous, embracing no less than 130 species. In June several *Limacinæ* are met with in such numbers on the coast and at the mouth of the glacier streams as to constitute the chief food of the gulls. At some places the mussels and univalves reach a comparatively colossal size and appear in incredible abundance. Of Crustaceans no fewer than 100 species have been recognized in the waters of the archipelago.

The marine fauna is exceedingly rich in the bluish warmer waters of the Gulf Stream, and the dredgings of the Swedish expeditions, which were prosecuted even under the ice, never failed to bring to the surface a rich variety of remarkable or new forms. From a depth of 8400 feet the "bull-dog" machine lifted mud of a temperature of 33° Fahr. (0.3° C.), charged with Radiolarians, *Polythalamæ*, *Globigerinæ*, *Biloculinæ*, *Dentalia*, and *Nonioninæ*, together with some Annelids (*Spiochætopterus* and *Cirratulus*), two Crustaceans (*Cuma rubicunda* and *Apseudes*), one Mollusc, two *Holothuriæ*, one *Gephyrea*, and one Sponge. Even at a depth of 15,900 feet animal life was found in unexpected profusion, the mud consisting almost entirely of brown and white *Foraminiferæ*, among them one Crustacean (a species of *Cuma*). But marine life is much poorer on the east coast, resembling that of Greenland.

Man does not live on Spitzbergen, and the attempts of the Swedes to winter there have for the most part proved failures, except in the case of the "Sofia" expedition, which succeeded in wintering without great loss, though not without suffering from scurvy. None but the Russian "Pomory" (inhabitants of the Murman coast) have succeeded in enduring the arctic winters. The patriarch of Spitzbergen, the Pomor Staraschin (Starostine), spent no less than thirty-two winters (fifteen being consecutive) on the islands, dying of old age in 1826. There was a time in the 17th and 18th centuries when thousands of Dutch, Danes, and others were attracted to Spitzbergen by the whale-fishing. Whole villages sprang up on the shores, the best being that of the Dutch—Smeerenberg—which is said to have been visited by 18,000 men in a single summer. The "right whale" having disappeared, the whalers ceased to visit Spitzbergen and only quite recently an attempt has been made to renew the pursuit of the *Balænoptera boops*. The chief object of pursuit is the walrus, carried on by Norwegians; sea-birds and eider are also occasionally sought.

History.

Expeditions.

History.—Spitzbergen was discovered in 1596 by William Barents, and his companion, Cornelius Rijp, is believed to have circumnavigated the archipelago. Nevertheless it was long considered as a part of Greenland, and described under the names of East Greenland, Newland, King James's Land, until the old name of Spitzbergen gained the ascendency. But long before Barents discovered it the Russians had known it under the name of Grumant (a word of unknown origin), and when Chancellor arrived at Archangel in 1553 he learned that the Russians visited Grumant for hunting purposes. After the 17th and 18th century whalers, the Russians began to visit the group, chiefly for walruses, seals, foxes, reindeer, bears, and birds; their huts and crosses are met with at very many places on the coast. Many wintered for several consecutive winters. Since 1830 their visits have almost ceased. The Norwegians began to visit the archipelago about 1795, and their small vessels now visit the Spitzbergen waters in considerable numbers. In 1822 a party wintered successfully, but later attempts have for the most part proved fatal on account of scurvy. To these experienced arctic navigators—assisted by Norwegian *savants*—we are indebted for so many important discoveries in the Barents, Kara, and Siberian Seas.

Several expeditions have made Spitzbergen their base in attempts to reach the north pole. The Russian admiral Tchitchagoff visited it twice, in 1765 and 1766, and reached 80° 28′ N. lat. John Phipps mapped the north of Spitzbergen in 1773, and reached 80° 37′ N. lat.[1] In 1818 Buchan and Franklin reached 80° 34′ to the north of the archipelago. Clavering and Sabine in 1823 explored the islands, and Sabine made his remarkable magnetic observations while Clavering reached 80° 20′ N. lat. Parry, shortly after his return from his third voyage, went to Spitzbergen and reached 82° 44′ N. lat.[1] on sledges. In the same year the Norwegian geologist Keilhau visited the group and has related his experiences in a remarkable book, *Resa i Ost og West Finmarken*. The Swedish professor Lovén was the first to undertake, in 1837, dredging and geological explorations in Spitzbergen and its vicinity. Next year a body of French, Swedish, Danish, and Norwegian naturalists, among whom was Charles Martins, visited the western coast. From 1858 onwards the archipelago has been the object of a series of scientific expeditions. At the suggestion of Lovén, Otto Torell, accompanied by Nordenskjöld and Quennerstedt, opened the series, making many important observations and bringing home rich geological collections. In 1861 a larger expedition led by Torell, Nordenskjöld, Malmgren, Chydenius, and Petersen set out with the object of finding how far it was possible to obtain a measurement of an arc of meridian of sufficient extent. This aim was only partly accomplished, but the expedition returned with an invaluable stock of various observations. The work of the measurement of the arc was completed in 1864 by another expedition conducted by Nordenskjöld, assisted by Malmgren and Dunér, who returned again with a vast number of new and important observations. This expedition was followed in 1868 by that of the "Sofia," under Nordenskjöld, having on its scientific staff Holmgren, Malmgren, and F. Smitt, zoologists; Berggren and Fries, botanists; Lemström, physicist; and Nauckhoff, geologist. They were prevented by ice from getting higher than 81° 42′ N. lat.; but, to use Oswald Heer's words, the expedition "achieved more and gave a wider extension to the horizon of our knowledge than if it had returned merely with the information that the 'Sofia' had hoisted her flag on the north pole." In 1870 two young Swedish savants, Naathorst and Wilander, visited Spitzbergen in order to examine the phosphoric deposits, and two years a later a colony was formed in Ice Fjord, and a small railway constructed to work the beds. The attempt, however, did not prove successful. Mr. Leigh Smith and the Norwegian Captain Ulve visited and mapped parts of East Spitzbergen in 1871, returning with valuable information. They reached 81° 24′ N. lat. In the same year Mr. Lamont visited the archipelago. In 1872 a great polar expedition set out to winter on Spitzbergen with the intention of attempting in the spring to advance towards the pole on sledges drawn by reindeer. But the expedition encountered a series of misfortunes. The ships were beset in the ice very early in Mussel Bay, and, six Norwegian fishing vessels having been likewise overtaken and shut in, the expedition had to feed the crews on its provisions and thus to reduce the rations of its own men. The reindeer all made their escape during a snow-storm; and, when the sledge party reached the Seven Islands, they found the ice so packed that all idea of going north had to be abandoned. Instead of this, Nordenskjöld explored North-East Land, and crossed the vast ice-sheet which covers it. The expedition returned in 1873 with a fresh store of important scientific observations, especially in physics and submarine zoology. In 1873 Drasche, the geologist, paid a short visit to Spitzbergen, and the Dutch polar expedition approached it in 1882. In 1882 the Swedish geologists Naathorst and De Geer made a journey to which we are indebted for most interesting data about the flora of the islands. In the same year a polar meteorological station was established at Cape Horsden for carrying on the observations desired by the international polar committee. The year 1883 being very favorable, the Norwegian walrus-hunters Andreasen and Johannesen pushed to the northeast of Spitzbergen and discovered new land to the northeast of the archipelago apparently extending as far as 39° E. long.

Bibliography.—The literature of the subject is very voluminous, and for full bibliographical details reference must be made to such works as Chydenius's *Svenska Expeditionen til Spetsbergen*, translated into German by Passarge (Jena, 1869); A. Leslie's *Arctic Voyages of A. E. Nordenskjöld* (London, 1879); and Chavanne's *Bibliographie der Polar-Regionen*, 1878. The earliest maps of Spitzbergen up to 1864 have been reprinted in a Dutch publication (*Tijdschrift van het Aardrijkskundig Genotschap te Amsterdam*, pt. iii.); it contains the maps of 1596, 1612, 1625, 1634, 1642, 1648, and so on. *Petermann's Mittheilungen*, with *Ergänzungshefte*, the *Geographische Jahrbücher*, the *Imer* (journal of the Swedish Geographical Society), and the *Journal of the Roy. Geog. Society* contain more or less detailed accounts of all the Swedish expeditions up to date. The scientific results of the Swedish expeditions are embodied in very many papers, amounting to from 6000 to 7000 printed pages, reference to which will be found in the above-mentioned works and periodicals. Oswald Heer's *Flora Fossilis Arctica* deserves special mention. Every volume of the memoirs and proceedings (*Handlingar* and *Förhandlingar*) of the Swedish Academy of Sciences contains some remarkable contributions to our scientific knowledge of the far north, and the same can be

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[1] [For latitude reached by Phipps and Parry see vol. xix. pp. 331, 332.—AM. ED.]

said of many volumes of the Christiania Academy of Sciences and the Swedish Geological, Botanical, and Zoological Societies.
(P. A. K.)

SPLEEN. See VASCULAR SYSTEM. For diseases of the spleen, see PATHOLOGY, vol. xviii. p. 383 *sq.*; also MALARIA and WOOL-SORTER'S DISEASE.

SPOHR, LUDWIG (1784–1859), violinist and composer, was born at Brunswick on 25th April, 1784, but spent his childhood at Seesen, where in 1789 he began to study the violin, and worked so industriously that at six years old he was able to take the leading part in Kalkbrenner's trios. He received his general education at the Brunswick grammar-school,—taking lessons on the violin from Kunisch and studying composition under Hartung. The little he learned from the last-named professor was the only theoretical instruction he ever received, for, as he himself tells us, he taught himself to compose by studying the scores of Mozart. After playing a concerto of his own at a school concert with marked success, he was placed for a time under Maucourt, the leader of the duke's band; and so rapid was his progress that in 1798 he was able to start on his first artistic tour. This proved a failure; but on his return to Brunswick the duke gave him an appointment in his band, and defrayed the expense of his future education under Franz Eck, in company with whom he visited St. Petersburg and other European capitals. His first violin concerto was printed in 1803. In that year Spohr returned to Brunswick and resumed his place in the duke's band. A visit to Paris was prevented by the loss of his favorite violin,—a magnificent Guarnerius, presented to him in Russia. Having played in Berlin, Leipsic, Dresden, and other German towns, his increasing reputation gained for him in 1805 the appointment of leading violinist at the court of the duke of Gotha. Soon after this he married his first wife, Dorette Scheidler, a celebrated harpist. At Gotha he composed his first opera, *Die Prüfung*, but did not succeed in placing it on the stage. *Alruna* was equally unfortunate, though it was rehearsed with approval at Weimar in 1808. During this year Spohr accomplished one of the most extraordinary musical exploits on record. Hearing that Talma was performing at Erfurt before the reigning princes assembled for the famous congress, and failing in his attempt to obtain admission to the theatre, he bribed a horn-player to send him as his deputy; and, though he had never touched a horn in his life, he learned in a single day to play it so well that in the evening he was able to fulfil his self-imposed duty without exciting suspicion or remark. Spohr's third opera, *Der Zweikampf mit der Geliebten*, written in 1809, was successfully performed at Hamburg in the following year. In 1811 he produced his (first) *Symphony in E♭*, and in 1812 composed his first oratorio, *Das jüngste Gericht*.[1] It was while employed in the preparation of this work that he first felt the inconvenience inseparable from an imperfect theoretical education; and with characteristic energy, he set about the diligent study of Marpurg's *Abhandlung von der Fuge*.

In 1812 Spohr visited Vienna, where his splendid violin-playing created a profound sensation, and he was induced to accept the appointment of leader of the orchestra at the Theatre an der Wien. He then began the preparation of his greatest dramatic composition, *Faust*, which he completed in 1813, though it was not performed until five years later. His strength as a composer was now fully developed; and the fertility of his imagination enabled him to produce one great work after another with astonishing rapidity. He resigned his appointment at Vienna in 1815, and soon afterwards made a tour in Italy, where he performed his eighth violin concerto, the *Scena Cantante nello Stilo Drammatico*,—the finest of his compositions for his favorite instrument. The performer was described by the leading critics of the country as "the finest singer on the violin that had ever been heard." On Spohr's return to Germany in 1817 he was appointed conductor of the opera at Frankfort; and in that city in 1818 he first produced his dramatic masterpiece, *Faust*. The favor with which this was received led to the composition of *Zemire und Azor*, a romantic piece founded on the story of *Beauty and the Beast*, which, though by no means equal to its predecessor in merit, soon attained a much higher degree of popularity. There can, indeed, be no doubt that *Faust* suffered from the very first from the weakness of its miserable libretto. Had the words been worthy of the music *Faust* would have taken rank among the finest German operas in existence.

Spohr first visited England in 1820, and on 6th March played his *Scena Cantante* with great success at the first Philharmonic concert. At the third he produced a new *Symphony* (No. 2) *in D minor*, written expressly for this occasion, which is remarkable as the first on which the conductor's *bâton* was used at a concert of the Philharmonic Society. Spohr's new symphony met with an enthusiastic reception, as did the earlier one (No. 1, in E♭), which was played, together with his *Nonetto*, at the last concert of the series. Indeed he had a triumphant success both as composer and as *virtuoso*; and he on his side was delighted with the performances of the Philharmonic orchestra. Before leaving London he gave a farewell concert, at which Madame Dorette Spohr played on the harp for the last time. Her health at this period was so delicate that she was recommended to exchange her favorite instrument for the less fatiguing pianoforte; and Spohr, with his accustomed facility, wrote a number of pieces for pianoforte and violin, which the husband and wife played together with perfect artistic sympathy. After supplementing his visit to England by a short sojourn in Paris, Spohr returned to Germany and settled for a time in Dresden, where German and Italian opera were flourishing side by side under the direction of Weber and Morlacchi. His artistic relations with the composer of *Der Freischütz* were not altogether satisfactory; nevertheless Weber did not hesitate to recommend him strongly to the elector of Hesse Cassel as "kapellmeister." Spohr entered upon his duties at Cassel on 1st January, 1822, and soon afterwards began the composition of his sixth opera, *Jessonda*, which he produced in 1823. This work—which he himself always regarded as one of his best productions—marks an important epoch in his career as a dramatic composer. It was the first opera he ever wrote with accompanied recitative throughout in place of the usual spoken dialogue; and by a remarkable coincidence it was produced in the same year as Weber's *Euryanthe*, a work characterized by the same departure from established custom. Unhappily Weber's early death prevented him from making a second essay in the same direction; but Spohr consistently carried out the idea in his later operas, and always with marked success.

Spohr's appointment at Cassel gave him the opportunity of bringing out his new works on a grander scale and with more careful attention to detail than he could have hoped to attain in the service of a less generous patron than the elector. And he never failed to use these privileges for the purpose of doing justice to the works of other composers. Soon after his instalment in his new office Mendelssohn, then a boy of thirteen, visited Cassel with his father; notwithstanding the disparity of their years, a firm and lasting friendship sprang up between the rising genius and the already famous composer, which ceased only with Mendelssohn's death in 1847; and in other similar cases Spohr always proved himself ready to appreciate and foster the talent displayed by others, though it must be admitted that as a critic he was very difficult to please. The success of *Jessonda* led him to produce in 1825 a seventh opera—*Der Berggeist*—founded upon the old German legend of Rübezahl, the ruling spirit of the Riesengebirge. Though less popular than its predecessor, this fine work attained a very fair success. But a far greater triumph awaited the composer at the Rhenish musical festival held at Düsseldorf in 1826. On this occasion his oratorio *Die letzten Dinge* met with so enthusiastic a reception that it had to be repeated a few days later for the benefit of a charity. This work, known in England as *The Last Judgment*, is undoubtedly the greatest of Spohr's sacred compositions, and is remarkable as the first oratorio in which the romantic element is freely introduced, with marked success throughout, and without detriment either to the solemnity of the subject or the sobriety of style which has always been regarded as an indispensable characteristic of sacred music of the highest order. In 1827 Spohr produced his eighth opera, *Pietro von Abano*, the plot of which depends for its chief interest upon the resuscitation by the famous necromancer of a lady long since dead and committed to the tomb. The work met with a fair, though not a lasting success; and the same may be said of a much finer opera, *Der Alchymist*, produced in 1830. Spohr's next publication was of a very different character. His *Violin School*, produced in 1831, is so useful as a code of instruction for advanced students that there is probably no great violinist now living who has not been more or less indebted to it for the perfection of his technique. It holds with regard to the violin a position no less important than that which Cramer's *Studies* has so long held in connection with the pianoforte.

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[1] Literally *The Last Judgment*, but not to be confounded with the oratorio now so well known by that name in England.

The year 1833 Spohr spent in the preparation of a new oratorio—*Des Heiland's letzte Stunden*, known in England as *Calvary* or *The Crucifixion*—which was performed at Cassel on Good Friday, 1835, and sung in English at the Norwich festival of 1839, under Spohr's own direction, with such unexampled success that he was accustomed to speak of this event as the greatest triumph of his life. For the Norwich festival of 1842 he composed *The Fall of Babylon*, which also was a perfect success. His last opera, *Die Kreuzfahrer*, was produced at Cassel in 1845. Of his nine symphonies the finest, *Die Weihe der Töne*, was produced in 1832. His compositions for the violin include concertos, quartetts, duets, and other concerted pieces and solos, adapted for the chamber and the concert room, and among these a high place is taken by four double quartetts,—a form of composition of which he was both the inventor and the perfecter. He was, indeed, very much inclined to explore new paths, notwithstanding his attachment to classical form, and his freedom from prejudice was proved by the care with which he produced Wagner's *Flying Dutchman* and *Tannhäuser* at Cassel in 1842 and 1853, in spite of the elector's opposition. Spohr retained his appointment until 1857, when, very much against his wish, he was pensioned off. In the same year he broke his arm, but he was able to conduct *Jessonda* at Prague in 1858. This, however, was his last effort. He died at Cassel on 16th October, 1859. (W. S. R.)

SPOLETO (Lat. *Spoletium*), a city of Italy, in Umbria, placed in a commanding position near the Via Flaminia, between Rome and Perugia, is said to have been colonized in 240 B.C. (Liv., *Epit.*, xx.; Vell. Pat., i. 14), and is called by Cicero (*Pro Balb.*, 21) "colonia Latina in primis firma et illustris." After the battle of Trasimenus (217 B.C.) Spoletium was attacked by Hannibal, who was repulsed by the inhabitants (Liv., xxii. 9). During the Second Punic War the city was a useful ally to Rome. It suffered greatly during the civil wars of Marius and Sulla. The latter, after his victory over Crassus, confiscated the territory of Spoletium and reduced it to the rank of a military colony. Under the empire it again became a flourishing town (Strabo, v. p. 227; Plin., *H.N.*, iii. 14; Ptol., iii. 1, 54). Owing to its elevated position it was an important stronghold during the Vandal and Gothic wars; its walls were dismantled by Totila (Procop., *Bell. Got.*, iii. 12). Under the Lombards Spoleto became the capital of an independent duchy (from *c.* 570), and its dukes ruled a considerable part of central Italy. Together with other fiefs, it was bequeathed to Pope Gregory VII. by the empress Matilda, but for some time struggled to maintain its independence. In 1881 it had a population of 7969 (commune, 21,507), many of whom are occupied in the weaving of woollen stuffs. It is the seat of an archbishopric for the three dioceses of Spoleto, Bevagna, and Trevi.

The city contains many interesting ancient remains,—traces of an early polygonal wall, a Roman theatre, and parts of three temples, built into the churches of S. Agostino, S. Andrea, and S. Giuliano. Remains of a fine Roman bridge were found a few years ago buried in the former bed of a torrent, which now runs along a different line. These remains have recently been buried again under a newly made road. On the citadel, which commands the town, still stands an ancient castle, originally built by Theodoric. This castle was mostly destroyed by the Goths, but was afterwards rebuilt and enlarged at many different times, especially by Pope Nicholas V. The existing building contains work of many different dates. The cathedral of S. Maria Assunta dates partly from the time of the Lombard duchy, but was much modernized in 1644. Over the main entrance is a very interesting and large mosaic of Christ in Majesty signed "Salsernus," 1207; at the sides are figures of the Virgin and St. John. In the choir and on the half cupola of the apse are some of the finest frescos of Lippo Lippi, representing scenes from the life of the Virgin. Lippo died in 1469, leaving part of the work to be completed by his assistant Fra Diamante. The fine stalls and panelling in the choir are attributed to Bramante. The church of S. Pietro is a fine early example of Lombard architecture, though much modernized. The façade is remarkable for its rich sculptured decorations of grotesque figures, dragons, and foliage. S. Domenico is a fine example of later Italian Gothic with bands of different colored stones. The three-apsed crypt of the church of S. Gregorio is of great interest; it probably dates from the founding of the church in the 9th century. S. Niccolo is a beautiful example of Pointed Gothic.

The city is still supplied with water by a grand aqueduct (see vol. ii. pl. IV.) across the adjacent gorge; it has stone piers and brick arches, and is about 268 feet high and 676 feet long. It is said to have been built in 604 by Theodelapius, the third Lombard duke, and the stone piers belong probably to that time. The brick arches are later restorations.

SPONGES.

THE great advance which has been made during the past fifteen years in our knowledge of the sponges is due partly to the vivifying influence of the evolutional hypothesis, but still more to the opportunities afforded by novel methods of technique. To the strength and weakness of the deductive method Haeckel's work on the *Kalkschwämme* (**6**)[1] is a standing testimony, while the slow but sure progress which accompanies the scientific method is equally illustrated by the works of Schulze (**20**), who by a masterly application of the new processes has more than any one else reconstructed on a sure basis the general morphology of the sponges. In the general progress the fossil sponges have been involved, and the application of Nicol's method of studying fossil organisms in thin slices has led, in the hands of Zittel and others (**24**, **35**), to a complete overthrow of those older classifications which relegated every obscure petrifaction to the fossil sponges and consigned them all to orders no longer existing. But, whilst many problems have been solved, still more have been suggested. An almost endless diversity in details differentiates the sponges into a vast number of specific forms; the exclusive possession in common of a few simple characters closely unites them into a compact group, sharply marked off from the rest of the animal kingdom.

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[1] These numbers refer to the bibliography at the end of the article.

Structure and Form.

Simple sponge.

Description of a Simple Sponge.—As an example of one of the simplest known sponges we select *Ascetta primordialis* (Fig. 1), Haeckel. This is a hollow vase-like sac closed at the lower end, by which it is attached, opening above by a comparatively large aperture, the *osculum* or vent, and at the sides by numerous smaller apertures or *pores*, which perforate the walls. Except for the absence of tentacles and the presence of pores it offers a general resemblance to some simple form of *Hydrozoon*. Histologically, however, it presents considerable differences, since, in addition to an endoderm and an ectoderm, a third or mesodermic layer contributes to the structure of the walls; and the endoderm consists of cells (see Fig. 21*g*) each of which resembles in all essential features those complicated unicellular organisms known as choanoflagellate *Infusoria* (see PROTOZOA, vol. xix. p. 883). With this positive character is associated a negative one: nematocysts are entirely absent. The activity of the *Ascetta*, as of all sponges, is most obviously manifested, as Grant (**5**) first observed, by a rapid outflow of water from the oscule and a gentle instreaming through the pores,—a movement brought about by the energetic action of the flagella of the endodermic cells. The instreaming currents bear with them into the cavity of the sac (paragastric cavity) both protoplasmic particles (such as *Infusoria*, diatoms, and other small organisms) and dissolved oxygen, which are ingested by the flagellated cells of the endoderm. The presence of one or more contractile vacuoles in these cells suggests that they extricate water, urea, and carbonic acid. The insoluble residue of the introduced food, together with the fluid excreta, is carried out through the oscule by the excurrent water. New individuals are produced from the union of ova and spermatozoa, which develop from wandering amœboid cells in the mesoderm. The walls of *Ascetta* are strengthened by calcareous scleres, more especially designated as spicules, which have the form of triradiate needles. If we make abstraction of these we obtain an ideal sponge, which Haeckel has called *Olynthus* (**6**), and which may be regarded as the ancestral form from which all other sponges have been derived. To give greater exactness to our abstraction we should perhaps stipulate for the *Olynthus* a somewhat thicker mesoderm and more spherical form than a decalcified Ascon presents.

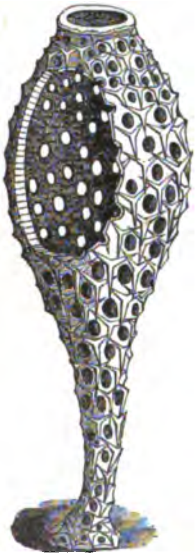

FIG. 1.

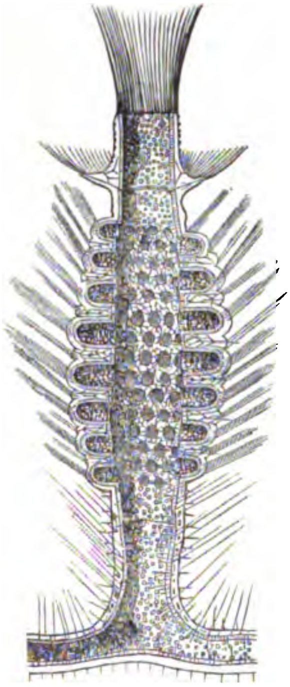

FIG. 2.

FIG. 1.—*Ascetta primordialis*, Hk. After Haeckel.
FIG. 2.—*Homoderma sycandra*, Lfd. One half cut away by a vertical median section. After V. Lendenfeld (× about 6).

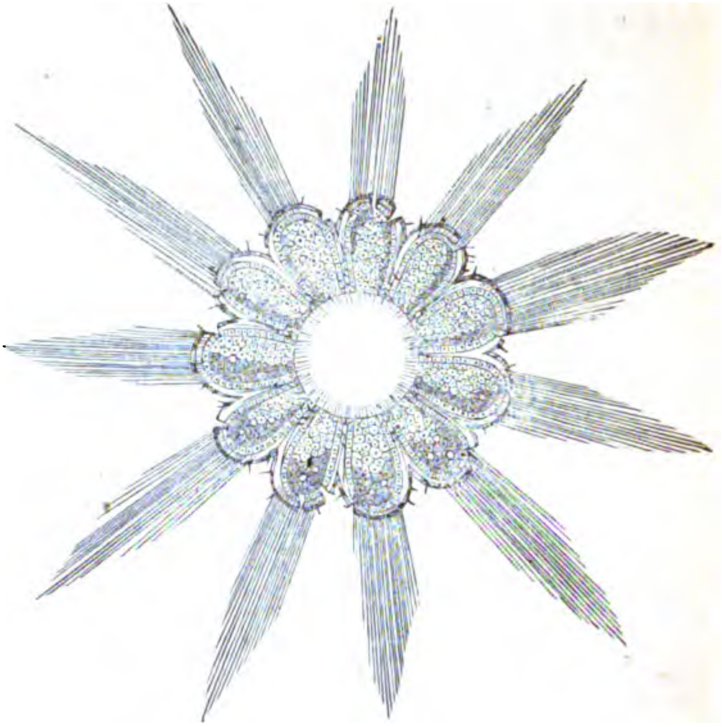

FIG. 3.—*Homoderma sycandra*, Lfd. Transverse section, showing radial tubes opening into central paragastric cavity. After V. Lendenfeld (× about 12).

Canal System.—We shall now trace the several modifications which the *Olynthus* has undergone as expressed in the different types of canal system.

Ascon type.

The simple paragaster of *Ascetta* may become complicated in a variety of ways, such as by the budding off from a parent form of stolon-like extensions, which then give rise to fresh individuals, or by the branching of the Ascon sac and the subsequent anastomosis of the branches; but in no case, so long as the sponge remains within the Ascon type, does the endoderm become differentiated into different histological elements. The most interesting modification of the Ascon form occurs in *Homoderma sycandra* (**12**), in which from the walls of a simple Ascon cæcal processes grow out radiately in close regular whorls, each process reproducing the structure of the parent sponge (Figs. 2, 3). From this it is but a short step to the important departure which gives rise to the Sycons.

Sycon type.

In the simplest examples of this type the characters of *Homoderma sycandra* are reproduced, with the important exception that the endoderm lining the paragastric cavity of the original Ascon form loses its primitive character, and from a layer of flagellated cells becomes converted into a pavement epithelium, not in any distinguishable feature different from that of the ectoderm. The flagellated cells are thus restricted to the cæcal outgrowths or radial tubes. Concurrently with this differentiation of the endoderm a more abundant development of mesoderm occurs. In some Sycons (*Sycaltis*, Hk.) the radial tubes remain separate and free; in others they lie close together and are united by trabeculæ, or by a trabecular network, consisting of mesodermic strands surrounded by ectoderm (Fig. 4). The spaces between the contiguous radial tubes thus become converted into narrow canals, through which water passes from the exterior to enter the pores in the walls of the radial tubes. These canals are the "inter-canals" of Haeckel, now generally known by their older name of *incurrent* canals. The openings of the incurrent canals to the exterior are called pores, a term which we have also applied to the openings which lead directly into the radial tubes or paragastric cavity; to avoid ambiguity we shall for the future distinguish the latter kind of opening as a *prosopyle*. The term "pore" will then be restricted to the sense in which it was originally used by Grant. The mouth by which a radial tube opens into the paragaster is known as a *gastric ostium*. In the higher forms of Sycons the radial tubes no longer arise as simple outgrowths of the whole sponge-wall, but rather as outgrowths of the endoderm into the mesoderm, which together with the ectoderm, exhibits an independent growth of its own; and this results in the formation of a thick investment, known as the *cortex* (Fig. 5), to the whole exterior of the sponge. The radial tubes may branch, *Heteropegma* (Fig. 4). If the branches are given off regularly, as the radial tubes were in the first plant and if at the same time the original radial tube exchanges its flagellated for a pavement epithelium, a structure as shown in Fig. 6 (*Polejna connexiva*, Pol.) will result. This form might also be brought about by unequal growth of the gastral endoderm leading to a folding of the inner part of the sponge-wall. Very little direct evidence exists as to which of these two plans has actually been followed. Phylogenetically the transition from a simple Ascon to the most complicated Sycon can be traced step by step; and ontogeny shows that such a Sycon form as *Grantia raphanus* passes through an Ascon phase in the course of its larval development.

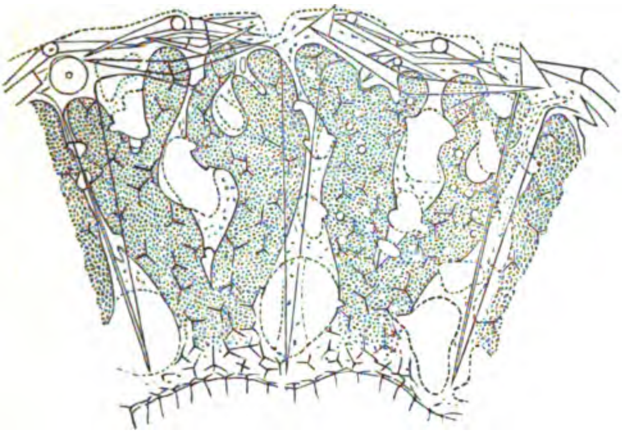

FIG. 4.—*Heteropegma nodus-gordii*, Pol. Part of a transverse section. The straight lines indicate spicules; the poriferous surface is uppermost; the branching radial tubes are rendered dark by numerous small circles representing choanocytes. After Polejaeff, "*Challenger*" *Report* (× 50).

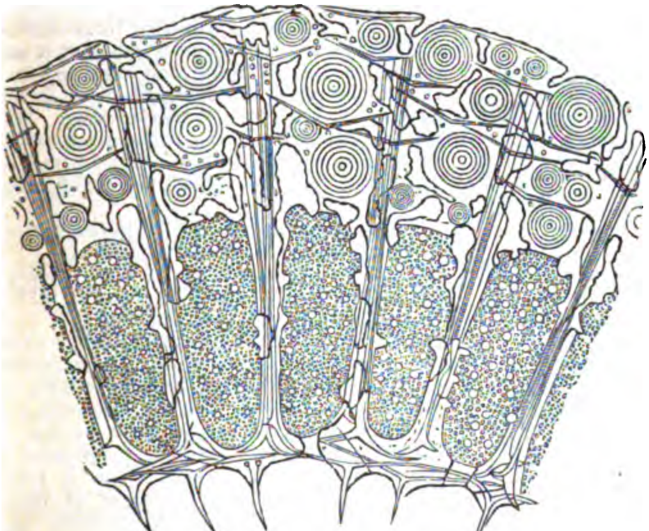

FIG. 5.—*Ute Argentea*, Pol. Part of a transverse section. The concentric circles, indicating transverse sections of spicules, lie within the cortex. After Polejaeff, "*Challenger*" *Report* (× 100).

Rhagon type.

Returning to the ancestral form of sponge, *Olynthus*, let us conceive the endoderm growing out into a number of approximately spherical chambers, each of which communicates with the exterior by a prosopyle and with the paragastric cavity by a comparatively large aperture, which we may term for distinction an *apopyle;* at the same time let the endoderm lose its flagellated character and become converted into a pavement epithelium, except in the spherical chambers. Such a form, called by Haeckel "dyssycus," may be more briefly named a *Rhagon* from the grape-like form of its flagellated chambers, which differ from those of a Sycon both by their form and their smaller dimensions. The Rhagon occurs as a stage in the early development of *Plakina monolopha* (Schulze) and *Reniera fertilis* (**9**) (Fig. 7); a calcareous sponge which appears to approach it somewhat is *Leucopsis pedunculata*, Lfd. By the folding of the wall of a Rhagon, or by its outgrowth into lobes, a complicated structure such as that of *Plakina monolopha* (**20**) (see Fig. 26 *f*) results. This is characterized by the chambers retaining their immediate communication with the incurrent and excurrent canals, opening into the latter by the widely open apopyle and receiving the former by one or several prosopyles. This may be termed the *eurypylous* type of Rhagon canal system. The folding of the sponge-wall may be simple, as in the example given, or too complex to unravel. In higher forms of sponges (*Geodinidæ*, *Stellettidæ*) the chambers cease to open abruptly into the excurrent canals; each is prolonged into a narrow canal, *aphodus*, or *abitus*, which usually directly, sometimes after uniting with one or more of its fellows, opens into an excurrent canal. The prosopyles, now restricted to one for each chamber, may remain unchanged in character, or at the most be prolonged into very short tubes, each a *prosodus* or *aditus*

(Fig. 8). This may be termed the *aphodal* or *racemose* type of Rhagon system, since the chambers at the ends

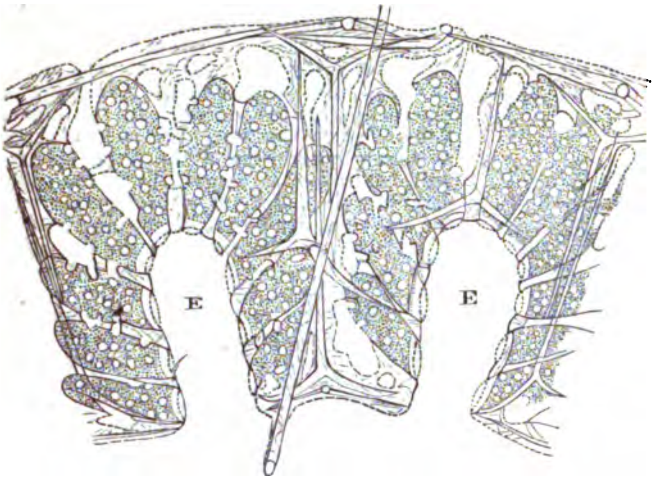

FIG. 6.—*Polejna connexiva*, Pol. Part of a transverse section. E, excurrent canals, into which the flagellated chambers open. After Polejaeff, "*Challenger*" *Report* (× 50).

of the aphodi radiating from the excurrent canal look like grapes on a bunch. As Haeckel, however, has used "racemose" in a different sense, we shall adopt here the alternative term. By the extension of the prosodal or adital canals into long tubes a still higher differentiation is reached (Fig. 9). This, which from the marked presence of both prosodal and aphodal canals may be termed the *dioplodal* type of the Rhagon canal system, occurs but rarely. *Chondrosia* is an example.

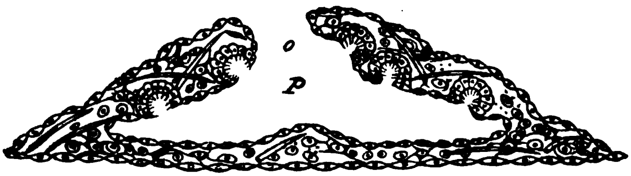

FIG. 7.—Vertical section of a Rhagon, partly diagrammatic. *o*, oscule; *p*, paragaster. After Keller (× about 100).

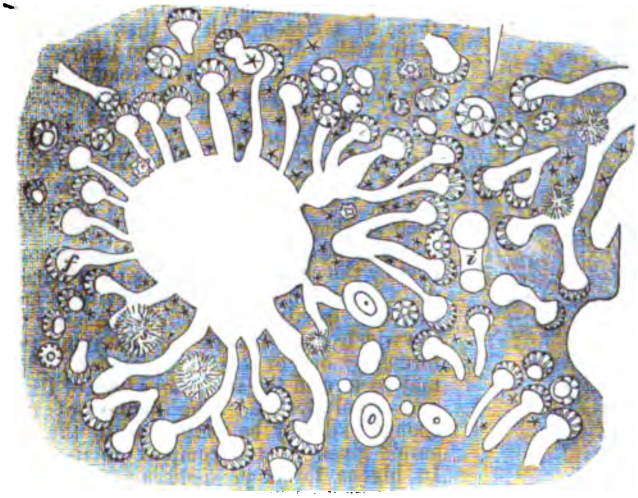

FIG. 8.—Transverse section across an excurrent canal and surrounding choanosome of *Cydonium eosaster*, Soll. *e*, excurrent canal; *f*, flagellated chambers communicating with it by aphodal canals; *i*, an incurrent canal cut across; *s*, a sterraster; *o*, an oxea cut across. After Sollas, "*Challenger*" *Report* (× 125).

The following scheme will render clear the foregoing distinctions;

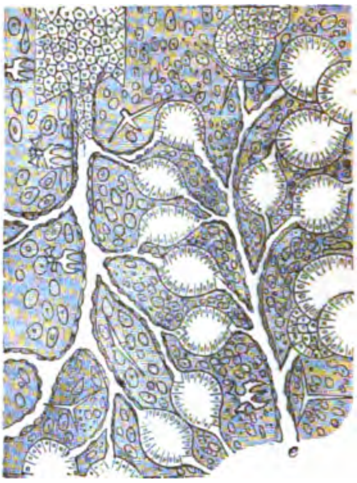

FIG. 9.—Diplodal canal system in *Corticium candelabrum*, O.S. *e*, excurrent canal; the incurrent canal is shown on the left-hand side, near its commencement in the cortex. After F. E. Schulze (× 200).

1. **Ascon type**: simple, ex. *Ascetta*, Hk.; strobiloid, ex. *Homoderma*, Lfd.
2. **Sycon type**: simple radial tubes, ex. *Sycetta*, Hk.; branched radial tubes (cylindrical chambers), ex. *Heteropegma*, Fl.; chamber-layer folded, ex. *Polejna*, Pol.
3. **Rhagon type**: eurypylous, with several prosopyles to each chamber, ex. *Spongelia*; with a single prosopyle to each chamber, ex. *Oscarella*, *Thenea*; aphodal, aphodal canals well developed, ex. *Geodia*, Lmk.; diplodal, with both aphodal and prosodal canals well developed, ex. *Chondrosia*, O.S.

In the case of the calcareous sponges Polejaeff has argued forcibly that the eurypylous type arises directly from the Sycon and not from the Rhagon. It is, therefore, doubtful how far the Rhagon in other sponges is a primitive form derived directly from an *Olynthus*, or whether it may not be a secondary larval state resulting from the abbreviated development of a former Sycon predecessor. Whatever may have been its past history, the Rhagon serves now at all events as a starting-point for the development of the higher forms of canal system.

Subdermal cavities.

In the higher Rhagons, as in the Sycons, further complications ensue, owing to an independent growth of the external ectoderm and the adjacent mesoderm. While the endoderm, with its associated mesoderm, is growing out or folding to form the excurrent canal system, the superficial mesoderm increases in thickness, and the ectoderm, extending laterally from the sides of the incurrent sinuses, burrows into it, parallel to the surface of the sponge. Thus it forms beneath the skin (*i.e.*, the layer of superficial mesoderm and investing ectoderm) cavities which may be either simple and spacious or be broken up into a number of labyrinthine passages by a network of mesoblastic strands (invested with ectoderm) which extend irregularly from roof to floor of the chamber. These cavities are known as *subdermal chambers*.

With the appearance of subdermal chambers the

Ectosome, choanosome.

sponge becomes differentiated into two almost independent regions, an outer or *ectosome* and an inner or *choanosome*, which is characterized by the presence of flagellated chambers. The ectosome forms the roof and walls of the subdermal chambers, and is in its simplest form merely an investing skin; but in a large number of sponges it acquires considerable thickness and a very complicated histological structure. It is then known as a *cortex*.

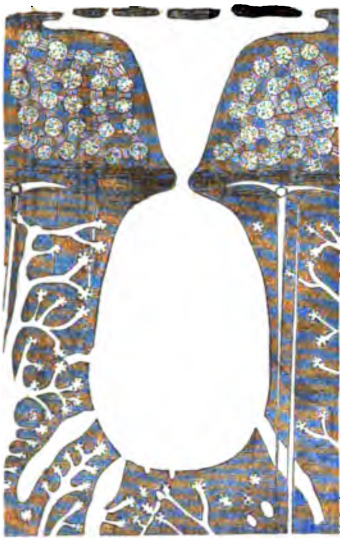

Fig. 10.—Section through the cortex of *Cydonium eosaster*, Soll., showing the pore-sieve overlying the chone, which communicates through a sphinctrate aperture with the subcortical crypt, lying in the choanosome with its flagellated chambers. The dotted circles in the cortex are sterrasters connected by fibrous strands. After Sollas, "*Challenger*" *Report* (×73).

Chone.

Endosome.

The thickening which gives rise to a cortex takes place chiefly beneath those parts of the skin which are not furnished with pores. Beneath the pores—in this case collected into sieve-like areas—dome-like cavities are left in the cortex; they open freely into the subdermal cavities below and their roof is formed by the cribriform pore membrane above. In many sponges (*Geodia*, *Stelletta*) the cortical domes are constricted near their communication with the subdermal cavity (sub-cortical crypt) by a transverse muscular sphincter, which defines an outer division or *ectochone* from an inner or *endochone* (Fig. 10), the whole structure being a *chone*. The endochone is frequently absent (Fig. 10). The early development of the cortex has scarcely yet been studied. In *Stelletta phrissens* (Soll.), one of the "Challenger" *Stellettidæ*, an early form of the sponge (Fig. 11), shows the choanosome already characteristically folded within the cortex, which forms a complete not-folded envelope around it. The roots of the recurrent sinuses form widely open spaces immediately beneath the cortex and are the rudiments of subcortical crypts. Again, in some sponges a part of the endoderm and associated mesoderm may likewise develop independently of the rest of the sponge, as in the *Hexactinellida*, where the choanosome forms a middle layer between a reticulation of ectosome on the one side and of endoderm and mesoderm, *i.e.*, *endosome*, on the other. Finally, the attached or lower half of a Rhagon may develop in an altogether different manner from the other or upper half, the endoderm not producing any flagellated chambers. In this case the upper portion alone is characterized by the flagellated chambers, which are the distinctive mark of a sponge, and hence may be called the *spongomere;* the lower half, which consists of all three fundamental layers, may be called the *hypomere*.

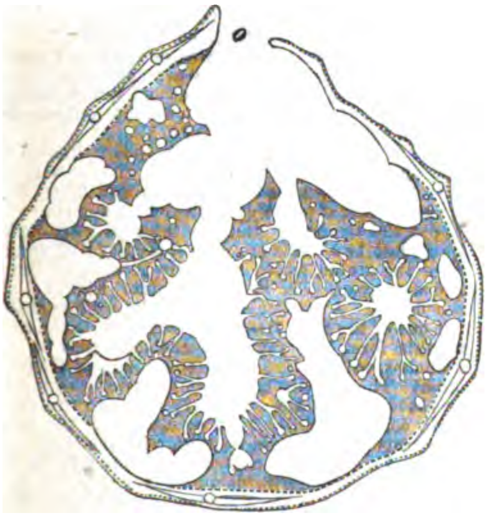

Fig. 11.—Young sponge of *Stelletta phrissens*, Soll. Longitudinal median section, showing the choanosome folded within the cortex. *o*, oscule. After Sollas, "*Challenger*" *Report* (× 50).

Oscule.

The form and general composition of sponges are exceedingly various and often difficult to analyze, presenting, along with some important differences, a remarkable general resemblance to the *Cœlentera* in these respects. Like them, some sponges are simple, and others, through asexual multiplication, compound. The only criterion by which the individual sponge can be recognized is the osculum; and, as it is frequently difficult, and in many cases impossible, to distinguish this from the gastric opening of a large excurrent canal, there are many cases in which the simple or compound nature of the sponge must remain open to doubt. The oscule may also fail (*lipostomosis*), and so may the paragastric cavity (*lipogastrosis*); the problem then becomes insoluble. The loss of the oscule may in some cases be due to the continued growth of several endodermal folds towards the exterior, with a corresponding absorption of the mesoderm and ectoderm, which lie in the way, till the folds penetrate to the ectoderm and open at the exterior, thus giving rise to excurrent openings, which are not readily distinguishable from pores. At the same time the original osculum closes up and entirely disappears. Lipogastrosis, on the other hand, may be produced by the growing together of the roots of the choanosomal folds, thus reducing the paragastric cavity to a labyrinth of canals, which may easily be confounded with the usual form of excurrent canals. While in some sponges the original oscule is lost, in others secondary independent openings, deceptively like oscules, are added. This pseudostomosis is due to a folding of the entire sponge, so as to produce secondary canals or cavities, which may be incurrent (*vestibular*) or excurrent (*cloacal*), the opening of the latter to the exterior being termed a *false oscule* or *pseudostome*. The faulty use of the term oscule for what is neither functionally nor morphologically a mouth is here obvious, for in one sense the oscule is always a pseudostome; it would be better if the term *pseudoproct* could be substituted.

Skeleton.

Skeleton.—All sponges, except three or four genera belonging to the *Myxospongiæ*, possess some kind of skeletal structures. They may be either calcareous or silicious or horny scleres, the latter usually having the form of fibres, which sometimes enclose silicious needles (spicules) or foreign bodies introduced from without. Foreign bodies also contribute to the formation of the skeleton of some silicious sponges, and occasionally form the entire skeleton, no other hard parts being present.

Mineral scleres usually occur in the form of spicules.

Mineral spicules.

The spicules of calcareous sponges consist of carbonate of lime, having the crystalline structure and other properties of calcite (**29**). Each spicule, so far as its mineral component is concerned, is a single crystal, all the molecules of calcite of which it is built up being similarly oriented. On the other hand, its form and general structure are purely organic. Its surfaces are always curved, and usually it has the form of a cone or combination of cones, each of which consists of concentric layers of calcite surrounding an axial fibre of organic matter,—probably of the same nature as spongiolin or spongin, the chief constituent of the fibres of horny sponges. A thin layer of organic matter, known as the *spicule sheath*, forms an outer investment to the spicule and is best rendered visible as a residue by removing the calcite with weak acid. Silicious spicules consist of colloid silica or opal, and hence can be distinguished from calcareous by having no influence upon polarized light. Structurally the two kinds of spicules present no important difference. The spicules of different sponges differ greatly both in form and in size. They may be conveniently divided into two groups,—minute or flesh spicules, which usually serve as the support of a single cell only (*microscleres*), and larger or skeletal spicules, which usually contribute to the formation of a more or less consistent skeleton (*megascleres*). The distinction is not one that can be exactly defined, and must so far be regarded as of a provisional nature. There is usually but little difficulty in applying it in practice, except in some doubtful cases where large spicules do not form a continuous skeleton, or in others where flesh spicules appear to be passing into those of larger size. It is indeed highly probable that all large spicules have originated from flesh spicules (**12**).

Megascleres.

(1) *Monaxon Biradiate Type* (*rhabdus*).—By far the commonest form is the oxea, a needle-shaped form pointed at both ends and produced by growth from a centre at the same rate in opposite directions along the same axis. It is therefore uniaxial and equibiradiate (Fig. 12 *a*). (2) *Monaxon Uniradiate Type* (*stylus*).—By the suppression of one of the rays of an oxea, an acuate spicule or stylus results (Fig. 12 *b*). (3) *Triaxon Triradiate Type.*—Linear growth from a centre in three directions inclined at an angle of 120° to each other gives rise to the primitive form of triradiate spicule so eminently characteristic of the calcareous sponges, but by no means confined to them (Fig. 12 *c*). (4) *Tetraxon Quadriradiate Type* (*Calthrops*).—Growth from a centre in four directions inclined at about 110° to each other produces the primitive quadriradiate form of the *Tetractinellida* and of some calcareous sponges (Fig. 12 *d*). (5) *Sexradiate Type.*—Growth in six directions along three rectangular axes produces the primitive sexradiate spicule of the *Hexactinellida* sponges (Fig. 12 *e*). (6) *Multiradiate Type.*—Extensions radiating in many directions from a centre produce a stellate form (Fig. 12 *f*). (7) *Spherical Scleres.*—Concentric growth of silica about an organic particle produces the sphere, which occurs as a reduction of the rhabdus in some species of *Pœcillastra*, or as an overgrown globule (flesh spicule) in *Caminus*.

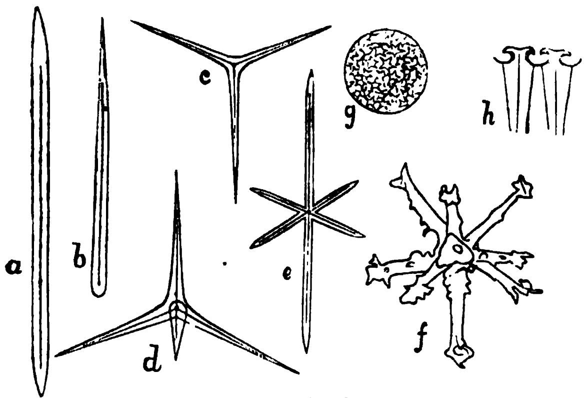

FIG. 12.—Typical megascleres. *a*, rhabdus (monaxon diactine); *b*, stylus (monaxon monactine); *c*, triod (triaxon triactine); *d*, calthrops (tetraxon tetractine); *e*, triaxon hexactine; *f*, desma of an anomocladine Lithistid (polyaxon); *g*, sterraster (polyaxon); *h*, radial section through the outer part of *g*, showing two actines soldered together by intervening silica, the free ends terminating in recurved spines and the axis traversed by a central fibre.

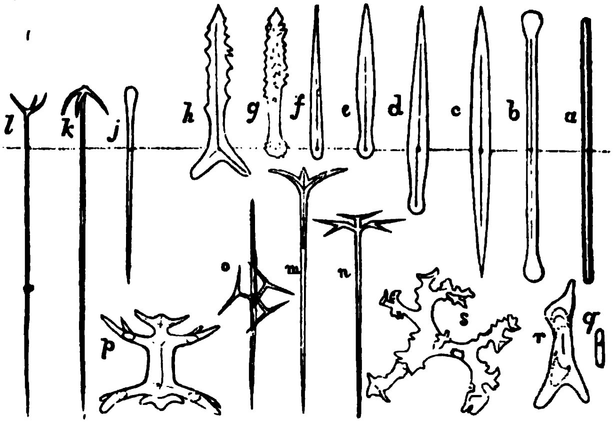

FIG. 18.—Modifications of monaxon type. *a*, strongyle; *b*, tylote; *c*, oxea; *d*, tylotoxea; *e*, tylostyle; *f*, style; *g*, spined tylostyle; *h*, sagittal triod (a triaxon form derived from the monaxon); *j*, oxytylote; *k*, anatriæne; *l*, protriæne; *m*, orthotriæne; *n*, dichotriæne; *o*, centrotriæne; *p*, amphitriæne (this is trichocladose); *q*, crepidial strongyle (basis of Rhabdocrepid Lithistid desma); *r*, young form of Rhabdocrepid desma, showing crepidial strongyle coated with successive layers of silica; *s*, Rhabdocrepid desma fully grown. The dotted line through the upper figures marks the origin of the actines.

Uniaxial type.

Usually conical, the spicular rays often become cylindrical; usually pointed (*oxeate*) at the ends, they are also frequently rounded off (*strongylate*), or thickened into knobs (*tylotate*), or branched (*cladose*). Their growth is not always rigorously confined to a straight line; frequently they are curved or even undulating. They are also liable to become spined, either by mere superficial thickening or by a definite outgrowth involving the axial fibre (Fig. 13 *g*, *h*).

The rhabdus if pointed at both ends is known as an *oxea* (Fig. 13 *c*); if rounded at both ends as a ***strongyle*** (Fig. 13 *a*); if knobbed at both ends as a ***tylote*** (Fig. 13 *b*); the tylote if pointed at one end is a ***tylotoxea*** (Fig. 13 *d*); the strongyle similarly becomes a ***strongyloxea***. These last two forms are with difficulty distinguished from the stylus, which is usually pointed at the end, and strongylate (Fig. 13 *f*) or tylotate (Fig. 13 *e*) about the origin. A particular case of the cladose rhabdus, but one of the most frequent occurrence, is the ***triæne***; in this form one ray of a rhabdus ends in three branches, which diverge at equal angles from each other. The rhabdus then becomes known as the shaft or ***rhabdome***, and the secondary rays are the arms or *cladi*, collectively the head or *cladome* of the spicule. The arms make different angles with the shaft; when recurved a grapnel or ***anatriæne*** is produced (Fig. 13 *k*), when projecting forwards a ***protriæne*** (Fig. 13 *l*), and when extended at right angles an ***orthotriæne*** (Fig. 13 *m*). The arms of a triæne may bifurcate (***dichotriæne***) once (Fig. 13 *n*), twice, or oftener, or they may trifurcate. Again they may extend laterally into undulating lamellæ, or unite to form a disk, the triæne character of which is indicated by the included axial fibre. The shaft may also become trifid at both ends, ***amphitriæne*** (Fig. 13 *p*), and the resulting rays all bifurcate, or the cladome may arise from the centre of the rhabdome, ***centrotriæne*** (Fig. 13 *o*). Amongst one group of Lithistid sponges (*Rhabdocrepida*) the normal growth of a strongyle is arrested at an early stage; it then serves as a nucleus upon which further silica is deposited, and in such a manner as to produce a very irregularly branching sclere or desma (Fig. 13 *s*), within which the fundamental strongyle can be seen inclosed. In such a desma no axial fibre besides that of the inclosed strongyle is formed.

Triradiate type.

The chief modification of the triradiate spicule is due to an elongation of one ray, distinguished as *apical*, the shorter paired rays being termed *basal*, and the whole spicule a sagittal triradiate. The angle included by the basal rays is usually over 120° (Fig. 14 *a*).

Quadriradiate type.

Some or all of the rays of the primitive calthrops (Fig. 14 *b*) may subdidivide into a number of terminal spines *candelabra* (Fig. 14 *c*); or some or all of them may bifurcate once or twice and finally terminate by subdividing into numerous variously shaped processes; such a *tetracladine* desma (Fig. 14 *e*) characterizes one division of the Lithistid sponges.

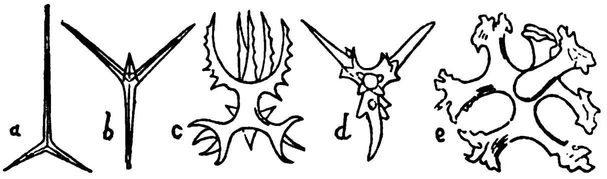

FIG. 14.—Modifications of the triaxon and tetraxon types. *a*, sagittal triradiate or triod; *b*, calthrops; *c*, candelabra (a polycladose microcalthrops); *d*, a spined microcalthrops; *e*, Tetracladine Lithistid desma.

Sexradiate type.

By the excess or defect of one or more rays a series of forms such as are represented in Fig. 15 arise. In the oxea, which results from the suppression of all rays but two, the sexradiate character is sometimes preserved by the axial fibre, which gives off two or four processes in the middle of the spicule where the defective arms would arise. Let Fig. 12 *e* represent a regular sexradiate spicule with its four horizontal arms extended beneath the dermis of its sponge; the over-development of the proximal ray and a reduction of the distal ray produce a form known as the *dagger* (Fig. 15 *a*); the suppression of the proximal ray and the development of spines projecting forwards on the distal ray produce the *pinnulus* (Fig. 15, *b*, *c*); the suppression of both proximal and distal rays gives the *staurus* (Fig. 15 *f*), and the suppression of two of the remaining horizontal rays a dermal rhabdus (Fig. 15 *g*). The suppression of a distal ray, excessive development of a proximal ray, and recurved growth of the remaining rays produce an *anchor*. In *Hyalonema* (glass rope sponge) anchors over a foot long occur, but their arms or teeth are not restricted to four, and the axial fibre gives off its processes before reaching the head of the spicule. Such a grapnel helps to support the sponge in the ooze of the sea-bed. Other characteristic spicules belonging to sponges distinguished by sexradiate spicules are the following: the *uncinaria* (Fig. 16 *a*), a spinose oxea with the spines all pointing one way; the *clavula*, a tylotate form with a toothed margin to the head (Fig. 16 *b*); the *scopularia* (Fig. 16 *c*), a besom-shaped spicule with tylotate rays, which vary in number from two to eight; the *amphidisk* (Fig. 15 *d*), a shaft terminating at each end in a number of recurved rays. When the sexradiate spicules of the *Hexactinellida* unite together in a manner to be described later, the rays may be bent in a variety of ways out of the triaxial type, so that the sexradiate character alone remains.

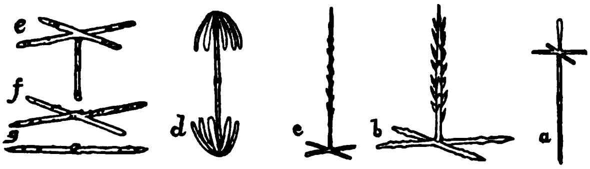

FIG. 15.—Modifications of the triaxon hexactine type. *a*, dagger; *b*, *c*, two varieties of pinnulus; *d*, amphidisk; *e*, pentactine; *f*, staurus; *g*, dermal rhabdus. After Schulze.

Multiradiate type.

Multiradiate Type.—The rays of an aster as of other spicules may be spined or tylotate. In one remarkable form known as a *sterraster* (Fig. 12 *g*, *h*), and characteristic of the family *Geodinidæ*, the rays are almost infinite in number, and coalesced for the greater part of their length; the distal ends, however, remain separate, and, becoming slightly tylotate, are produced into four or five recurved spines, which give attachment to connective tissue fibres by which adjacent sterrasters are united together.

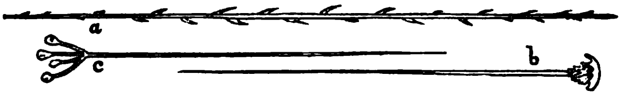

FIG. 16.—*a*, uncinaria; *b*, clavula; *c*, scopularia. After Schulze.

In one aberrant group of Lithistid sponges (*Anomocladina*) the skeleton is formed of desmas, which are multiradiate, each presenting a massive centrum (with an included cavity) produced into a variable number (4 to 8) of rays, which rays terminate in expanded ends (Fig. 12 *f*).

Microscleres.

It is doubtful whether a distinction between megascleres and microscleres can be maintained in the calcareous sponges, unless the minute oxeas which occur in *Eilhardia schulzei*, Pol. (**16**), are to be referred to this group. They are widely distributed throughout the silicious sponges, and by their different forms afford characters of the highest importance in classification.

One of the simplest forms is the *sigmaspire* (Fig. 17 *a*, *b*); it looks like the letter C or S, according to the direction in which it is viewed, its actual form being that of a single turn of a cylindrical spiral. A turn and a part of a turn of a spiral of somewhat higher pitch than that of a sigmaspire gives the *toxaspire* (Fig. 17 *c*); a continued spiral growth through several revolutions gives the *polyspire*. The sigmaspire becoming spined produces the *spiraster* or *spinispirula* (Fig. 17 *d*); this, by losing its curvature, becomes the *sanidaster* (Fig. 17 *e*), and by simultaneous concentration of its spines into a whorl at each end, the *amphiaster* (Fig. 17 *f*). By reduction of the spire the spiraster passes into the *stellate* or *aster* (Fig. 17 *n*). A thickening about the centre of the aster produces the *spheraster* (Fig. 17 *m*), allied to which is the sterraster. By a reduction in the number of its rays the aster becomes a minute calthrops, from which by increased growth, the skeletal calthrops may very well be derived; by further reduction to two rays a little rhabdus or microrabd results, and of this numerous varieties exist, of which the oxeate microrabd is the most interesting, since it only differs in size from the commonest of all skeletal spicules, the oxeate or acerate rhabdus. The sigmaspire is formed as a superficial spiral thickening in the wall of a spicule cell or scleroblast; as superficial deposits also the next group of spicules, the so-called *anchorates*, arise. Take a hen's egg as a model of a scleroblast, draw round it a broad meridional band, interrupted only on one side, for 30° above and below the equator; this will represent a truly C-shaped spicule, which differs from a sigmaspire by the absence of spiral twist. It may be termed a *cymba* (Fig. 17 *g*). The back of the "C" is the *keel* or *tropis*; the points are the *prows* or *proræ*. Now broaden out the prora on the eggshell into oval lobes (*proral*

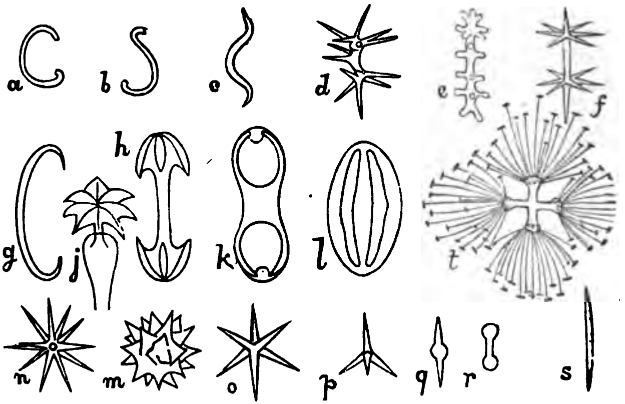

FIG. 17.—Microscleres. *a*, *b*, sigmaspire viewed in different directions—*a*, along axis, and *b*, obliquely; *c*, toxaspire; *d*, spiraster; *e*, sanidaster; *f*, amphiaster; *g*, sigma or cymba; *h*, cymba, with three ptera at each end,—the central one a proral pteron and the lateral, pleural ptera; *j*, one end of another form of cymba, showing seven ptera; *k*, monopteral cymba,—proral ptera only, developed at ends, tropidial ptera much enlarged; *l*, oocymba, in which proral and pleural ptera have grown towards each other and coalesced; *m*, spheraster; *n*, oxyaster; *o*, the same, with six actines; *p*, the same, with four actines; *q*, the same, with two actines (a centrotylote microxea); *r*, microtylote; *s*, microxea (*q*, *r*, and *s* are reduced asters); *t*, rosette.

pteres); and from each pole draw a lobe midway between the prora and the tropis (*pleural pteres*), and a common form of anchorate, the *pterocymba* results (Fig. 17 *h*). The pterocymba is subject to considerable modifications; the prows may be similar (*homoproral*) or dissimilar (*heteroproral*); the pteres may be lamellar or ungual; additional lamellæ (*tropidial pteres*) may be produced by a lateral outgrowth of the keel (Fig. 17 *k*); and by growing towards the equator the opposed proral and pleural pteres may conjoin, producing a spicule of two meridional bands (*oocymba*, Fig. 17 *l*). A curious group of flesh spicules are the *trichites*. In this group silica, instead of being deposited in concentric coatings around an axial fibre, forms within the scleroblast a sheaf of immeasurably fine fibrillæ or trichites, which may be straight (Fig. 17 *m*) or twisted. The trichite sheaf may be regarded as a fibrillated spicule. Trichite sheaves form in some sponges, as *Dragmastra* (25), a dense accumulation within the cortex. In Hexactinellid sponges the rays of the aster are limited to six, arranged as in a primitive sexradiate spicule, but divided at the ends into an indefinite number of slender filaments, which may or may not be tylotate, *rosettes* (Fig. 17 *t*).

Spongin scleres.

Spongin is a horny substance, most similar to silk in chemical composition, from which it differs in being insoluble in an ammoniacal solution of copper sulphate (cuproso-ammonium sulphate). In *Darwinella aurea*, F. Müller, it occurs in forms somewhat resembling tri-, quadri-, and sex-radiate spicules. But usually the spongin skeleton takes the form of fibres, consisting of a central core of soft granular substance around which the spongin is disposed in concentric layers, forming a hollow cylinder (Fig. 23 *b*). The relative diameters of the soft core and of the spongin cylinder differ greatly in different sponges. The fibres branch so as to form antler-like twigs or bushy tree-like growths, or anastomose to form a continuous network, as in the bath sponge (*Euspongia officinalis*.) The detailed characters of the network differ with the species, and are useful in classification. In *Ianthella* certain cells (sponginblasts) become included between the successive layers of the spongin cylinder, and their deep violet color, contrasting with the amber tint of the spongin, renders them very conspicuous. .

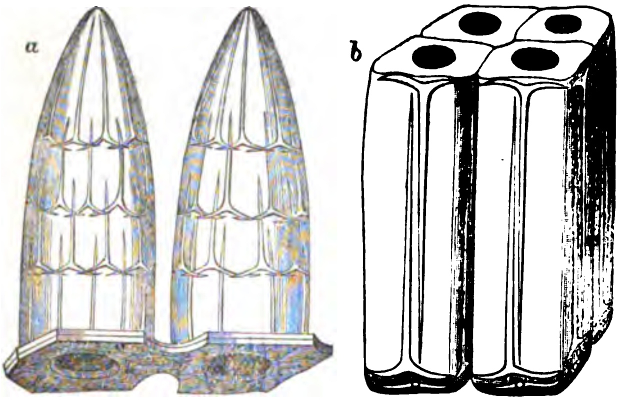

FIG. 18.—Articulate and inarticulate tubar skeletons of calcisponges. *a*, articulate; *b*, inarticulate skeleton. After Haeckel.

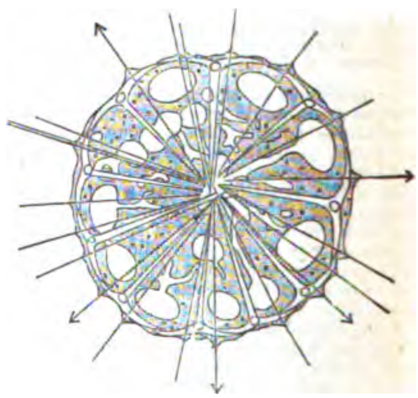

FIG. 19.—Mode of arrangement of spicules in a young Stellettid sponge, *Dragmastra normani*, Soll. After Sollas.

Union of scleres into a skeleton.

In some sponges the scleres are simply scattered through the mesoderm and do not give rise to a continuous skeleton,—*Corticium*, *Chondrilla*, *Thrombus*. In the *Calcarea* and many silicious sponges they are dispersed through the mesoderm, but so numerously that by the overlapping of their rays a loosely felted skeleton is produced. In the calcareous sponges the spicules are frequently regularly disposed; and in the Sycons in particular a definite arrangement, on two plans, the *articulate* and *inarticulate*, can be traced in the skeleton of the radial tubes. On the latter plan the triradiate or quadriradiate spicules, the apical rays of which are of considerable length, are arranged in two sets, one having the basal rays lying in the mesoderm of the paragastral wall and the other with the corresponding rays in the dermal mesoderm. The apical rays of each set lie in the mesoderm of the radial tubes parallel to their length, but pointing in opposite directions (Fig. 18 *b*). In the articulate division numerous spicules, small in comparison with the size of the radial tubes, form a series of rows round the tubes, their basal rays lying parallel to the paragastric surface and the apical pointing towards the ends of the radial tubes (Fig. 18 *a*).

In the *Silicispongia* sheaves of long oxeate spicules radiate from the base of the sponge if of a plate-like form, or from the centre if globular, and extend to the surface. If triænes are present their arms usually extend within the mesoderm immediately below the dermal surface (Fig. 19). Single spicules reach from centre to surface only in small sponges. As the sponge increases in size the spicules must either correspondingly lengthen, or fresh spicules must be added, if a continuous skeleton is to be formed. The latter is the plan followed in fact: the additional spicules overlap the ends of those first formed like the fusiform cells in a woody fibre. With the formation of a fibre, often strengthened by spongin or bound together with connective tissue, there appears to be a tendency for the constituent spicules to diminish in size, and the length of each in the most markedly fibrous sponges is insignificant when compared with the length of the fibre. The spicular fibre thus formed may be simple or echinated by spicules either similar to those which form its mass or different. More usually they are different, and generally styles, often spinose about their origin. The spongin which sometimes cements together the spicules of a fibre may progressively increase in quantity and the spicules diminish in number, till a horny fibre containing one or more rows of small oxeas results. In an echinated fibre the axial spicules may disappear and the echinating spicules persist. Finally all spicules may be suppressed and the horny fibre of the Ceratose sponges results. The horny fibres may next acquire the habit of embedding foreign bodies in their substance, though foreign enclosures are not confined to the *Ceratosa* but occur in some *Silicispongiæ* as well. The included foreign bodies may increase in quantity out of all proportion to the horny fibres; and finally the skeleton may consist of them alone, all spongin matter having disappeared.

In the Lithistid sponges a skeleton is produced by the articulation of desmas into a network. The rays of the desmas (Figs. 12 *f*, 13 *s*, 14 *e*) terminate in apophyses, which apply themselves to some part of adjacent desmas, either to the centrum, shaft, arms, or similar apophyses, and then, growing round them like a saddle on a horse's back, clasp them firmly without anchylosis. Thus they give rise to a rigid network, in conjunction with which fibres composed of rhabdus spicules may exist. In the *Hexactinellida* both spicular felts and fibres occur, and in one division (*Dictyonina*) a rigid network is produced, not, however, by a mere clasping of apophyses, but by a true fusion. The rays of adjacent spicules overlap and a common investment of silica grows over them.

Histology.

Ectoderm.

The ectoderm usually consists of simple pavement epithelial cells (*pinnacocytes*), the margins of which can be readily rendered visible by treatment with silver nitrate, best by Harmer's method.[1] The nucleus and nucleolus are usually visible in preparations made from spirit specimens, the nucleus being often readily recognizable by its characteristic bulging beyond the general surface. In some sponges (*Thecaphora*) the epithelium may be replaced locally by columnar epithelium, and the cells of both pavement and columnar epithelium may bear flagella (*Aplysilla violacea*, *Oscarella lobularis*).

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[1] S. F. Harmer, "On a Method for the Silver Staining of Marine Objects," *Mitth. Zoolog. Station zu Neapel*, 1884, p. 445.

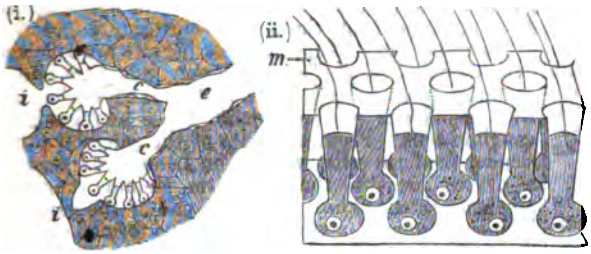

FIG. 20.—Choanocytes with coalesced collars. (i.) Longitudinal section through two flagellated chambers of *Anthastra communis*, Soll.; *i*, prosopyles; *c*, aphodal canals leading from the flagellated chambers; *e*, excurrent canal; the tissue surrounding the chambers is sarcenchyme (× 360). (ii.) Diagram showing the fenestrated membrane (*m*) produced by coalesced collars of choanocytes. After Sollas, "*Challenger*" *Report*.

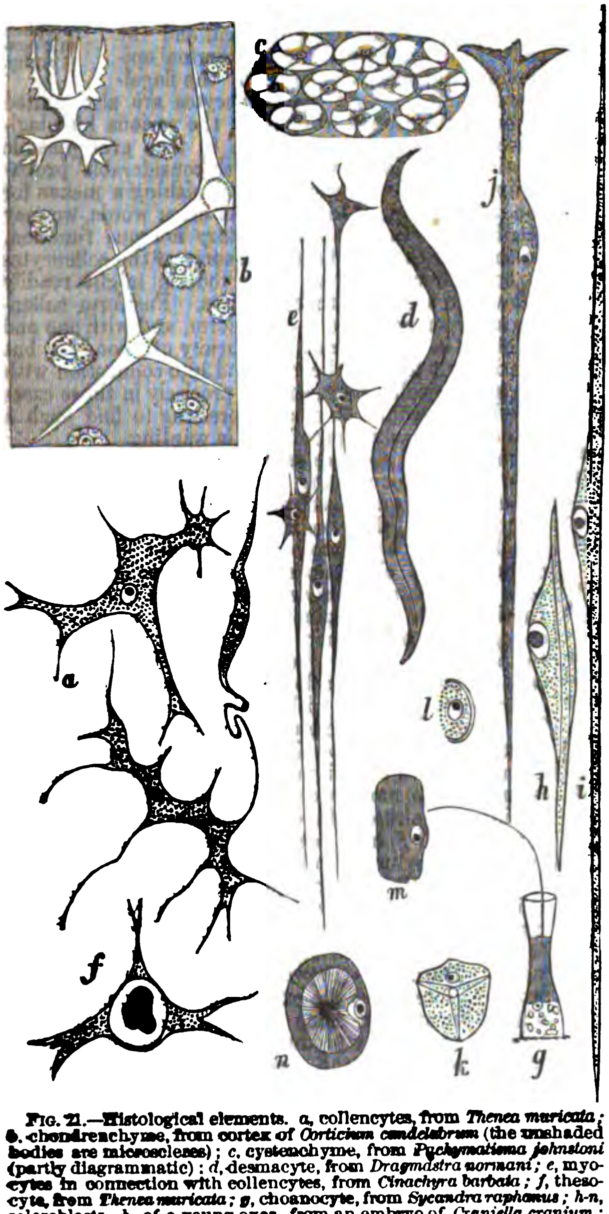

FIG. 21.—Histological elements. *a*, collencytes, from *Thenea muricata*; *b*, chondrenchyme, from cortex of *Corticium candelabrum* (the unshaded bodies are microscleres); *c*, cystenchyme, from *Pachymatisma johnstoni* (partly diagrammatic): *d*, desmacyte, from *Dragmastra normani*; *e*, myocytes in connection with collencytes, from *Cinachyra barbata*; *f*, thesocyte, from *Thenea muricata*; *g*, choanocyte, from *Sycandra raphanus*; *h-n*, scleroblasts—*h*, of a young oxea, from an embryo of *Craniella cranium*; *i*, of a fully grown oxea, from an adult *C. cranium*; *j*, orthotriæne, with associated scleroblast from *Stelletta*; *k*, of a tetracladine desma, from *Theonella swinhoei*; *l*, of a sigmaspire, from *Craniella cranium*; *m*, of an orthodragma, from *Disyringa dissimilis*; *n*, of a sterraster, from *Geodia barretti*. Figs. *b* and *g* after Schulze, the others after Sollas.

Endoderm.

The endoderm presents the same characters as the ectoderm, except in the Ascons and the flagellated chambers of all other sponges, where it is formed of collared flagellated cells or *choanocytes*, — cells with a nearly spherical body in which a nucleus and nucleolus can be distinguished and one or more contractile vacuoles. The endoderm extends distally in a cylindrical neck or *collum*, which terminates in a long flagellum surrounded by a delicate protoplasmic frill or collar (Fig. 21 *g*). In *Tetractinellida*, and probably in many other sponges—certainly in some—the collars of contiguous choanocytes coalesce at their margins so as to produce a fenestrated membrane, which forms a second inner lining to the flagellated chamber (Fig. 20, ii.). The presence of this membrane enables us readily to distinguish the excurrent from the incurrent face of the chamber, since its convex surface is always turned towards the prosopyle. In sponges with an aphodal canal system the flagellated chambers usually pass gradually into the aphodal canal, but the incurrent canal enters abruptly. This abrupt termination of the incurrent canal appears to mark the termination of the ectoderm and the commencement of the endoderm. The flagellated chambers differ greatly in size in different sponges, and evidently manifest a tendency to become smaller as the canal system increases in complexity; thus Sycon are always larger than Rhagon chambers, and eurypylous than aphodal Rhagon chambers.

Mesoderm.

In most sponges except the Ascons the mesoderm is largely developed, and in many it undergoes a highly complex histological differentiation. In its commonest and simplest form it consists of a clear, colorless, gelatinous matrix in which irregularly branching stellate cells or connective tissue corpuscles are embedded; these may be termed *collencytes* (Fig. 21 *a*) and the tissue *collenchyme*. In the higher sponges (*Geodia*, *Stelletta*) it consists of small polygonal granular cells either closely contiguous or separated by a very small quantity of structureless jelly, and in this form may be termed *sarchenchyme* (Fig. 20). Collenchyme does not originate through the transformation of sarcenchyme, as one might expect, for it precedes the latter in development. Schulze (**20**), who has compared collenchyme to the gelatinous tissue which forms the chief part of the umbrella of "jelly-fish," describes it as becoming granular immediately in the neighborhood of the flagellated chambers in the bath sponge, the granules becoming more numerous in sponges in which the canal system acquires a higher differentiation, till at length the collencytes are concealed by them. According to this view, sarcenchyme would appear to originate from a densely granular collenchyme. Amœboid wandering cells or *archæocytes* (Fig. 22) are scattered through the matrix of the collenchyme. They evidently serve very different purposes: some appear to act as carriers of nourishment or as scavengers of useless or irritant foreign matter; others may possibly contribute to the formation of higher tissues, some certainly becoming converted into sexual products. Their parentage and early history are unknown.

A tissue (*cystenchyme*) which in some respects resembles certain forms of vegetable parenchyme occurs in some sponges, particularly *Geodinidæ* and other *Tetractinellida*. It consists of closely adjacent large oval cells, with thin well-defined walls and fluid contents. Somewhere about the middle of the cell is the nucleus with its nucleolus, supported by protoplasm, which extends from it in fine threads to the inner side of the wall, where it spreads out in a thin investing film (Fig. 21 *c*). Cystenchyme very commonly forms a layer just below the skin of some *Geodinidæ*, particularly of *Pachymatisma*, and, as on teasing the cortex of this sponge a large number of refringent fluid globules immiscible with water are set free, it is just possible that it is sometimes a fatty tissue, and if so the contained oil must be soluble in alcohol, for alcoholic preparations show no trace of it. A tissue resembling cartilage, *chondrenchyme*, occurs in *Corticidæ* (Fig. 21 *b*).

Desmacytes.

Connective-tissue cells or *desmacytes* are present in most sponges; they are usually long fusiform bodies, consisting of a clear, colorless, often minutely fibrillated sheath, surrounding a highly refringent axial fibre, which stains deeply with reagents (Fig. 21 *d*). In other cases the desmacyte is simply a fusiform granular cell, with a nucleus in the interior and a fibrillated appearance towards the ends. The desmacytes are gathered together, their ends overlapping, into fibrous strands or felted sheets, which in the ectosome of some sponges may acquire a considerable thickness, often constituting the greater part of the cortex. The spicules of the sponge often furnish them with a surface of attachment, especially in the *Geodinidæ*, where each sterraster of the cortex is united to its neighbors by desmacytes, in the manner shown in Fig. 10.

Myocytes.

Contractile fibre cells or *myocytes* occur in all the higher sponges. They appear to be of more than one kind. Most usually they are fine granular fusiform cells with long filiform terminations, and with an inclosed nucleus and nucleolus (Fig. 21 *e*). In the majority of sponges both excurrent and incurrent canals are constricted at intervals by transverse diaphragms or *vela*, which contain myocytes concentrically and sometimes radiately arranged. The excessive development of myocytes in such a velum gives rise to muscular sphincters such as those which close the chones of many corticate sponges, such as *Pachymatisma*. In this sponge, which occurs on the British shores, the function of the oscular sphincters can be readily demonstrated, since irritation of the margin of the oscule is invariably followed after a short interval by a slow closure of the sphincter.

Æsthacytes.

Supposed sense-cells or *æsthacytes* (Fig. 22) were first observed by Stewart and have since been described by Von Lendenfeld (**12**). According to the latter, they are spindle-shaped cells, 0.01 mm. long by 0.002 thick; the distal end projects beyond the ectodermal epithelium in a fine hair or palpocil; the body is granular and contains a large oval nucleus; and the inner end is produced into fine threads, which extend into the collenchyme and are supposed—though this is not proved—to become continuous with large multiradiate collencytes, which Von Lendenfeld regards as multipolar ganglion cells (Fig. 22). More recently he has described an arrangement of these cells curiously suggestive of a sense-organ. Numerous æsthacytes are collected over a small area, and at their inner ends pass into a granular mass of cells with well-marked nuclei, but with boundaries not so evident; these he regards as ganglion cells. From the sides of the ganglion other slender fusiform cells, which Von Lendenfeld regards as nerves, pass into the mesoderm, running tangentially beneath the skin. The inner end of the ganglion is in communication with a membrane formed of fusiform cells which Von Lendenfeld regards as muscular. If his observations and inferences are confirmed, it is obvious that we have here a complete apparatus for the conversion of external impressions into muscular movements.

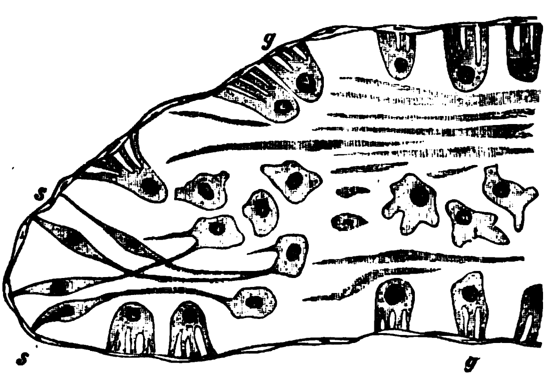

Fig. 22.—Transverse section through the edge of a pore in *Dendrilla cavernosa*, Lfd.; cells in the middle to the right, archæocytes; fusiform cells on each side of them, myocytes; *g*, above and below these with processes terminating against the epithelium, gland cells; fusiform cells terminating against the epithelium at *s*, æsthacytes; at their inner ends these are continuous with ganglion cells. After Von Lendenfeld (× 800).

Protoplasmic continuity.

In most sponges a direct connection can be traced by means of their branching processes between the collencytes of the mesoderm and the cells of the ectodermal and endodermal epithelium and the choanocytes of the flagellated chambers. As the collencytes are also united amongst themselves, they place the various histological constituents of the sponge in true protoplasmic continuity. Hence we may with considerable probability regard the collencytes as furnishing a means for the transmission of impulses: in other words, we may attribute to them a rudimentary nervous function. In this case the modification of some of the collencytes in communication with the ectoderm might readily follow and special æsthacytes arise. Fusiform collencytes perpendicular to the ectoderm, and with one end touching it, are common in a variety of sponges; but it is difficult to trace the inner end into connection with the stellate collencytes, so that precisely in those cases in which it would be most interesting to find such a connection absolute proof of it is wanting.

Pigment cells.

The color of sponges usually depends on the presence of cells containing granules of pigment; though dispersed generally through the mesoderm, these cells are most richly developed in the ectosome. Pigment granules also occur in the choanocytes of some sponges,—*Oscarella lobularis* and *Aplysina aerophoba*, for instance. In the latter the pigment undergoes a remarkable change of color when the sponge is exposed to the air, and finally fades away. In many cases sponges borrow their colors from parasitic algæ (*Oscillatoria* and *Nostoc*) with which they are infested. The colors of sponge-pigments are very various. They have been examined by Krukenberg and Merejknovsky Zoonerythin, a red pigment of the lipochrome series, is one of the most widely diffused; it is regarded as having a respiratory function. Reserve cells or *thesocytes* (Fig. 21 *f*) have been described in several sponges as well as amylin and oil-bearing cells.

Scleroblasts.

Each spicule of a sponge originates in a single cell (Fig. 21 *h-n*), within which it probably remains inclosed until it has completed its full growth; the cell then probably atrophies. During its growth the spicule slowly passes from the interior to the exterior of the sponge, and is finally (in at least some sponges, *Geodia*, *Stelletta*) cast out as an effete product. The sponge is thus constantly producing and disengaging spicules; and in this way we may account for the extraordinary profusion of these structures in some modern marine deposits and in the ancient stratified rocks. Within the latter these deciduous spicules have furnished Silica for the formation of flints, which have been produced by a silicious replacement of carbonate of lime (**26**).

The horny fibres of the *Ceratosa* are produced as a secretion of cells known as *spongioblasts*, which surround as a continuous mantle the sides of each growing fibre, and cover in a thick cap each growing point

(Fig. 23). The lateral sponginblasts are elongated radially to the fibre; the terminal cells are polygonal and depressed. The latter give rise to the soft granular core and the former to the spongin-walls of the fibre. Cells similar to the lateral sponginblasts, and regarded as homologous with them, occur in a single layer just below the outer epithelium of some horny sponges (*Aplysilla* and *Dendrilla*), and under certain circumstances secrete a large quantity of slimy mucus (**11**).

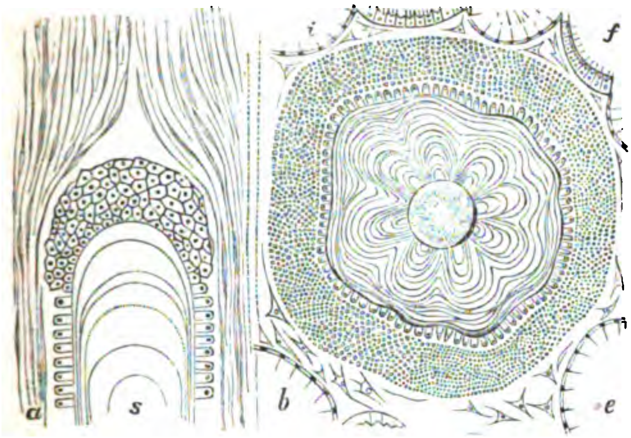

FIG. 23.—Section through the horny fibre and associated tissues of a horny sponge (*Dendrilla*). A, longitudinal section; *s*, layers of spongin, surrounded at the sides by the lateral mantle of sponginblasts, and at the ends by the terminal cap. A desmachymatous sheath, *a*, surrounds the whole (× 150). B, transverse section; in the centre is the soft core, surrounded by wavy spongin layers, the outermost being surrounded by sponginblasts, and these by a fibrous sheath; *i*, part of an incurrent canal lined by flagellated epithelium; *e*, part of an excurrent canal; *f*, part of a flagellated chamber (× 150). After Von Lendenfeld.

Classification.

Classification. The phylum *Parazoa* or *Spongiæ* consists of two main branches, as follows:

Branch A.—*MEGAMASTICTORA.*

Class CALCAREA, Grant.
  Order 1.—*Homocœla*, Pol.
  Order 2.—*Heterocœla*, Pol.

Branch B.—*MICROMASTICTORA.*

Class I.—MYXOSPONGIÆ, Haeckel.
  Order 1.—*Halisarcina.*
  Order 2.—*Chondrosina.*
Class II.—SILICISPONGIÆ.
  Sub-class i.—HEXACTINELLIDA, O. Schmidt.
    Order 1.—*Lyssacina*, Zittel.
    Order 2.—*Dictyonina*, Zittel.
  Sub-class ii.—DEMOSPONGIÆ, Sollas.
    Tribe *a*.—**Monaxonida.**
      Order 1.—*Monaxona.*
      Order 2.—*Ceratosa*, Grant.
    Tribe *b*.—**Tetractinellida**, Marshall.
      Order 1.—*Choristida*, Sollas.
      Order 2.—*Lithistida*, O. S.

Position in animal kingdom. By the possession of both sexual elements and a complex histological structure, and in the character of their embryological development, the sponges are clearly separated from the *Protozoa;* on the other hand, the choanoflagellate character of the endoderm, which it retains in the flagellated chambers throughout the group without a single exception, as clearly marks them off from the *Metazoa*. They may therefore be regarded as a separate phylum derived from the choanoflagellate *Infusoria*, but pursuing for a certain distance a course of development parallel with that of the *Metazoa*.

Different views have been propounded by other authors. Saville Kent regards the sponges as *Protozoa* (**10**); Balfour suggested that they branched off from the Metazoan phylum at a point below the *Cœlentera*, and considered them as intermediate between *Protozoa* and *Metazoa;* Schulze regards them as derived from a simple ancestral form of *Cœlentera* (**23**); Marshall advocates the view that they are degraded forms derived from Cœlenterates which were already in possession of tentacles and mesenteric pouches (**14**).

Subdivision in groups. As a phylum the *Spongiæ* are certainly divisible into two branches, one including the *Calcarea* and the other the remaining sponges, which Vosmaer has termed *Non-Calcarea*, and others *Plethospongiæ*. Since, however, the choanocytes of the *Calcarea* are usually, if not universally, larger than those of other sponges, we may make use of this difference in our nomenclature, and distinguish one branch as the *Megamastictora* (μαστίκτωρ, "scourger") and the other as the *Micromastictora.*

Branch A.—*MEGAMASTICTORA.*

Sponges in which the choanocytes are of comparatively large size, 0.005 to 0.009 mm. in diameter (Haeckel, **6**).

Class CALCAREA.

Calcarea. *Megamastictora* in which the skeleton is composed of calcareous spicules.

Order 1. HOMOCŒLA.—*Calcarea* in which the endoderm consists wholly of choanocytes. Examples: *Leucosolenia*, Bwk.; *Homoderma*, Lfd.

Order 2. HETEROCŒLA.—*Calcarea* in which the endoderm is differentiated into pinnacocytes, which line the paragastric cavity and excurrent canals, and choanocytes, which are restricted to special recesses (radial tubes or flagellated chambers). Examples: *Sycon*, O. S.; *Grantia*, Fl.; *Leuconia*, Bwk.

Branch B.—*MICROMASTICTORA.*

(*Non-Calcarea*, Vosmaer; *Plethospongiæ*, Sollas.) Sponges in which the choanocytes are comparatively small, 0.003 mm. in diameter.

Class I. MYXOSPONGIÆ.

Myxospongiæ. *Micromastictora* in which a skeleton or scleres are absent.

Order 1. HALISARCINA.—*Myxospongiæ* in which the canal system is simple, with simple or branched Sycon or eurypylous Rhagon chambers. An ectosome sometimes and a cortex always absent. Examples: *Halisarca*, Duj.; *Oscarella*, Vosm.; *Bajalus*, Lfd.

Order 2. CHONDROSINA.—*Myxospongiæ* in which the canal system is complicated, with diplodal Rhagon chambers and a well-developed cortex. Example: *Chondrosia*, O.S.

The *Halisarcina* are evidently survivals from an ancient and primitive type. The simplicity of the canal system is opposed to the view that they are degraded forms; we may therefore regard the absence of scleres as a persistent primary and not a secondary acquired character. They are as interesting, therefore, from one point of view (absence of scleres) as the Ascons are from another (undifferentiated endoderm). With the *Chondrosina* the case is different; they differ only from *Chondrilla* and its allies by the absence of asters; these differ only from the *Tethyidæ* by the absence of strongyloxeas; and we may very reasonably assume that in these three groups we have a series due to loss of characters, the *Chondrillæ* being reduced *Tethyidæ* and the *Chondrosina* reduced *Chondrillæ*. Still, as Huxley has well remarked, "classification should express not assumptions but facts"; and therefore till we are in possession of more direct evidence it will be well to exclude the *Chondrosina* from the *Silicispongiæ*.

Class II. SILICISPONGIÆ.

Micromastictora possessing a skeleton or scleres which are not calcareous.

Sub-class i. HEXACTINELLIDA.

Hexactinellida. *Silicispongiæ* characterized by sexradiate silicious spicules. Canal system usually simple, with Sycon chambers. Sponge differentiated into ecto-, choano-, and endo-some.

Order 1. LYSSACINA.—*Hexactinellida* in which the skeleton is formed of separate spicules, or, if united, then by a subsequent not a contemporaneous deposit of silica. Examples: *Euplectella*, Owen; *Asconema*, S. Kent; *Hyalonema*, Gray; *Rossella*, Crtr.

Order 2. DICTYONINA.—*Hexactinellida* in which sexradiate spicules are cemented together by a silicious deposit into a continuous network *pari passu* with their formation. Examples: *Farrea*, Bwk.; *Eurete*, Marshall; *Aphrocallistes*, Gray; *Myliusia*, Gray; *Dactylocalyx*, Stutchbury.

The *Hexactinellida* are a very sharply defined group, impressed with marked archaic features. No other *Silicispongiæ* possess, so far as is known, so simple a syconate canal system. The oldest known fossil sponge is a member of the *Lyssacina* (7 and 24). viz., *Protospongia*, Salter, from the Menevian beds, Lower Cambrian, St. David's Head, Wales. The group is almost world-wide in distribution, chiefly affecting deep water, from 100 to 300 fathoms, but often extending into abyssal depths; occasionally, however, though rarely, it frequents shallow water (*Cystispongia superstes* dredged off Yucatan in 18 fathoms).

Sub-class ii. **DEMOSPONGIÆ.**

Demospongiæ.

Silicispongiæ in which sexradiate spicules are absent.

Tribe *a*. *MONAXONIDA.*

Demospongiæ in which the skeleton consists either of silicious spicules which are not quadriradiate, or of horny scleres or included foreign bodies, or of one or more of these constituents in conjunction.

Order 1. MONAXONA.—The skeleton is characterized by either uniaxial or polyaxial spicules. Examples: *Amorphina*, O. S. ("crumb of bread" sponge); *Spongilla*, Lmk. ("freshwater" sponge); *Chalina*, Bwk.; *Pethya*, Lmk.

Order 2. CERATOSA.—The skeleton consists of horny scleres which never include "proper" spicules, or of introduced foreign bodies, or of both these in conjunction. Examples: *Darwinella*, F. Müller; *Euspongia*, Bronn (the "bath" sponge).

Tribe *b*. *TETRACTINELLIDA.*

Demospongiæ possessing quadriradiate or triæne spicules or Lithistid scleres (desmas).

Order 1. CHORISTIDA.—*Tetractinellida* with quadriradiate or triæne spicules, which are never articulated together into a rigid network. Examples: *Tetilla*, O. S.; *Thenea*, Gray; *Geodia*, Lmk.; *Dercitus*, Gray.

Order 2. LITHISTIDA.—*Tetractinellida* with branching scleres (desmas), which may or may not be modified tetrad spicules, articulated together to form a rigid skeleton. Triæne spicules may or may not be present in addition. Examples: *Theonella*, Gray; *Corallistes*, O. S.; *Azorica*, Crtr.; *Vetulina*, O. S.

This large sub-class embraces the great majority of existing sponges. Its external boundaries are fairly well defined, its internal divisions much less so, as its various orders and families pass into each other at many points of contact. Although there does not appear to be much resemblance between a Lithistid sponge, such as *Theonella*, a Monaxonid such as *Amorphina*, and an ordinary "bath" sponge (*Euspongia*), yet between these extremes a long series of intermediate forms exists, so nicely graduated as to render their disruption into groups by no means an easy task. If the delimitation of orders is difficult, that of genera is often impossible, so that they are reduced to assemblages depending on the tact or taste of the author. Thus Polejaeff states that with a single exception "none of the genera of *Ceratosa* are separable by absolute characters." The chief spicules of *Monaxona* are uniaxial, often accompanied by characteristic microscleres. Although distinguished as a group by the absence of quadriradiate or triæne spicules, two exceptions are known in which these occur (*Tricentrion*, Ehlers, and *Acarnus*, Gray); these, however, present unusual characters which suggest an independent origin. The canal system of *Monaxona* has not yet been fully investigated; it appears usually to follow the eurypylous Rhagon type, but the aphodal is not unknown. The *Ceratosa* contain all sponges with a horny skeleton, except those in which the horny fibres are cored or spined with silicious spicules secreted by the sponge ("proper" spicules); these are arbitrarily assigned to the *Monaxona*. There is convenience in this proceeding, for horny matter is widely disseminated throughout the *Demospongiæ*, occurring even in the *Lithistida*, and it frequently serves to cement the oxeate spicules of the *Monaxona* into a fibre, without at the same time forming a preponderant part of the skeleton. It would be wellnigh impossible to say where the line should be drawn between a fibre composed of spicules cemented by spongin and one consisting of spongin with embedded spicules, while there is comparatively no difficulty in distinguishing between fibres containing spicules and fibres devoid of them. That the distinction, however, is entirely artificial is shown by the fact that, after spicules have disappeared from the horny fibre, they may still persist in the mesoderm; thus Von Lendenfeld announces the discovery of microscleres (cymba) in an Aplysillid sponge and of strongyles in a *Cacospongia*, both horny sponges. (A form intermediate between this Aplysillid and the *Desmacidonidæ* would appear to be *Toxochalina*, Ridley.) The *Ceratosa* frequently enclose sand, *Foraminifera*, deciduous spicules of other sponges and of compound Ascidians, and other foreign bodies within the horny fibres of their skeleton; they also sometimes attach this material, probably by a secretion of spongin, to their outer surface, and thus invest themselves in a thick protective crust. In some *Ceratosa* no other skeleton than that provided by foreign enclosures is present. The canal system is syconate or eurypylous in the simpler forms and diplodal in the higher. The *Monaxonida* make their earliest appearance in the Silurian rocks (*Climacospongia*, Hinde), and are now found in all seas at all depths. The only sponges inhabiting fresh water belong to this group. The *Tetractinellida* adhere to the *Monaxonida* at more than one point, and one of these groups has probably been a fruitful parent to the other, but which is offspring and which parent is still a subject for discussion. The *Choristida* in its simplest forms presents a eurypylous Rhagon system, in the higher an aphodal system. It is in this group that the most highly complex cortex is met with; in the *Geodinidæ*, for instance, it consists usually of at least five distinct layers. Thus, proceeding outwards, next to the choanosome is a layer of thickly felted desmachyme, passing into collenchyme on its inner face; then follows a thick stratum of sterrasters united together by desmacytes; this is succeeded by a layer of cystenchyme or other tissue of variable thickness; external to this is a single layer of small granular cells and associated dermal asters; and finally, the surface is invested by a layer of pavement epithelium. The *Lithistida*, like the *Ceratosa*, are possibly of polyphylitic origin; in one group (*Tetracladina*) the articulated scleres are evidently modified calthrops spicules (see Fig. 14 *e*), and associated with them are free triænes, which support the dermis and resemble precisely the triænes of the *Choristida*. In another group (*Rhabdocrepida*) the scleres are moulded on a Monaxonid base (see Fig. 13 *q*-*s*); but, associated with them, triænes sometimes occur similar to those of the *Tetracladina*. Both these groups are in all probability derived from the *Choristida*, and a distinct passage can be traced from the Tetracladose to the Rhabdocrepid group. In the *Rhabdocrepida* we find forms without triænes; these may possibly be degenerate forms. The third group of Lithistids is derived from the *Rhabdocrepida*, the Anomocladine desma being derivable from the Rhabdocrepid by a shortening of the main axis into a centrum. The thick centrum, from which the arms, variable in number, originate, is hollowed out by a cavity, which appears during life to have been occupied by a large nucleus, like that of a scleroblast, and it is quite conceivable that the scleroblast, which in the Tetracladine Lithistids lies in an angle between the arms, may have become enclosed in an overgrowth of silica, from which additional arms were produced. The constancy with which spicules in other sponges maintain their independence is very striking. When once a persistent character like this is disturbed, excessive variability may be predicted, as in the Anomocladine scleres.

Classification in families.

The classification of the sponges into families is shown in the following scheme:

Class *CALCAREA.*

Order 1. **HOMOCŒLA**, Pol.

Family 1. ASCONIDÆ, Hk.—*Homocœla* which are simple or composite, but never develop radial tubes. Examples: *Ascetta*, Hk. (Fig. 1 ; *Leucosolenia*, Bwk.

Family 2. HOMODERMIDÆ, Lfd.—*Homocœla* with radial tubes. Example: *Homoderma*, Lfd. (Figs. 3, 4).

Order 2. **HETEROCŒLA**, Pol.

Tribe *a*. †SYCONARIA.[1]

The flagellated chambers are either radial tubes or cylindrical sacs.

Family 1. SYCONIDÆ.—The radial tubes open directly into the paragastric cavity.

Sub-family *a*. **Syconina.**—The radial tubes are free for their whole length, or at least distally. Examples: *Sycetta*, Hk; *Sycon*, O. S.

Sub-family *b*. **Uteina.** Lfd.—The radial tubes are simple and entirely united. The ectosome is differentiated from the choanosome and sometimes develops into a cortex. Examples: *Grantissa*, Lfd.; *Ute*, O. S. (Fig. 5); *Sycortusa*, Hk ; *Amphoriscus*, Pol.

Sub-family *c*. **Grantina.** Lfd.—The radial tubes are branched. The incurrent canal system is consequently complicated. An ectosome is present. Examples: *Grantia*, Fl.; *Heteropegma*, Pol. (Fig. 4); *Anamaxilla*, Pol.

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[1] An * indicates that the group is only known in the fossil state, a † that it is both recent and fossil.

Family 2. Sylleibidæ, Lfd.—The choanosome is folded. The flagellated chambers (which are partly rhagose in *Vosmaeria*) communicate with the paragastric cavity by excurrent canals. Examples: *Polejna*, Lfd. (Fig. 6); *Vosmaeria*, Lfd.

Family 3. Teichonellidæ, Carter.—Composite *Sylleibidæ* with the oscules and pores occurring on different parts of the surface. Example: *Teichonella*, Crtr.

Tribe *b*. †Leuconaria.

The canal system belongs to the eurypylous Rhagon type.

Family 1. Leuconidæ, Hk.—The outer surface is not differentiated into osculiferous and poriferous areas. Examples: *Leucetta*, Hk.; *Leucaltis*, Hk.; *Leucortis*, Hk.

Family 2. Eilhardidæ, Pol.—Composite *Leuconaria*, with the outer surface differentiated into special osculiferous and poriferous areas. Example: *Eilhardia*, Pol.

The arrangement adopted above is founded on Von Lendenfeld's revision (11) of the classification propounded by Polejaeff (16), who in a masterly survey has thrown an unexpected light on the structure and inter-relationships of a group which Haeckel has rendered famous. It should not be overlooked that Vosmaer (31) had previously explained the structure of the Leucones. However erroneous in detail, Haeckel's views are confirmed in their broad outlines, and it was with true insight that he pronounced the *Calcarea* to offer one of the most luminous expositions of the evolutional theory. In this single group the development in general of the canal system of the sponges is revealed from its starting-point in the simple Ascon to its almost completed stage in the Leucon, with a completeness that leaves little further to be hoped for, unless it be the requisite physiological explanation.

Class *MYXOSPONGIÆ*.

Order 1. **HALISARCINA**.

Family 1. Halisarcidæ, Lfd.—The flagellated chambers are syconate. Examples: *Halisarca*, Duj. (with branched chambers); *Bajalus*, Lfd. (with simple chambers).

Family 2. Oscarellidæ, Lfd.—The flagellated chambers are eurypylous and rhagose. Example: *Oscarella*, Vosm.

Order 2. **CHONDROSINA**.

Family 1. Chondrosidæ.—With the characters of the order. Example: *Chondrosia*, O. S.

Class *SILICISPONGIÆ*.

Sub-class I. HEXACTINELLIDA.

Order 1. †**LYSSACINA**.

Family 1. Euplectellidæ.—The spicules of the dermal membrane are "daggers" (Fig. 15 *a*). Examples: *Euplectella*, Owen; *Holascus*, E. Sch.; *Habrodictyum*, W. T.

Family 2. Asconematidæ.—The dermal spicules are "pinnuli" (Fig. 15 *b*, *c*). Examples: *Asconema*, S. Kent; *Sympagella*, O. S.; *Caulophacus*, Schulze.

Family 3. Hyalonematidæ.—The dermal spicules are pinnuli and amphidisks (Fig. 15 *d*). Example: *Hyalonema*, Gray.

Family 4. †Rosselidæ.—The dermal spicules are gomphi, stauri (Fig. 15 *f*), and oxeas. Examples: *Rossella*, Crtr.; *Crateromorpha*, Gray; *Aulochona*, E. Sch.

Family 5. *Receptaculidæ, Hinde.—The distal ray of the dermal spicules is expanded horizontally into a polygonal plate. Example: **Receptaculites*, Defr.

Order 2. †**DICTYONINA**.

Sub-order 1. *UNCINITARIA*.

Uncinate spicules are present.

Tribe *a*. Clavularia.

Clavulæ (Fig. 16 *c*) are present.

Family 1. Farreidæ.—Characters those of the tribe. Example: *Farrea*, Bwk.

Tribe *b*. Scopularia.

The dermal spicules are scopulariæ (Fig. 16 *b*).

Family 1. †Euretidæ.—Branched anastomosing tubes, or goblet-shaped, with lateral outlets. Examples: *Eurete*, Marshall; *Periphragella*, Marshall; *Lefroyella*, Schulze.

Family 2. †Mellittonidæ.—Tubular or goblet-shaped, with honeycomb-like walls. Example: *Aphrocallistes*, Gray.

Family 3. †Chonelasmatidæ.—Flat or beaker-shaped; straight funnel-shaped canals perforating the wall perpendicularly and opening laterally on each side. Example: *Chonelasma*, Schulze.

Family 4. †Volvulinidæ.—Tubular, goblet-shaped, or massive; crooked canals more or less irregular in their course. Examples: *Volvulina*, Schulze; *Fieldingia*, S. Kent.

Family 5. Sclerothamnidæ.—Arborescent body; perforated at the ends and sides by round narrow radiating canals. Example: *Sclerothamnus*, Marshall.

Sub-order 2. *INERMIA*.

Dictyonina without uncinati, clavulæ, or scopulariæ.

Family 1. †Myliusidæ.—Depressed cup-shaped; a complex folding of the wall produces lateral excurrent tubes. Example: *Myliusia*, Gray.

Family 2. †Dactylocalycidæ.—Goblet-shaped or pateriform with a thick wall consisting of numerous parallel anastomosing tubes, of uniform breadth, which terminate at the same level within and without. Examples: *Dactylocalyx*, Gray; *Scleroplegma*, O. S.; *Margaritella*, O. S.

Family 3. †Euryplegmatidæ.—Goblet-shaped or resembling ear-shaped saucers; the wall deeply folded longitudinally so as to produce a number of dichotomously branched canals or covered-in grooves. Example: *Euryplegma*, Schulze.

Family 4. †Aulocystidæ.—Of massive rounded form, with an axial cavity; wall consisting of a system of obscurely radiating anastomosing tubes and intervening inter-canals; both inter-canals and the external terminations of the tubes are covered by a thin membrane, which is perforated by slit-like openings over the lumina of the tubes, and thus assumes a sieve-like character. Examples: *Aulocystis*, Schulze; *Cystispongia*, Roemer.

This arrangement of the *Hexactinellida* is taken from the latest work on the subject, Schulze's *Preliminary Report on the "Challenger"-Hexactinellida*. The reference of fossil forms to the families here instituted is rendered difficult by the disappearance of the requisite "guiding" spicules in the process of mineralization. A revision of the fossil families to bring them into harmony with the recent has certainly been rendered necessary, but this is too large a task to undertake in this place.

Sub-class II. DEMOSPONGIÆ.

Tribe *a*. Monaxonida.

Order 1. **MONAXONA**.

Family 1. Tethyidæ.—Skeleton consisting of radiately arranged strongyloxeas (except in the genus *Chondrilla*, which is without megascleres) and large spherasters. The ectosome is a thick fibrous cortex. Example: *Tethya*, Lmk.; *Chondrilla*, O. S.

Family 2. Polymastidæ.—Skeleton consisting of styles radiately arranged and cortical tylostyles. The oscules in many cases open at the ends of long papillæ. Examples: *Polymastia*, Bwk.; *Thecaphora*. O. S.; *Trichostemma*, Sars.

Family 3. Suberitidæ.—Skeleton consisting of strongylate or tylotate styles, arranged to form a felt. The flesh spicules when present are usually microrabds or spirasters. Examples: *Suberites*, Nardo; *Cliona*, Grant; *Poterion*, Schlegel.

Family 4. Desmacidonidæ.—The flesh spicules are cymbas. Examples: *Esperella*, Vosm.; *Desmacidon*, Bwk.; *Cladorhiza*, Sars.

Family 5. †Halichondridæ.—The flesh spicules when present are never cymbas. Examples; *Halichondria*, Fl.; *Reniera*, O. S.; *Chalina*, Bwk.; **Pharetrospongia*, Soll.

Family 6. Ectyonidæ.—The skeleton consists of fibres echinated by projecting spicules. Examples: *Plocamia*, O. S.; *Ectyon*, Gray; *Clathria*, O. S.

Family 7. †Spongillidæ.—*Halichondridæ* which are reproduced both sexually and by statoblasts. Habitat freshwater. Examples: *Spongilla*, Lmk.; *Ephydatia*, Lmk.; *Parmula*, Crtr.; *Potamolepis*, Marshall.[1]

The foregoing classification is purely provisional; the group requires a complete revision.

Order 2. **CERATOSA**.

Family 1. Darwinellidæ.—Canal system of the eurypylous Rhagon type. Flagellated chambers, pouch-shaped, large; the surrounding collenchyme not granular. Horny fibres with a thick core. Examples: *Darwinella*, Fritz Müller; *Aplysilla*, F. E. S.; *Ianthella*, Gray.

Family 2. Spongelidæ.—Canal system as in the *Darwinellidæ*, but the flagellated chambers more or less spherical. Horny fibres with a thin core, and usually containing foreign enclosures. Examples: *Velinea*, Vosm.; *Spongelia*, Nardo; *Psammoclema*, Marshall; *Psammopemma*, Marshall.

Family 3. Spongidæ.—Canal system aphodal. Chambers small and spherical; surrounding collenchyme granular. Fibres with a thin core. Examples: *Euspongia*, Bronn; *Coscinoderma*, Crtr.; *Phyllospongia*, Ehlers.

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[1] Freshwater sponges without statoblasts are excluded from this family, and left for distribution amongst allied marine genera.

Family 4. APLYSINIDÆ.—Canal system diplodal; collenchyme surrounding the flagellated chambers densely granular. Fibres with a thick core. Examples: *Luffaria*, Duch. and Mich.; *Verongia*, Bwk.; *Aplysina*, Nardo.

The species of sponge in common use are three: *Euspongia officinalis* (Linn.), the fine Turkey or Levant sponge; *E. zimocca* (O. S), the hard Zimocca sponge; and *Hippospongia equina* (O. S.), the horse sponge or common bath sponge. The genus *Euspongia* is distinguished by the regular development of the skeletal network throughout the body, its narrow meshes, scarcely or not at all visible to the naked eye, and the regular radiate arrangement of its chief fibres. *Hippospongia* is distinguished by the thinness of its fibres and the labyrinthic character of the choanosome beneath the skin. As a consequence its chief fibres have no regular radiate arrangement. The species of *Euspongia* are distinguished as follows. In *E. officinalis* the chief fibres are of different thicknesses, irregularly swollen at intervals, without exception cored by sand grains; in *E. zimocca* they are thinner, more regular, and almost free from sand. In *E. officinalis*, again, the uniting fibres are soft, thin, and elastic; whilst in *E. zimocca* they are denser and thicker, to which difference the latter sponge owes its characteristic hardness. Finally, the skeleton of *E. officinalis* is of a lighter color than that of *E. zimocca*. The common bath sponge (*Hippospongia equina*) has almost always a thick cake-like form; but its specific characters are not yet further defined.

Tribe *b*. TETRACTINELLIDA.

Order 1. **CHORISTIDA**.

Sub-order 1. *SIGMATOPHORA*.

The microsclere is a sigmaspire.

Family 1. TETILLIDÆ.—The characteristic megasclere is a protriæne. Canal system in the lower forms eurypylous, in the higher aphodal. The ectosome in the simpler forms is a dermal membrane, in the higher a highly differentiated cortex. Examples: *Tetilla*, O. S.; *Craniella*, O. S. (Fig. 21 *h*, *l*).

Family 2. SAMIDÆ.—The characteristic megasclere is an amphitriæne. Example: *Samus*, Gray.

Sub-order 2. *ASTEROPHORA*.

The microsclere is an aster.

Group 1. SPIRASTROSA.—A spiraster is usually present.

Family 1. THENEIDÆ, Carter.—The flesh spicule is a spiraster. Canal system eurypylous. Ectosome not differentiated to form a cortex. Examples: *Thenea*, Gray (Fig. 21 *a*, *f*); *Pœcillastra* (*Normania*), Bwk.

Family 2. †PACHASTRELLIDÆ.—Canal system eurypylous in the lower, aphodal in the higher forms. Examples: *Plakortis*, F. E. S.; *Dercitus*, Gray.

Group 2. EUASTROSA.—Spirasters are absent.

Family 1. †STELLETTIDÆ.—Canal system aphodal, but approaching the eurypylous in the lower forms. The cortex chiefly consists of collenchyme in the lower forms; in the higher it is highly differentiated. Examples: *Stelletta*, O. S. (Fig. 11); *Ancorina*, O. S.; *Myriastra*, Soll.

Family 2. TETHYIDÆ.—Although this family has been placed in the *Monaxonida*, this seems to be its more natural position.

Group 3. STERRASTROSA.—A sterraster is present, usually in addition to a simple aster.

Family 1. †GEODINIDÆ.—The megascleres are partly triænes. Canal system always aphodal. Cortex highly differentiated. Examples: *Geodia*, Lmk. (Fig. 21 *n*); *Pachymatisma*, Bwk. (Fig. 21 *c*); *Cydonium*, Müller (Fig. 10); *Erylus*, Gray.

Family 2. PLACOSPONGIDÆ.—The megasclere is a tylostyle. Triænes are absent. Example: *Placospongia*, Gray.

Sub-order 3. *MICROSCLEROPHORA*.

Microscleres only are present.

Family 1. PLAKINIDÆ, Schulze.—Canal system very simple, belonging to eurypylous Rhagon type. Characteristic spicules candelabra. Examples: *Plakina*, F. E. S. (Fig. 26).

Family 2. CORTICIDÆ.—Canal system aphodal or diplodal. Mesoderm a collenchyme crowded with oval granular cells; the spicules either candelabra, amphitriænes, or triænes, irregularly dispersed in it. Example: *Corticium*, O. S. (Figs. 9, 21 *b*).

Family 3. THROMBIDÆ.—Canal system diplodal. Spicules trichotriænes. Example: *Thrombus*, Soll.

The *Pachastrellidæ* or the *Corticidæ* are probably the families from which the Tetracladine Lithistids have been derived. In the *Tetillidæ* the characteristic microsclere may occasionally fail, but there is never any difficulty in identifying the sponge in this case, as the triænes are of a very characteristic form: the arms of the protriænes are slender, simple, and directed very much forwards, making a very large angle with the shaft. Microscleres, having the form of little globules, are sometimes present with the sigmaspires.

Order 2. **LITHISTIDA**, O. S.

Sub-order 1. *TETRACLADINA*, Zittel.

The desmas are modified calthrops spicules.

Family 1. TETRACLADIDÆ.—With the characters of the sub-order. Examples: *Theonella*, Gray (Fig. 21 *k*); *Discodermia*, Bocage; **Siphonia*, Parkinson.

Sub-order 2. *RHABDOCREPIDA*.

The desmas are of various forms, produced by the growth of silica over a uniaxial spicule.

Family 1. MEGAMORINIDÆ.—The desmas are comparatively large. Triænes, usually dichotriænes, help to support the ectosome. Microscleres usually spirasters. Examples: *Corallistes*, O. S.; **Hyalotragos*, Zittel; *Lyidium*, O. S.; **Dorydermia*, Zittel.

Family 2. MICROMORINIDÆ.—The desmas are comparatively small. Triænes and microscleres are both absent. Examples: *Azorica*, Crtr.; **Verruclina*, Zittel.

Sub-order 3. *ANOMOCLADINA*.

Desmas with a massive nucleated centrum, from which a variable number of arms (28) extend radiately (see Fig. 12 *f*). Examples: *Vetulina*, O. S.; **Astylospongia*, Roemer.

Reproduction and Embryology.

Fresh individuals arise by asexual gemmation, both external and internal, by fission, and by true sexual reproduction.

Asexual multiplication.

Fission is probably one of the processes by which compound sponges are produced from simple individuals. Artificial fission has been practiced with success in the cultivation of commercial sponges for the market. External gemmation has been observed in *Thenea*, *Tethya*, *Polymastia*, and *Oscarella*. A mass of indifferent sponge-cells accumulates at some point beneath the skin, bulges out, drops off, and gives rise to a new individual. Internal gemmation, which results in the formation of a statoblast, is only known to occur in the freshwater *Spongillidæ*. The statoblasts consist of a mass of yolk-bearing mesoderm cells, invested by a capsule, which in *Ephydatia fluviatilis* is composed of an inner cuticle of spongin separated from a similar outer layer by an intermediate zone of amphidisks and interspersed protoplasmic cells. On one side of the capsule is a hilum which leads into the interior.

Their development has recently been studied by Götte, with results that confirm the conclusions of Carter (3) and Lieberkühn (13). The process commences with an accumulation of amœboid cells within the mesoderm to form a globular cluster; yolk granules develop within them especially in those that lie nearer the centre. The external cells give rise to the investing capsules; some resemble sponginblasts and secrete the inner and outer horny cuticle; others give rise to the amphidisks and interspersed cells of the middle layer. Under favorable conditions the interior cells creep out through the pore of the capsule, and form a spreading heap, which by subsequent differentiation gives rise to a young *Spongilla*. Since the freshwater sponges can only be regarded as modified descendants of ancient marine species (probably of the family *Halichondridæ*), we may consider the internal gemmules, like the similar statoblasts of the freshwater *Polyzoa*, as special adaptations to a changed mode of life. They appear primarily to serve a protective purpose, ensuring the persistence of the race, since they only appear in extreme climates on the approach of drought, and in cold ones on the approach of winter. As a secondary function they serve for the dispersal of the species; some are light enough to float down a stream, but not too far, so that there is no danger of their being carried to sea; others, which are characterized by large air-chambers, are possibly distributed by the wind.

Both sexual elements may be formed in the same individual, *e.g.*, *Oscarella lobularis*, *Grantia raphanus*, and many others; but even in hermaphrodites one

Sexual reproduction.

or other element usually occurs to excess in different individuals, so that some are predominantly male and others predominantly female. Polejaeff found only one such male form to 100 female forms in *Grantia raphanus*. In other sponges—*Reniera fertilis*, *Euspongia officinalis*—the sexes are distinct. The ova develop from archæocytes or wandering amœboid cells, which increase in size and acquire a store of reserve nourishment in the form of yolk granules; at first they exhibit lively amœboid movements but later pass into a resting stage. The cavity of the mesoderm within which they are situated becomes lined by a layer of epithelium, which may not appear, however, till a late stage of segmentation. In *Euspongia officinalis* the ova occur congregated in groups within the mesoderm, thus presenting an early form of ovary. The spermatozoa, which also develop from wandering amœboid cells, are minute bodies with an oval or pear-shaped head and a long vibratile tail (Fig. 24 *k*). Each amœboid cell produces a large number of spermatozoa, which occur in spherical clusters or sperm-balls. The heads of the spermatozoa, as in the *Metazoa*, are produced from the nucleus of the mother-cell, the tails from the surrounding protoplasm.

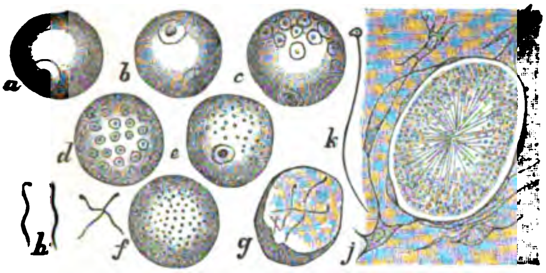

FIG. 24.—Spermatozoa. *a-h*, Development of spermatozoa in *Sycandra raphanus*, highly magnified; *h*, mature spermatozoa. After Polejaeff (× 792). *j*, A sperm ball in *Oscarella lobularis* (× 500); *k*, an isolated mature spermatozoon. After Schulze (× 800).

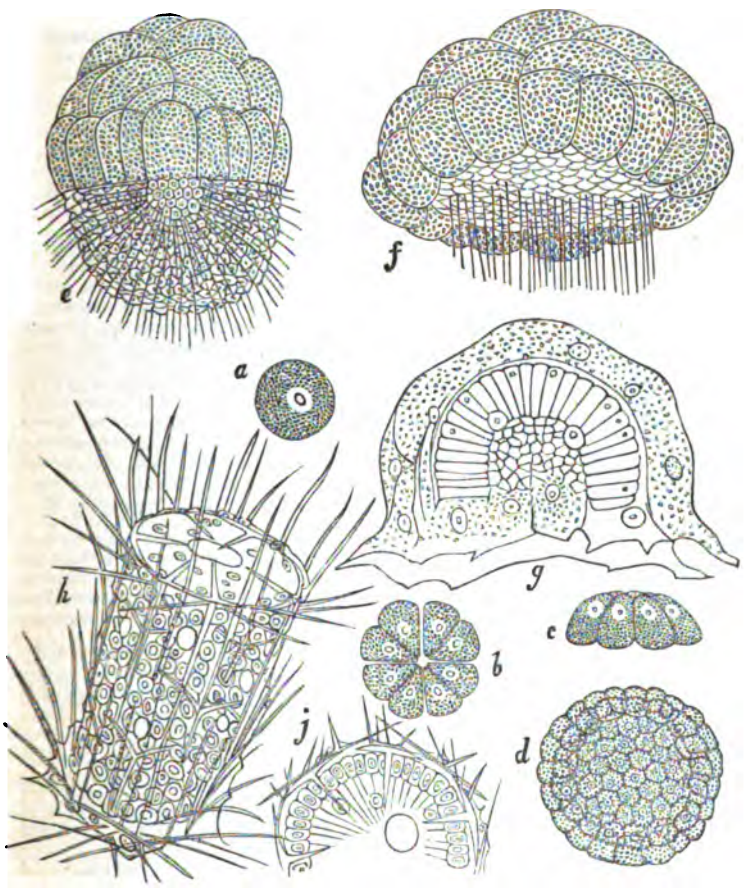

FIG. 25.—Development of a calcareous sponge (*Sycandra raphanus*). *a*, ovum; *b*, *c*, ovum segmented,—*b*, as seen from above; *c*, lateral view; *d*, blastosphere; *e*, amphiblastula; *f*, commencement of the invagination of the flagellated cells of the amphiblastula; *g*, gastrula attached by its oval face; *h*, *j*, young sponge (Ascon stage),—*h*, lateral view; *j*, as seen from above. After Schulze.

The development in detail is upon two plans. In *Grantia raphanus* (**15**) the nucleus of the mother-cell divides into two (Fig. 24 *b*); one of the resulting daughter nuclei undergoes no further change, but with a small quantity of peripheral protoplasm forms a "cover-cell" to the other or primitive sperm nucleus and its associated protoplasm. The sperm nucleus repeatedly divides, without involving the surrounding protoplasm (Fig. 24 *c-f*). The resulting nuclei at length cease to exhibit a nucleolus, and become directly transformed into the heads of spermatozoa; the tails are appropriated by each head from the common protoplasmic residue. The mother-cell in this case undergoes no increase in volume as development proceeds, and it is not enclosed within an "endothelial" layer. In the second and apparently more usual case (**20**) no "cover-cell" is formed, but the mother-cell divides and subdivides, protoplasm as well as nuclei, till a vast number of minute cells results; the nucleus of each becomes the head of a spermatozoon and the protoplasm its tail. In this case the sperm-ball does increase in bulk; it grows as it develops, and the cavity containing it becomes lined by epithelium, or so-called "endothelium" (Fig. 24 *j*). No doubt (**15**) the development of the epithelium stands in direct physiological connection with the growth of the sperm-ball.

Embryology.

Obscure as are the details of this subject, sufficient is known to enable us to make out two chief types of development. One, common amongst the calcareous sponges, and possibly occurring in a single genus (*Gummina*) of the *Micromastictora*, is characterized by what is known as the "amphiblastula" stage; the other, widely spread amongst the *Micromastictora* (*Reniera*, *Desmacidon*, *Euspongia*, *Spongelia*, *Aplysilla*, *Oscarella*), is characterized by a "planula" stage.

The first has been most thoroughly investigated in *Grantia raphanus* by Schulze (**20**). The ovum by repeated segmentation gives rise to a hollow vesicle, the wall of which is formed by a single layer of cells—*blastosphere* (Fig. 25 *d*). Eight cells at one pole of the blastosphere now become differentiated from the rest; they remain rounded in form, comparatively large, and become filled with granules (stored nutriment), while the others, rapidly multiplying by division, become small, clear, columnar, and flagellated. By further change the embryo becomes egg-shaped; the granular cells, now increased in number to thirty-two, form the broader end, and the numerous small flagellated cells the smaller end. Of the granular cells sixteen are arranged in an equatorial girdle adjoining the flagellate cells. A blastosphere thus differentiated into two halves composed of different cells is known as an *amphiblastula*. The amphiblastula (Fig. 25 *e*) now perforates the maternal tissue, and is borne along an excurrent canal to the oscule, where it is discharged to the exterior and swims about in a whirling lively dance. It then assumes a more spherical form, a change premonitory of the next most remarkable phase of its career. In this the flagellated layer becomes flattened, depressed, and finally invaginated within the hemisphere of granular cells, to the inner face of which it applies itself, thus entirely obliterating the cleavage cavity, but by the same process originating another (the invagination cavity) at its expense (Fig. 25 *f*). The two-layered sac thus produced is a *paragastrula*; its outer layer, known as the *epiblast*, gives rise to the ectoderm, the inner layer or hypoblast to the endoderm. The paragastrula next becomes somewhat beehive-shaped, and the mouth of the paragastric cavity is diminished in size by an ingrowth of the granular cells around its margin. The larva now settles mouth downwards on some fixed object, and exchanges a free for a fixed and stationary existence (Fig. 25 *g*). The granular cells completely obliterate the original mouth, and grow along their outer edge over the surface of attachment in irregular pseudopodial processes, which secure the young sponge firmly to its seat (Fig. 25 *h*). The granular cells now become almost transparent, owing to the exhaustion of the yolk granules, and allow the hypoblast within to be readily seen; a layer of jelly-like material, the rudimentary mesoderm, is also to be discerned between the two layers. The spicules then become visible; slender oxeas appear first, and afterwards tri- and quadri-radiate spicules. The larva now elongates into a somewhat cylindrical form; the distal end flattens; and an oscule opens in its midst. Pores open in the walls; the endodermal cells, which had temporarily lost their flagella, reacquire them, at the same time extending the characteristic collar. In this stage (Fig. 25 *h*, *j*) the young sponge corresponds to a true Ascon, no trace of radial tubes being visible; but as they characterize the parent sponge they must arise later, and thus we have clear evidence through ontogeny of the development of a Sycon sponge from an Ascon.

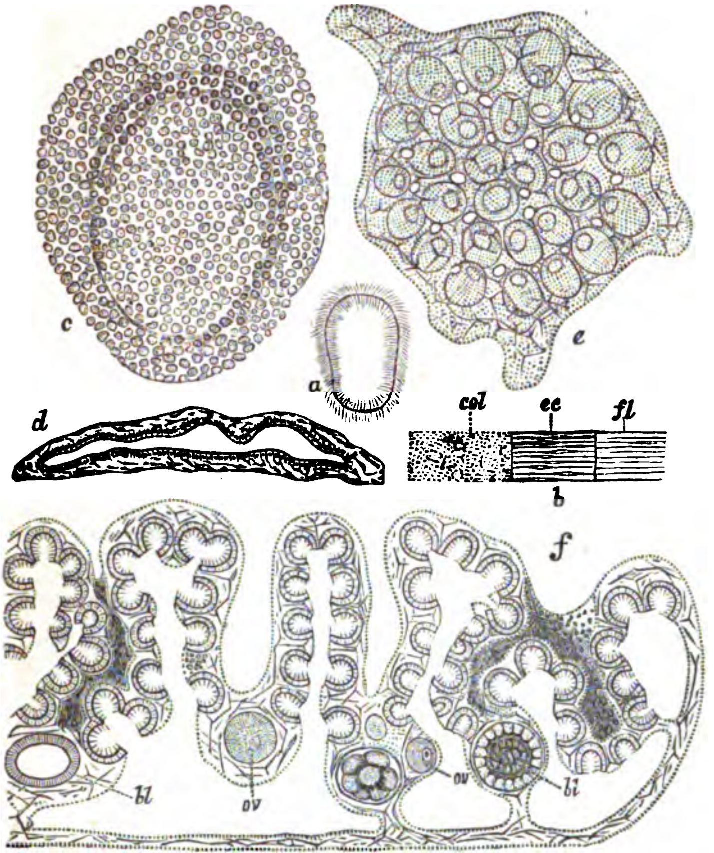

FIG. 26.—Development of a *Demospongia* (*Plakina monolopha*). *a*, planula (the central part should be shaded). *b*, Section through side of planula ; *ec*, flagellated cells ; *fl*, their flagella; *col*, cœnoblast. *c*, Attached gastrula (the paragaster is formed by fission). *d*, Section across the foregoing. *e*, Young sponge (Rhagon). *f*, Part of a section through fully grown sponge ; the attached basal layer is the hypomere ; the spongomere is folded so as to produce incurrent and excurrent canals ; the canal system is eurypylous ; *ov*, ova (a segmented ovum lies between two of them) ; *bl*, blastospheres. After Schulze.

The three most striking features in the history of this larva are, first, the amphiblastula stage; next the invagination of the flagellate cells within the granular, instead of invagination in the reverse order; and third the attachment of the larva by the oral instead of the aboral surface. Should Schulze be correct in deriving the sponges from the *Cœlentera*, it is probable that the reversal of the Cœlenterate history as exemplified in the last two events will furnish an explanation of the remarkable divergencies which distinguish the two phyla. The history of the second or planula type has been thoroughly worked out by Schulze (**20**) in a little incrusting Tetractinellid sponge (*Plakina monolopha*, Schulze). The ovum by regular segmentation produces a blastosphere, the blastomeres of which increase in number by further subdivision till they become converted into hyaline cylindrical flagellated cells (Fig. 26 *f*). Thus a blastosphere is produced consisting wholly of similar flagellated cells. It becomes egg-shaped, and, hitherto colorless, assumes a rose-red tint, which is deepest over the smaller end. The larva (now a planula, Fig. 26 *a*, by the filling in of the central cavity) escapes from the parent and swims about broad end foremost. In this stage thin sections show that the cleavage cavity is obliterated, its place being occupied by a mass of granular gelatinous material containing nuclei (Fig. 26 *b*.). In from one to three days after hatching the larva becomes attached. It then spreads out into a convex mass, and a cavity is produced within it by the splitting of the central jelly (Fig. 26, *c*, *d*; compare *Eucope* and others amongst the Cœlenterates). This cavity becomes lined by short cylindrical cells (endoderm), while the flagellated cells of the exterior lose their flagella and become converted into pinnacocytes (ectoderm). The gelatinous material left between the two layers now formed acquires the characters of true collenchyme and thus becomes the mesoderm. The endoderm then sends off into the mesoderm, as buds, rounded chambers, which communicate with the paragastric cavity by a wide mouth and with the exterior by small pores (Fig. 26 *e*). An oscule is formed later, and the sponge enters upon the Rhagon phase. Subsequent foldings of the sponge-wall give rise to a very simple canal system (Fig. 26 *f*). In addition to these two well-ascertained modes of development others have been described which at present appear aberrant.. In *Oscarella lobularis*, O. S. (**27**), a curious series of early developmental changes results in the formation of an irregular paragastrula, the walls of which become folded (while still within the parent sponge) in a complex fashion, so as to produce a form in which the incurrent and excurrent canals appear to be already sketched out before the flagellated chambers are differentiated off. In *Spongilla* Götte describes the ectoderm as becoming entirely lost on the attachment of the larva, so that the future sponge proceeds from the endoderm alone. As *Spongilla*, however, is a freshwater form, anomalies in its development (which remind us of those in the development of the freshwater *Hydra*) might almost be expected.

Homoplasy.

Probably in no other single group is the doctrine of homoplasy enunciated by Lankester more tellingly illustrated than in the sponges. The independent development of similar types of canal system in different groups, sometimes within the limits of a single family, is a remarkable fact. In the following table the sign × shows independent evolution of similar types of canal system in different groups :

	Ascon.	Sycon.	Rhagon.		
			Eurypylous.	Aphodal.	Diplodal.
Class *Calcarea*	×	×	×	...	...
Order *Halisarcina*....	...	×	×	...	...
Order *Monaxona*......	...	...	×	×	...
Order *Ceratosa*........	...	×	×	×	×
Sub-order *Microsclerophora*.....	...	...	×	×	×
Order *Choristida*......	...	...	×	×	...
Family *Tetillidæ*......	...	...	×	×	...

In the gross anatomy of the canal system similar homoplasy obtains; thus, to cite one case amongst many, a peculiar type of canal system characteristic of *Siphonia* (Lithistid) occurs also in *Emploca* (Hexactinellid), *Schmidtia* (Monaxonid), and other apparently unrelated genera. The development of a cortex has likewise taken place independently, but on parallel lines, in the *Syconidæ*, *Leuconidæ*, *Monaxona*, *Tetillidæ*, and *Stellettidæ*. Calcareous and silicious spicules have evidently an independent history, and yet all the chief forms of the former are repeated in the latter. Quite as remarkable is the similarity of the independently evolved horny spicules of *Darwinella aurea* to the quadri- and sex-radiate silicious spicules. We have now sufficient knowledge of the morphology and evolution of the sponge to furnish the physicist with data for an explanation of the skeleton, at least in its main outlines. The obvious conclusion from this is that variation does not depend upon accident, but on the operation of physical laws as mechanical in their action here as in the mineral world. Another important consequence follows: if homoplasy—*i.e.*, the independent evolution of similar structures—is of such certain and quite common occurrence in the case of the sponges, it is also to be looked for in other groups, and polyphylitic origin, so far from being improbable, is as likely an occurrence as monophylitic origin.

Physiology and Ætiology.

Physiology.

Under the head of "physiology" we have almost a blank. At present we do not even know what cells of the sponge are primarily concerned in the ingestion of food. If a living sponge, such as *Spongilla*, be fed with carmine for a few minutes, then immersed in dilute osmic acid, and examined in thin sections, its flagellated chambers are found to be all marked out as red circular patches, and a closer investigation shows that the choanocytes, and they alone, have ingested the carmine. In this way we confirm the earlier observations of Carter made by teasing carmine-fed sponges. This might be thought to decide the question; but, though it effectually disposes of Polejaeff's argument that the choanocytes do not ingest nutriment because mechanical disadvantages (conceived *a priori*) make it impossible, it has not proved a final solution. Von Lendenfeld, by feeding sponges such as *Aplysilla* with carmine for a longer interval—a quarter of an hour—finds that amœboid cells crowd about the sides and particularly the floor of the subdermal cavities, and are soon loaded with carmine granules; after a time they wander away to the flagellated chambers and there cast out into the ex-current canals the carmine they have absorbed, apparently in an altered state. On the other hand, the choanocytes, though they at first absorb the carmine, soon thrust it out, apparently in an unaltered state. Hence Von Lendenfeld concludes that it is the epithelium of the subdermal cavities which is charged with the function of ingestion, and that the amœboid cells subsequently digest and distribute it, and finally cast out the worthless residues. There may be much truth in this view, but it requires to be supported by further evidence. (1) Sufficient proof is not adduced to show that the carmine granules expelled from the amœboid cells are really more decomposed than those rejected by the choanocytes. (2) There is at present no proof that carmine is a food, or that if it is sponges will readily feed upon it. In either case one would expect the amœboid cells to play the part which they perform in other organisms and to remove as soon as possible useless or irritant matter from the surface which it encumbers; at the same time the choanocytes, not having found the food to their liking, would naturally eject it. (3) If the choanocytes do not ingest food, how does the Ascon feed, since in this sponge all the pinnacocytes are external? It is, however, a very noticeable fact that, as the organization of a sponge increases in complexity, the choanocytal layers become reduced in volume relative to the whole bulk of the individual; and it is quite possible that as histological differentiation proceeds it may be accompanied by physiological differentiation which relieves the choanocytes to some extent of the ingestive part of their labors.

Ætiology.

The origin of the sponges is to be sought for among the choanoflagellate *Infusoria*; and Saville Kent has described a colonial form of this group which is suggestively similar to a sponge. Its differences, however, are as marked as its resemblances, and have been sufficiently pointed out by Schulze (23). Kent has called this form *Proterospongia*, a name already made use of, and fortunately, as the organism is not in any sense a true sponge; the present writer proposes, therefore, to call it *Savillia*, in honor of its discoverer. It consists of choanoflagellate *Infusoria* (see PROTOZOA, vol. xix. p. 882, Fig. XXI., 15), half projecting from and half embedded in a structureless jelly or blastema, within which other cells of an amœboid character and reproductive function are immersed. Professor Haddon arrives at the generalization that conjugation amongst the *Protozoa* always takes place between individuals of the same order: flagellate cells conjugate with flagellate, amœboid with amœboid, but never with flagellate; while in true sexual reproduction the conjugation occurs between two individual cells in different stages of their life cycle: a flagellate cell conjugates with a resting amœboid cell. Now *Savillia* would appear to be extremely near such a true sexual process, since the simultaneous coexistence of cells in two different stages of life and within easy reach of each other—a necessary preliminary, one would think, to the union—has already been brought about. That coalescence between two different histological elements should result in products similarly histologically differentiated (compare amphiblastula stage of *Calcarea*) has in it a certain fitness, which, however, has still to be explained. The mode by which an organism like *Savillia* might become transformed into an Ascon cannot be suggestively outlined with any satisfactory results till our knowledge of the embryology of sponges is more advanced. The minute characters of the flagellate cells of the amphiblastula and other sponge larvæ are still a subject for research. They often possess a neck or collum; but the existence of a frill or collar is disputed. Kent asserts that it is present in several embryos which he figures; and Barrois makes the same assertion in respect to the larva of *Oscarella*, and illustrates his description with a figure. On the other hand, Schulze and Marshall both deny its existence, and the former attributes Kent's observations to error. One constant character they do possess: they are provided with flagella at some stage of their existence, but never with cilia. Ciliated cells, indeed, are unknown amongst the sponges, and, when pinnacocytes exceptionally acquire vibratile filaments, as in *Oscarella* and other sponges, these are invariably flagella, never cilia. An Ascon stage having been reached at some point in the history of the sponges, the Sycon tubes and Rhagon chambers would arise from it by the active proliferation of choanocytes about regularly distributed centres, possibly as a result of generous feeding. Vosmaer recognized as the physiological cause of Sycon an extension of the choanocytal layer. Polejaeff, relying on Von Lendenfeld's experiments, which seem to prove that it is the pinnacocytes and not the choanocytes which are concerned in the ingestion of nutriment, argues that, as in Sycon the pinnacocytal layer is increased relatively to the choanocytal, we have in this a true explanation of the transition. The existence of *Homoderma*, Lfd., however, shows that in the first stage there was not a replacement of choanocytes by pinnacocytes, but that this was a secondary change, following the development of radial tubes, and therefore cannot be relied upon to explain them. The radial tubes having been formed by a proliferation of choanocytal cells, the reduction of those lining the paragastric cavity to pinnacocytes would follow in consequence of the poisonous character of the water delivered from the radial tubes to the central cavity, since this water not only parts with its dissolved oxygen to the choanocytes it first encounters, but receives from them in exchange urea, carbonic acid, and fæcal residues. The development of subdermal cavities is explicable on Von Lendenfeld's hypothesis.

Distribution.

Distribution in space; Our knowledge of this subject is at present but fragmentary; we await fuller information in the remaining reports on the sponges obtained by the "Challenger." The sponges are widely distributed through existing seas, and freshwater forms are found in the rivers and lakes of all continents except Australia, and in numerous islands, including New Zealand. Many genera and several species are cosmopolitan, and so are most orders.

As instances of the same species occurring in widely remote localities we take the following from Polejaeff: *Sycon arcticum* is found at the Bermudas and in the Philippine Islands, as also are *Leuconia multiformis* and *Leucilla uter*; *Sycon raphanus* occurs at Tristan da Cunha and the Philippines; *Heteropegma nodus-gordii* and *Leuconia dura* at the Bermudas and Torres Straits. We do not know, however, whether these species are isolated in their distribution or connected by intermediate localities. Of the *Calcarea* about eighty-one species have been obtained from the Atlantic, twenty-two from the Pacific, and twenty-two from the Indian Ocean; but these numbers no doubt depend largely on the extent to which the several oceans have been investigated, for the largest number of species has been found in the ocean nearest home. Schulze states that the *Hexactinellida* brought home by the "Challenger" were obtained at seventeen Atlantic stations, twenty-seven Pacific, and nineteen in the South Seas. In the last the number of species was greatest, in the Atlantic least. They flourish best on a bottom of diatomaceous mud. The *Calcarea* and *Ceratosa* are most abundant in shallow water and down to 40 fathoms, but they descend to from 400 to 450 fathoms. The *Hexactinellida* are most numerous over continental depths, *i.e.*, 100 to 200 fathoms; but they extend downwards to over 2500 fathoms and upwards into shallow water (10 to 20 fathoms). The *Lithistida* are not such deep-water forms as the *Hexactinellida*, being most numerous from 10 to 150 fathoms. Only one or two species have been dredged from depths greater than 400 fathoms, and none from 1000 fathoms. The *Choristida* range from shallow water to abyssal depths. A characteristic deep-sea Choristid genus is *Thenea*, Gray (= *Wyville Thompsonia*, Wright; *Dorvillia*, Kent). This is most frequently dredged from depths of from 1000 to 2000 fathoms; but it extends to 2700 fathoms on the one hand and to 100 on the other.

in time. Until about 1876 one of the chief obstacles to the interpretation of fossil sponges arose from a singular mineral replacement which most of them have undergone, leading to the substitution of calcite for the silica of which their skeletons were originally composed. This change was demonstrated by Zittel (**35**) and Sollas (**24**), and, though it was at first pronounced impossible, owing to objections founded on the chemical nature of silica, it has since become generally recognized. These observers also showed that the fossil sponges do not belong to extinct types, but are assignable to existing orders. Zittel in addition subjected large collections to a careful analysis and marshalled them into order with remarkable success. Since then several palæontologists have worked at the subject,—Pŏcta, Dunikowski, and Hinde (**7**), who has published a *Catalogue*—which is much more than a catalogue—of the sponges preserved in the British Museum. The result of their labors is in general terms as follows: Fossil sponges are chiefly such as from the coarseness or consistency of their skeletons would be capable of preservation in a mineralized state. Thus the majority are *Hexactinellida*, chiefly *Dictyonina*; *Tetractinellida*, chiefly *Lithistida*; and *Calcarea*, chiefly *Leuconaria*. Monaxonid sponges rarely occur; the most ancient is *Climacospongia*, Hinde, found in Silurian rocks. A very common Halichondroid sponge of this group (*Pharetrospongia strahani*, Soll) occurs in the Cambridge greensand; it owes its preservation to the collection of its small oxeate spicules into dense fibres. The *Choristida*, though not so common as the Lithistids are commoner than the Monaxonids, particularly in Mesozoic strata.

The distribution of fossil sponges in the stratified systems may be summarized as follows: CALCAREA.—*Homocœla*, none. *Heterocœla*, a Syconid, in the Jurassic system. Numerous *Leuconaria* from the Devonian upwards. MYXOSPONGIÆ.—None; not fitted for preservation. HEXACTINELLIDA.—*Lyssacina*, from the Lower Cambrian upwards. *Dictyonina*, commencing in the Silurian; most numerous in the Mesozoic group; still existing. MONAXONIDA.—*Monaxona*, from the Silurian upwards. *Ceratosa*, none; few are fitted for preservation. TETRACTINELLIDA.—*Choristida*, from the Carboniferous upwards; most numerous in the Cretaceous system. *Lithistida*, from the Silurian upwards; most numerous in the Mesozoic group. In ancient times the Hexactinellids and Lithistids seem not to have been so comparatively uncommon in shallow water as they are at the present day. Thus, in the Lower Jurassic strata of the southwest of England we find Dictyonine Hexactinellids, Lithistids, and Leuconarian *Calcarea* associated together in a shelly breccia and in company with littoral shells, such as *Patella* and *Trochus*. Several Palæozoic Hexactinellids actually occur in a fine-grained sandstone. Of the Chalk, which is the great mine of fossil sponges, we must speak with caution, owing to the insufficient evidence as to the depth at which it was deposited.

As shown by *Proterospongia*, the phylum of the sponges was in existence in very early Cambrian times, and probably much earlier. Before the end of the Silurian period its main branches had spread themselves out, and, developing fresh shoots since then, they have extended to the present day. Of the offshoots none of higher value than families are known to have become extinct, and of these decayed branches there are very few. The existence in modern seas of the *Asconidæ*, which must surely have branched off very near the base of the stem, is another curious instance of the persistence of simple types, which would thus appear not to be so vastly worse off in the struggle for existence than their more highly organized descendants.

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Commerce.

When the living matter is removed from a Ceratose sponge a network of elastic horny fibres, the skeleton of the animal, remains behind. This is the sponge of commerce. Of such sponges the softest, finest in texture, and most valued is the Turkey or Levant sponge, *Euspongia officinalis*, Lin. The other two varieties are the *Hippospongia equina*, O. Schmidt, and the Zimocca sponge, *Euspongia zimocca*, O. S., which is not so soft as the others (see p. 440 above).

Distribution.

All three species are found at from 2 to 100 fathoms along the whole Mediterranean coast, including its bays, gulfs, and islands, except the western half of its northern shores as far as Venice, and the Balearic Isles, Corsica, Sardinia, and Sicily. Bath sponges occur around the shores of the Bahamas, and less abundantly on the north coast of Cuba. They are of several kinds, one not distinguishable from the fine Levant sponge; others, the "yellow" and "hardhead" varieties, resemble the Zimocca sponge; and of horse sponges there appear to be several varieties, such as the "lamb's-wool" and the "velvet" sponge (*Hippospongia gossypina* and *H. meandriformis*). The fine bath sponge occurs on the shores of Australia (Torres Straits, the west coast, and Port Phillip on the south coast). A sponge eminently adapted for bathing purposes (*Coscinoderma lanuginosum*, Crtr.; *Euspongia mathewsii*, Lfd.) but not yet brought into the market, occurs about the South Caroline Islands, where it is actually in use, and at Port Phillip in Australia. The fine bath sponge occurs in the North Pacific, South Atlantic, and Indian Oceans, so that its distribution is world-wide.

Fishing.

The methods employed to get sponges from the bottom of the sea, where they grow attached to rocks, stones, and other objects, depend on the depths from which they are to be brought. In comparatively shallow water they may be loosened and hooked up by a harpoon; at greater depths, down to 30 or 40 fathoms, they are dived for; and at depths of from 50 to 100 fathoms they are dredged with a net. The method of harpooning was the earliest practiced, and is still carried on in probably its most primitive form by the Dalmatian fishermen. Small boats are used, manned by a single harpooner with a boy to steer; when, however, the expedition is to extend overnight the crew is doubled. The harpoon is a five-pronged fork with a long wooden handle, and if this is not long enough another harpoon is lashed on to it. The Greek fishers use a large boat furnished with two or three smaller ones from which the actual harpooning is carried on; the crew numbers seven or eight. One of the chief difficulties is to see the bottom distinctly through a troubled surface. The Dalmatian fishers throw a smooth stone dipped in oil a yard or so in front of the boat; the stone scatters drops of oil as it flies and so makes a smooth track for the "lookout." The Greeks use a zinc-plate cylinder about 1½ feet long and 1 foot wide, closed at the lower end by a plate of glass, which is immersed below the surface of the sea; on looking through this the bottom may be clearly seen even in 30 fathoms. This plan is also adopted in the Bahamas, where harpooning, carried on after the Greek system, gives employment to over 5000 men and boys.

The primitive method of diving with no other apparatus than a slab of stone to serve as a sinker and a cord to communicate with the surface, is still practiced in the Mediterranean. The diver carries a net around his neck to hold the sponges. On reaching the bottom he hastily snatches up whatever sponge he sees. After staying down as long as he is able—an interval which varies from two to at the most three minutes—he tugs violently at the cord and is rapidly drawn up. On entering the boat from depths of 25 fathoms he quickly recovers from the effects of his plunge after a few powerful respirations; but after working at depths of 30 to 40 fathoms or more, he reaches the surface in a swooning state. At the beginning of the season blood usually flows from the mouth and nose after a descent; this is regarded as a symptom of good condition; should it be wanting the diver will scarcely venture a second plunge for the rest of the season. The work is severe, and frequently the diver returns empty-handed to the boat. Diving is usually carried on in the summer months; in winter it is too cold, at all events without a diving-dress. The ordinary diver's dress with pumping apparatus is largely used by the Greeks. The diving is carried on from a ship manned by eight or nine men, including one, or rarely two, divers. At a depth of from 10 to 15 fathoms the diver can remain under for an hour, at greater depths up to 20 fathoms only a few minutes; the consequences of a longer stay are palsy of the lower extremities, stricture, and other complaints. Dredging is chiefly carried on along the west coast of Asia Minor, principally in winter after the autumn storms have torn up the seaweeds covering the bottom. The mouth of the dredge is 6 yards wide and 1 yard high; the net is made of camel's-hair cords of the thickness of a finger, with meshes 4 inches square. It is drawn along the bottom by a tow-line attached to the bowsprit of a sailing vessel, or hauled in from the shore.

Cultivation.

Prompted by a suggestion made by Oscar Schmidt, that sponges might be artificially propagated from cuttings, the Italian Government supplied funds for experiments to determine the feasibility of cultivating sponges as an industrial pursuit. A station was established on the island of Lesina, off the Dalmatian coast, and experiments were carried on there for six years (1867–72) under the superintendence of Von Buccich. The results were on the whole successful, but all expectations of creating a new source of income for the sponge-fishers of Dalmatia were defeated by the hostility of the fishers themselves.

The details of the methods of sponge-farming as practiced by Von Buccich are briefly as follows: The selected specimens, which should be obtained in as uninjured a state as possible, are placed on a board moistened with sea water, and cut with a knife or fine saw into pieces about 1 inch square, care being taken to preserve the outer skin as intact as possible. The operation is best performed in winter, as exposure to the air is then far less fatal than in summer. The sponge cuttings are then trepanned and skewered on bamboo rods; the rods, each bearing three cuttings, are secured in an upright position between two parallel boards, which are then sunk to the bottom of the sea and weighted with stones. In choosing a spot for the sponge-farm the mouths of rivers and proximity to submarine springs must be avoided; mud in this case, as in that of reef-building corals, is fatal. A favorable situation is a sheltered bay with a rocky bottom overgrown with green seaweed and freshened by gentle waves and currents. So favored, the cuttings grow to a sponge two or three times their original size in one year, and at the end of five to seven years are large enough for the market. Similar experiments, with similar results, have more recently been carried on in Florida. The chief drawback to successful sponge-farming would appear to be the long interval which the cultivator has to wait for his first crop.

Preparation for market.

After the sponge has been taken from the sea, it is exposed to the air till signs of decomposition set in, and then without delay either beaten with a thick stick or trodden by the feet in a stream of flowing water till the skin and other soft tissues are completely removed. If this process is postponed for only a few hours after the sponge has been exposed a whole day to the air, it is almost impossible to completely purify it. After cleaning it is hung up in the air to dry, and then with others finally pressed into bales. If not completely dried before packing the sponges "heat," orange yellow spots appearing on the parts attacked. The only remedy for this is to unpack the bale and remove the affected sponges. The orange-colored spots produced by this "pest," or "cholera" as the Levant fishermen term it, must not be confounded with the brownish-red color which many sponges naturally possess, especially near their base. The sponges on reaching the wholesale houses are cut to a symmetrical shape and further cleaned. The light-colored sponges often seen in chemists' shops have been bleached by chemical means which impair their durability. Sponges are sold by weight; sand is used as an "adulteration."

It is difficult to obtain recent statistics as to the extent of the sponge trade; the following table gives a summary of the sponges sold in Trieste, the great European sponge market, in the year 1871:

Description of Sponge.	For Export.		For Home Consumption.	
	Value in £.	Mean price per pound.	Value in £.	Mean price per pound.
Horse sponge...............	£60,000	6s.	£4400	6s.
Zimocca sponge...........	20,000	6s.	550	6s.
Fine Levant sponge.....	20,000	14s.	950	14s.
Fine Dalmation sponge	2,000	8s.	...	...

(W. J. S.)

SPONSOR. The presence of some suitable sponsor or sponsors to give the answers required and undertake the vows involved would seem to be almost essential to the right administration of the sacrament of baptism, in the case of infants at least. In this aspect, however, as in many others, the early history of the development of the rite of baptism remains obscure. The Greek word for the person undertaking this function is ἀνάδοχος, to which the Latin *susceptor* is equivalent. The word "sponsor" in this ecclesiastical sense occurs for the first time, but incidentally only, and as if it were already long familiar, in Tertullian's treatise *De Baptismo* (c. 18), where, arguing that in certain circumstances baptism may conveniently be postponed, especially in the case of little children, he asks: "For why is it necessary that the sponsors likewise should be thrust into danger, who both themselves by reason of mortality may fail to fulfil their promises, and may also be disappointed by the development of an evil disposition [in those for whom they become sponsors]?" There is nothing to make it unlikely that the sponsors here alluded to may have been in many cases the actual parents, and even in the 5th century it was not felt to be inappropriate that they should be so; Augustine, indeed, in one passage appears to speak of it as a matter of course that parents should bring their children and answer for them "tanquam fidejussores" (*Epist. . . . ad Bonif.*, 98). The comparatively early appearance, however, of such names as *compatres*, *commatres*, *propatres*, *promatres*, *patrini*, *matrinæ* is of itself sufficient evidence, not only that the sponsorial relationship had come to be regarded as a very close one, but also that it was not usually assumed by the natural parents. How very close it was held to be is shown by the Justinianian prohibition of marriage between godparents and godchildren. On the other hand, the anciently allowable practice of parents becoming sponsors for their own children seems to have lingered until the 9th century, when it was at last formally prohibited by the council of Mainz (813). For a long time there was no fixed rule as to the necessary or allowable number of sponsors, and sometimes the number actually assumed was large. By the council of Trent, however, it was decreed that one only, or at most two, these not being of the same sex, should be permitted. The rubric of the Church of England according to which "there shall be for every male child to be baptized two godfathers and one godmother, and for every female one godfather and two godmothers," is not older than 1561; in the *Catechism* the child is taught to say that he received his name from his "godfathers and godmothers." At the Reformation the Lutheran churches retained godfathers and godmothers, but the Reformed churches reverted to what they believed to be the more primitive rule, that in ordinary circumstances this function should be undertaken by a child's proper parents. All churches, it may be added, of course demand of sponsors that they be in full communion. In the Church of Rome priests, monks, and nuns are disqualified from being sponsors, either "because it might involve their entanglement in worldly affairs," or more probably because every relationship of fatherhood or motherhood is felt to be in their case inappropriate.

SPONTINI, GASPARO LUIGI PACIFICO (1774–1851), dramatic composer, was born at Majolati (Ancona) in Italy, 14th November, 1774, and educated at the Conservatorio de' Turchini at Naples under Sala, Tritto, and Salieri. After producing some successful operas at Rome, Florence, Naples, and Palermo, he settled in 1803 at Paris. His reception in the French capital was anything but flattering. His first comic opera, *Julie*, proved a failure; his second, *La Petite Maison*, was hissed. Undaunted by these misfortunes, he abandoned the light and somewhat frivolous style of his earlier works, and in *Milton*, a one-act opera produced in 1804, achieved a real success. Spontini henceforth aimed at a very high ideal, and during the remainder of his life strove so earnestly to reach it that he frequently remodelled his passages five or six times before permitting them to be performed in public, and wearied his singers by introducing new improvements at every rehearsal. His first masterpiece was *La Vestale*, completed in 1805, but kept from the stage through the opposition of a jealous clique until 15th December, 1807, when it was produced at the Académie, and at once took rank with the finest works of its class. The composer's second opera, *Ferdinand Cortez*, was received with equal enthusiasm in 1809; but his third, *Olympia*, was much less warmly welcomed in 1819.

Spontini had been appointed in 1810 director of the Italian opera; but his quarrelsome and grasping disposition led to his summary dismissal in 1812, and, though reinstated in 1814, he voluntarily resigned his post soon afterwards. He was in fact very ill fitted to act as director; yet on 28th May, 1820, five months after the failure of *Olympia*, he settled in Berlin by invitation of Frederick William III., commissioned to superintend all music performed at the Prussian court and compose two new grand operas, or three smaller ones, every three years. But he began by at once embroiling himself with the intendant, Count Brühl. Spontini's life at Berlin may be best described as a ceaseless struggle for precedence, under circumstances which rendered its attainment impossible in the sense in which he desired it. Yet he did good work, and did it well. *Die Vestalin*, *Ferdinand Cortez*, and *Olympia*—the last two entirely remodelled—were produced with great success in 1821. A new opera, *Nourmahal*, founded on Moore's *Lalla Rookh*, was performed in 1822, and another entitled *Alcidor*, in 1825; and in 1826 Spontini began the composition of *Agnes von Hohenstaufen*, a work planned on a grander scale than any of his former efforts. The first act was performed in 1827, and the complete work in three acts graced the marriage of Prince William in 1829. Though the German critics abused it bitterly, *Agnes von Hohenstaufen* is undoubtedly Spontini's greatest work. In breadth of conception and grandeur of style it exceeds both *Die Vestalin* and *Ferdinand Cortez*, and its details are worked out with untiring conscientiousness; yet Spontini was utterly dissatisfied with it, and at once set to work upon an entire revision, which on its representation in 1837 was in many parts scarcely recognizable by those who had heard the opera in its original form.

This was his last great work. He several times began to rewrite his early opera, *Milton*, and contemplated the treatment of many new subjects, such as *Sappho*, *La Colère d'Achille*, and other classical myths, but with no definite result. He had never been popular in Berlin; and he has been accused of endeavoring to prevent the performance of *Euryanthe*, *Oberon*, *Die Hochzeit des Camacho*, *Jessonda*, *Robert the Devil*, and other works of genius, through sheer envy of the laurels won by their composers. But the critics and reviewers of the period were so closely leagued together against him that it is difficult to know what to believe. After the death of Frederick William III. in 1840, Spontini's conduct became so violent and imperious that in 1842 Frederick William IV. dismissed him, with power to retain his titles and live wherever he pleased in the enjoyment of his full salary. He elected to settle once more in Paris, after a short visit to Italy; but beyond conducting occasional performances of some of his own works he made but few attempts to keep his name before the public. In 1847 he revisited Berlin and was invited by the king to conduct some performances during the winter. In 1848 he became deaf. In 1850 he retired to his birthplace, Majolati, and died there on 14th January, 1851, bequeathing all he possessed to the poor of his native town.

SPOONBILL. The bird now so called was formerly known in England as the Shovelard or Shovelar, while that which used to bear the name of Spoonbill, often amplified into Spoon-billed Duck, is the SHOVELER (see vol. xxi. p. 882) of modern days—the exchange of names having been effected, as already stated (*loc. cit.*), about 200 years ago, when the subject of the present notice—the *Platalea leucorodia* of Linnæus as well as of recent writers—was doubtless far better known than now, since it evidently was, from ancient documents, the constant concomitant of Herons, and with them the law attempted to protect it.[1] Mr. Harting (*Zoologist*, 1886, pp. 81 *et seq.*) has cited a case from the "Year-Book" of 14 Hen. VIII. (1523), wherein the then bishop of London (Cuthbert Tunstall) maintained an action of trespass against the tenant of a close at Fulham for taking Herons and "Shovelars" that made their nests on the trees therein growing, and has also printed (*Zoologist*, 1877, pp. 425 *et seq.*) an old document showing that "Shovelars" bred in certain woods in west Sussex in 1570. Nearly one hundred years later (*circa* 1662) Sir Thomas Browne, in his *Account of Birds found in Norfolk* (*Works*, ed. Wilkin, iv. pp. 315, 316), stated of the "*Platea* or *Shovelard*" that it formerly "built in the Hernerie at Claxton and Reedham, now at Trimley in Suffolk." This last is the latest known proof of the breeding of the species in England; but more recent evidence to that effect may be hoped for from other sources. That the Spoonbill was in the fullest sense of the word a "native" of England is thus incontestably shown; but for many years past it has only been a more or less regular visitant, though not seldom in considerable numbers, which would doubtless, if allowed, once more make their home there; but its conspicuous appearance renders it an easy mark for the greedy gunner and the contemptible collector. What may have been the case formerly is not known, except that, according to Belon, it nested in his time (1555) in the borders of Brittany and Poitou; but as regards northwestern Europe it seems of late years to have bred only in Holland, and there it has been deprived by drainage of its favorite resorts, one after the other, so that it must shortly become merely a stranger, except in Spain or the basin of the Danube and other parts of southeastern Europe.

The Spoonbill ranges over the greater part of middle and southern Asia,[2] and breeds abundantly in India, as well as on some of the islands in the Red Sea, and seems to be resident throughout Northern Africa. In Southern Africa its place is taken by an allied species with red legs, *P. cristata* or *tenuirostris*, which also goes to Madagascar. Australia has two other species, *P. regia* or *melanorhynchus*, with black bill and feet, and *P. flavipes*, in which those parts are yellow. The very beautiful and wholly different *P. ajaja* is the Roseate Spoonbill of America, and is the only one found on that continent, the tropical or juxta-tropical parts of which it inhabits. The rich pink, deepening in some parts into crimson, of nearly all its plumage, together with the yellowish green of its bare head and its lake-colored legs, sufficiently marks this bird; but all the other species are almost wholly clothed in pure white, though the English has, when adult, a fine buff pectoral band, and the spoon-shaped expanse of its bill is yellow, contrasting with the black of the compressed and basal portion. Its legs are also black. In the breeding season, a pendent tuft of white plumes further ornaments the head of both sexes, but is longest in the male. The young of the year have the primary quills dark-colored.

The Spoonbills form a natural group, *Plataleidæ*, allied, as before stated (IBIS, vol. xii. p. 642), to the *Ibididæ*, and somewhat more distinctly to the Storks (see STORK),—all belonging to the *Pelargomorphæ* of Prof. Huxley. They breed in societies, not only of their own kind, but in company with Herons, either on trees or in reed-beds, making large nests in which are commonly laid four eggs,—white, speckled, streaked, or blotched, but never very closely, with light red. Such breeding-stations have been several times described, and among the more recent accounts of one of them are those of Messrs. Sclater and W. A. Forbes (*Ibis*, 1877, p. 412), and Mr. Seebohm (*Zoologist*, 1880, p. 457), while a view of another has been attempted by Schlegel (*Vog. Nederland*, taf. xvii.). The latest systematic revision of the group is by Dr. Reichenow (*Journ. für Ornithologie*, 1877, pp. 156–159), but his views have not been wholly accepted in the present article. (A. N.)

SPORADES, the islands "scattered" (as the name, from σπείρειν, "to sow," imports) about the Greek Archipelago, are distinguished on the one hand from the Cyclades, which are grouped around Delos, and on the other from the islands attached, as it were, to the mainland of Europe and Asia. The distinction is not in either case a very definite one, and hence both ancient and modern writers differ as to the list of the Sporades. Details of classification are given by Bursian (*Griechenland*, ii. 348 *sq.*). The Doric Sporades

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[1] Nothing shows better the futility of the old statutes for the protection of birds than the fact that in 1584 the taking of the eggs of Herons, Spoonbills (Shovelars), Cranes, Bitterns, and Bustards was visited by a heavy penalty, while there was none for destroying the parent birds in the breeding-season. All of the species just named, except the Heron, have passed away, while there is strong reason to think that some at least might have survived had the principle of the Levitical law (Deut. xxii. 6) been followed.

[2] Ornithologists have been in doubt as to the recognition of two species from Japan described by Temminck and Schlegel under the names of *P. major* and *P. minor*. Lately it has been suggested that the former is only the young of *P. leucorodia*, and the latter the young of the Australian *P. regia*.

—Melus (MELOS),[1] Pholegandrus, Sicinus, THERA, Anaphe, Astypalæa, and Cos—were by some considered a southern cluster of the Cyclades. In modern times the name Sporades is more especially applied to two groups—the Northern Sporades, which lie northeast of Negropont (Eubœa), along with which they constitute a nomarchy of the kingdom of Greece; and the Southern Sporades, lying off the southwest of Asia Minor, and included in the Turkish vilayet of the "Islands of the White Sea." The Northern, which have altogether an area of 180 square miles and a population of 13,394 (1879), comprise Skiatho, Khiliodromi or Ikos, Skopelo, Pelagonisi, Giura, Pipari, and Skiro (SCYROS), with their adjacencies. The Southern are as follows: Icaria, PATMOS, Leros, Calymno, Astypalæa (Stampalia) Cos (Stanko), Nisyros, Tilos or Episcopi, Sime, Khalki, RHODES, CRETE, and a multitude of lesser isles.

SPORTS, THE BOOK OF, or more properly the DECLARATION OF SPORTS, was issued by James I. in 1617 on the recommendation of Thomas Morton, bishop of Chester, for use in Lancashire, where the king on his return from Scotland found a conflict on the subject of Sunday amusements between the Puritans and the gentry, many of whom were Roman Catholics. Permission was given for dancing, archery, leaping, vaulting, and other harmless recreations, and of "having of May games, Whitsun ales, and morris dances. and the setting up of May-poles and other sports therewith used, so as the same may be had in due and convenient time without impediment or neglect of divine service, and that women shall have leave to carry rushes to church for the decorating of it." On the other hand, "bear and bull baiting, interludes, and (at all times in the meane sort of people by law prohibited) bowling" were not to be permitted on Sunday (Wilkins, *Concilia*, iv. 483). In 1618 James transmitted orders to the clergy of the whole of England to read the declaration from the pulpit; but so strong was the opposition that he prudently withdrew his command (Wilson, in Kennet, ii. 709; Fuller, *Church History*, v. 452). In 1633 Charles I. not only directed the republication of his father's declaration (Rushworth, ii. 193) but insisted upon the reading of it by the clergy. Many of the clergy were punished for refusing to obey the injunction. With the fall of Laud all attempt to enforce it necessarily came to an end.

SPOTSWOOD, or SPOTISWOOD, JOHN (1565–1639), archbishop of St. Andrews, was the son of John Spotswood, minister of Calder and "superintendent" of Lothian, and was born in 1565. He was educated at Glasgow, and succeeded his father in the parish of Calder when but eighteen years of age. In 1601 he attended Ludowick, duke of Lennox, as his chaplain, in an embassy to the court of France, and returned in the duke's retinue through England. In 1603 he was nominated by the king to the see of Glasgow, but his consecration (in London) did not take place until October, 1610. In 1615 he was translated as successor of Gladstanes to St. Andrews, and thus became primate and metropolitan of Scotland. In this capacity he presided in several assemblies of the Church of Scotland. At that of Perth, in 1618, over which he presided, he used his influence to obtain a reluctant assent to the Five Articles. He continued in high esteem with James VI. and Charles I., who was crowned by him in 1633 at Holyrood. In 1635 Spotswood was advanced to the chancellorship, but the increasing strength of the Covenanters compelled his resignation in 1638. He was deposed and excommunicated by the Glasgow assembly in that year; charges affecting his moral character were brought against him, but no attempt was made to substantiate these. He died in London on 26th December, 1639, and was buried in Westminster Abbey.

In 1620 he published *Refutatio Libelli de Regimine Ecclesiæ Scoticanæ*—an answer to a tract of Calderwood, who replied in the *Vindiciæ* subjoined to his *Altare Damascenum*. The only other writing of Spotswood published during his lifetime was the sermon he preached at the Perth assembly. His most considerable work appeared posthumously—*The History of the Church and State of Scotland, beginning the year of our Lord* 203 *and continued to the end of the reign of James VI. of ever blessed memory*, London, 1655, fol. It displays considerable research and sagacity, and even when dealing with contemporary events gives a favorable impression, upon the whole, of the author's candor and truth. An appendix was afterwards added by Thomas Middleton.

Spotswood left two sons,—Sir John Spotswoode of Dairsie in Fife, where the archbishop erected a church and bridge, which are still extant, and Sir Robert a lawyer of great learning, who became president of the Court of Session, and was executed in 1646 for taking part in the expedition of Montrose.

SPOTTISWOODE, WILLIAM (1825–1883), mathematician and physicist, was born in London 11th January, 1825. His father, Andrew Spottiswoode, who was descended from an ancient Scottish family, represented Colchester in parliament for some years, and in 1831 became junior partner in the firm of Eyre & Spottiswoode, printers. William was educated at Laleham, Eton, Harrow, and Balliol College, Oxford. His bent for science showed itself while he was still a schoolboy, and indeed his removal from Eton to Harrow is said to have been occasioned by an accidental explosion which occurred whilst he was performing an experiment for his own amusement. At Harrow he obtained in 1842 a Lyon scholarship, and at Oxford in 1845 a first-class in mathematics, in 1846 the junior and in 1847 the senior university mathematical scholarship. In 1846 Spottiswoode left Oxford to take his father's place in the business, in which he was engaged until his death. In 1847 he issued five pamphlets entitled *Meditationes Analyticæ*. This was his first publication of original mathematical work; and from this time scarcely a year passed in which he did not give to the world further mathematical researches. In 1856 Spottiswoode travelled in eastern Russia, and in 1860 in Croatia and Hungary; of the former expedition he has left an interesting record entitled *A Tarantasse Journey through Eastern Russia in the Autumn of* 1856 (London, 1857). In 1870 he was elected president of the London Mathematical Society. In 1871 he began to turn his attention to experimental physics, his earlier researches bearing upon the polarization of light and his later work upon the electrical discharge in rarefied gases. He wrote a popular treatise upon the former subject for the "Nature" series (1874). In 1878 he was elected president of the British Association, and in the same year president of the Royal Society, of which he had been a fellow since 1853. He died of fever on 27th June, 1883, and was buried in Westminster Abbey.

As a mathematician he occupied himself with many branches of his favorite science, more especially with higher algebra, including the theory of determinants, with the general calculus of symbols, and with the application of analysis to geometry and mechanics. The following brief review of his mathematical work is quoted from the obituary notice which appeared in the *Proceedings of the Royal Society*, (vol. xxxviii. p. 34): "The interesting series of communications on the contact of curves and surfaces which are contained in the *Philosophical Transactions* of 1862 and subsequent years would alone account for the high rank he obtained as a mathematician. . . . The mastery which he had obtained over the mathematical symbols was so complete that he never shrank from the use of expressions, however complicated—nay, the more complicated they were the more he seemed to revel in them—provided they did not sin against the ruling spirit of all his work—symmetry. To a mind imbued with the love of mathematical symmetry the study of determinants had naturally every attraction. In 1851 Mr. Spottiswoode published in the form of a pamphlet an account of some elementary theorems on the subject. This having fallen out of print, permission was sought by the editor of *Crelle* to reproduce it in the pages of that journal. Mr. Spottiswoode granted the request and undertook to revise his work. The subject had, however, been so extensively developed in the interim that it proved necessary not merely to revise it but entirely to rewrite the work, which became a memoir of 116 pages. To this, the first elementary treatise on determinants, much of the rapid development of the subject is due. The effect of the study on Mr. Spottiswoode's own methods was most pronounced; there is scarcely a page of his mathematical writings that does not bristle with determinants." The Royal Society's *Catalogue of Scientific Papers* (vols. i.–viii.) shows a list of 49 papers by Spottiswoode, to which must be added about 66 more, the titles of which have not yet been printed in that catalogue. These were published principally in the *Philosophical Transactions*, *Proceedings of the Royal Society*, *Quarterly Journal of Mathematics*, *Proceedings of the London Mathematical Society*, and *Crelle*, and one or two in the *Comptes Rendus* of the Paris Academy. Another list of his papers, arranged according to the several journals in which they originally appeared, with short notes upon the less familiar memoirs, is given in *Nature*, vol. xxvii. p 599.

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[1] The names of those Sporades which are treated under separate headings are printed in small capitals.

SPRAIN. See SURGERY, *infra.*

SPRAT, a marine fish (*Clupea sprattus*), named "garvie" in Scotland, one of the smallest species of the genus *Clupea* or herrings, rarely exceeds 5 inches in length, and occurs in large shoals on the Atlantic coasts of Europe. It is found also in the southern hemisphere, on the coasts of Tasmania and New Zealand, where, however, it seems to be less abundant, since its presence at the antipodes has been discovered only recently, and it does not seem to be the object of a regular fishery. Sprats are very often confounded with young herrings, which they much resemble, but can always be distinguished by the following characters: they do not possess any teeth on the palate (*vomer*), like herrings; their gill-covers are smooth, without the radiating striæ which are found in the shad and the pilchard; the anal fin consists of from seventeen to twenty rays, and the lateral line of forty-seven or forty-eight scales. The ventral fins are even with the origin of the dorsal fin; and the spine consists of from forty-seven to forty-nine vertebræ. The sprat is one of the more important food-fishes on account of the immense numbers which are caught when the shoals approach the coasts. They are somewhat capricious, however, as regards the place and time of their appearance, the latter falling chiefly in the first half of winter. They are caught with the seine or with the bag-net in the tide-way. Large quantities are consumed fresh, but many are pickled or smoked, and others prepared like anchovies. Frequently the captures are so large that the fish can be used as manure only.

SPREMBERG, a small town of Prussia, in the province of Brandenburg, is situated about 75 miles to the southeast of Berlin, partly on an island in the river Spree and partly on the west bank. It carries on considerable manufactures of woollen cloth, and has greatly advanced in importance and population since the beginning of the 19th century. In 1885 its population numbered 11,011. The only building of note is the château, built by a son of Elector John George about the end of the 16th century.

SPRENGEL, KURT (1766–1833), German botanist and physician, was born on 3d August, 1766, at Boldekow in Pomerania. His father, a clergyman, provided him with a thorough education of wide scope; and the boy at an early age distinguished himself as a linguist, not only in Latin and Greek, but also in Arabic. He appeared as an author at the age of fourteen, publishing a small work called *Anleitung zur Botanik für Frauenzimmer* in 1780. In 1784 he commenced in the university of Halle to study theology and medicine, but soon relinquished the former. He graduated in medicine in 1787. In 1789 he was appointed an extraordinary professor of medicine in his *alma mater*, and in 1795 was promoted to an ordinary professorship. He devoted much of his time to medical work and to investigations into the history of medicine; and he published several very valuable works in this department of knowledge, and made himself well known as one of the ablest medical men in Germany. He held a foremost rank in medicine and in botany as an original investigator, and in both published works of great value, besides numerous articles in scientific journals and in the proceedings of learned societies. His accomplishments as a linguist probably, in part at least, determined him in the choice of the department to which he most fully devoted himself, and in which he stood *facile princeps*. Among the more important of his many services to the science of botany was the part he took in awakening and stimulating microscopic investigation into the anatomy of the tissues of the higher plants, though defective microscopic appliances rendered the conclusions arrived at by himself unreliable. He also made many improvements in the details of both the Linnæan and the "natural" systems of classification. His life passed quietly at Halle in the pursuit of the studies dear to him, and in the enjoyment of the honors bestowed upon him by over seventy learned societies, and also by monarchs. In 1828 the death of a son, professor of surgery at Greifswald, was felt by him very severely. He experienced several apoplectic seizures, and died in one on 15th March, 1833.

Subjoined is a list of the more important of his works: *Beiträge zur Geschichte d. Pulses*, 1787; *Galens Fieberlehre*, 1788; *Apologie des Hippokrates*, 1789; *Versuch einer pragmatischen Geschichte der Arzneikunde*, 1792–99; *Handbuch der Pathologie*, 1795–97; *Institutiones Medicæ*, 1809–16 (in 6 vols.); *Geschichte der Medicin*, completed in 1820; *Antiquitatum botanicarum specimen*, 1798; *Historia rei herbariæ*, 1807–8; *Anleitung zur Kenntniss der Gewächse*, 1802–4, and again 1817–18; *Geschichte der Botanik*, 1817–18; *Von dem Bau und der Natur der Gewächse*, 1812; *Flora Halensis*, 1806–15 and in 1832; *Species umbelliferarum minus cognitæ*, 1818; *Neue Entdeckung im ganzen Umfang der Pflanzenkunde*, 1820–22. He edited an edition of Linnæus's *Systema vegetabilium* in 1824 and of the *Genera plantarum* in 1830. His short papers are too numerous to be quoted; a list of those in botany, from 1798 onwards, will be found in the Royal Society's *Catalogue of Scientific Papers*.

SPRINGBOK. See ANTELOPE, vol. ii. p. 90.

SPRINGFIELD, a city of the United States, capital of Illinois and the county seat of Sangamon county, 185 miles southwest of Chicago and 95 northeast of St. Louis, at the intersection of the main lines of the Chicago and Alton and the Wabash, St. Louis, and Pacific Railways. It is situated in 39° 48′ N. lat. and 89° 33′ W. long., on a plateau 4 miles south of the Sangamon river. The State capitol (1868–1886) is constructed of Joliet marble in the form of a Greek cross, with porticos of granite; it is 385 feet long and 296 wide, and has a central dome surmounted by a lantern with a ball on the pinnacle (360 feet). It contains a general library, a law library, geological and agricultural museums, and a memorial hall of the Civil War, as well as the usual Government offices. Other buildings of note are the United States executive mansion, custom-house and post-office (1866–68), and the house formerly occupied by Lincoln. In Oak Ridge cemetery, adjacent to the city, is the Lincoln monument (1874), beneath which that president was buried. The monument designed by Larkin G. Mead, consists of a granite obelisk, reaching a height of 98⅓ feet from the centre of a spacious basement (119½ feet long and 72½ wide), which contains a catacomb and a memorial hall,—the latter a museum of Lincolniana. A bronze statute of Lincoln and four groups of figures in bronze, symbolizing the army and navy of the United States, are arranged round the foot of the obelisk. The town has a public library, two hospitals, two orphanages, and various other charitable institutions. Extensive deposits of bituminous coal occur in and near Springfield, which is the seat of extensive iron-rolling mills, watch factories, railway machine shops, plough works, and woollen, paper, and flour mills. It is also the headquarters of six of the principal live-stock associations of the country. The population was 4533 in 1850, 9320 in 1860, 17,364 in 1870, 19,743 (1328 colored) in 1880, and in 1887 it was estimated at 25,000.

Laid out in 1822, Springfield was selected as State capital in 1837, and was made a city in 1840.

SPRINGFIELD, a city of the United States, the county seat of Hampden county, Massachusetts, on the east bank of Connecticut river, opposite West Springfield, with which it is connected by road and railway bridges. By rail it is 98 miles west by south of Boston on the route to Albany, and it forms a very important railway junction. The western part of Springfield is built on low and level ground, the eastern on the ascent from the river valley. The streets are wide and well shaded with elm and maple. A United States arsenal (founded 1777) and armory (1794), employing some 460 hands, is the largest in the republic. The Springfield breech-loading rifle of 45 calibre has been the regulation pattern in the United States army since 1873. A pistol-factory, car-works, manufactories of cotton and silk goods, buttons, needles, envelopes, paper, watches, skates, and brass-work may be mentioned among the industrial establishments. The city hall (1855), a Romanesque building with an audience-room capable of holding 2700 persons; the city free library (1871), a Gothic building of brick, which contains 56,000 volumes and a museum; the granite court-house; the Roman Catholic cathedral of St. Michael; Christ Church, Episcopal; the Church of the Unity, a fine Gothic structure in brown stone; the South Congregational church; the office of the Boston and Albany Railroad, a massive granite block; and the high school are among the chief architectural features of the city. Races are held in Hampden Park by the river side. The population was 15,199 in 1860, 26,703 in 1870, 33,340 in 1880 (775 colored), and 37,577 in 1885.

Springfield was settled in 1636 by William Pynchon and emigrants from Roxbury,—the determination of the founder being to limit the "town" to forty or at most fifty families. The name was at first Agawam; but the present designation was adopted in 1641 in memory of Springfield (Essex), Pynchon's residence in his native country, England, to which he was obliged to return in 1652 to escape the clerical persecution called forth by his book on the *Meritorious Price of Our Redemption*. The town was burned by the Indians in 1675; and in 1787 the arsenal was attacked by Shays's rebels. The opening of the Boston and Albany Railroad in 1839 was the beginning of rapid development, and the town was made a city in 1852. The manufacture of firearms carried on here during the Civil War, 1861-65, gave the city a great impulse.

SPRINGFIELD, a city of the United States, county seat of Greene county, Missouri, occupies a pleasant and healthy site on the Ozark Hills, 238 miles by rail southwest of St. Louis by the St. Louis and San Francisco Railroad, which here joins with the Kansas City, Fort Scott, and Gulf Railroad. Springfield is the chief commercial centre of southwest Missouri, one of the great lead and zinc mining districts of the States. It contains a number of factories (cotton, wool, wagons, furniture, tobacco, etc.), and is the seat of a court-house and of Drury College (1873), which provides scientific and classical training and has a musical conservatory attached. The population was 5555 in 1870, 6522 in 1880, and in 1886 was estimated at 18,000.

Originally an Indian trading post and frontier village, Springfield was incorporated in 1830 and began to be a prosperous place at the close of the Civil War, during which it had several times changed hands and been the scene of hostilities.

SPRINGFIELD, a city of the United States, county seat of Clark county, Ohio, lies at the confluence of Mad river and Lagonda creek (sub-tributaries of the Ohio through the Miami), 84 miles northeast of Cincinnati. It has a large trade in the agricultural produce of the fertile and populous district in which it is pleasantly situated, and is the seat of a very large manufactory of agricultural machinery, which turns out 75,000 reapers and mowers per annum, besides grain-drills, steam-engines, cider-mills, and a great variety of articles. In 1870 the population of the city was 12,652, in 1880 20,730 (township, 24,455), and 33,484 in 1886. Among the public institutions are Wittenberg College (Lutheran), founded in 1845, and a small public library.

SPRINGS. See GEOLOGY, vol. x. pp. 199, 269 *sq.*, and MINERAL WATERS, vol. xvi. p. 450.

SPRUCE. See FIR, vol. ix. p. 193.

SPURZHEIM, KASPAR, phrenologist, was born at Longwich near Treves on 31st December, 1776, and died at Boston, United States, on 10th November, 1832. See PHRENOLOGY, vol. xvi. p. 858.

SQUARING (or QUADRATURE) OF THE CIRCLE is the problem of finding a square equal in area to a given circle. Like all problems, it may be increased in difficulty by the imposition of restrictions; consequently under the designation there may be embraced quite a variety of geometrical problems. It has to be noted, however, that, when the "squaring" of the circle is especially spoken of, it is almost always tacitly assumed that the restrictions are those of the Euclidean geometry.

Since the area of a circle equals that of the rectilineal triangle whose base has the same length as the circumference and whose altitude equals the radius (Archimedes, Κύκλου μέτρησις, prop. 1), it follows that, if a straight line could be drawn equal in length to the circumference, the required square could be found by an ordinary Euclidean construction; also, it is evident that, conversely, if a square equal in area to the circle could be obtained, it would be possible to draw a straight line equal to the circumference. Rectification and quadrature of the circle have thus been, since the time of Archimedes at least, practically identical problems. Again, since the circumferences of circles are proportional to their diameters—a proposition assumed to be true from the dawn almost of practical geometry—the rectification of the circle is seen to be transformable into finding the ratio of the circumference to the diameter. This correlative numerical problem and the two purely geometrical problems are inseparably connected historically.

Probably the earliest value for the ratio was 3. It was so among the Jews (1 Kings, vii. 23), the Babylonians (Oppert, *Journ. Asiatique*, August, 1872, October, 1874), the Chinese (Biot, *Journ. Asiatique*, June, 1841), and probably also the Greeks. Among the ancient Egyptians, as would appear from a calculation in the Rhind papyrus, the number $(\frac{4}{3})^4$, *i.e.*, 3.16 . . . , was at one time in use.[1] The first attempts to solve the purely geometrical problem appear to have been made by the Greeks (Anaxagoras, etc.),[2] one of whom, Hippocrates,[3] doubtless raised hopes of a solution by his quadrature of the so-called *meniscoi*. As for Euclid, it is sufficient to recall the facts that the original author of prop. 8 of book iv. had strict proof of the ratio being <4, and the author of prop. 15 of the ratio being >3, and to direct attention to the importance of book x. on incommensurables and props. 2 and 16 of book xii., viz, that "circles are to one another as the squares on their diameters" and that "in the greater of two concentric circles a regular $2n$-gon can be inscribed which shall not meet the circumference of the less," however nearly equal the circles may be. With Archimedes (287-212 B.C.) a notable advance was made. Taking the circumference as intermediate between the perimeters of the inscribed and the circumscribed regular n-gons, he showed that, the radius of the circle being given and the perimeter of some particular circumscribed regular polygon obtainable, the perimeter of the circumscribed regular polygon of double the number of sides could be calculated; that the like was true of the inscribed polygons; and that consequently a means was thus afforded of approximating to the circumference of the circle. As a matter of fact, he started with a semi-side AB of a circumscribed regular hexagon meeting the circle in B (see Fig. 1), joined A and B with O the centre, bisected the <AOB by OD, so that BD became the semi-side of a circumscribed regular 12-gon; then as AB : BO : OA : : 1 : $\sqrt{3}$: 2 he sought an approximation to $\sqrt{3}$ and found that AB : BO > 153 : 265. Next he applied his theorem[1] BO + OA : AB : : OB : BD to calculate BD; from this in turn he calculated the semi-sides of the circumscribed regular 24-gon, 48-gon, and 96-gon, and so finally established for the circumscribed regular 96-gon that perimeter : diameter < $3\frac{1}{7}$: 1. In a quite analogous manner he proved for the inscribed regular 96-gon that perimeter : diameter > $3\frac{10}{71}$: 1. The conclusion from these therefore was that the ratio of circumference to diameter is < $3\frac{1}{7}$ and > $3\frac{10}{71}$. This is a most notable piece of work; the immature condition of arithmetic at the time was the only real obstacle preventing the evaluation of the ratio to any degree of accuracy whatever.[2]

---

[1] Eisenlohr, *Ein math. Handbuch d. alten Aegypter, übers. u. erklärt*, Leipsic, 1877; Rodet, *Bull. de la Soc. Math. de France*, vi. pp. 139-149.

[2] Hankel, *Zur Gesch. d. Math. im Alterthum*, etc., chap. v., Leipsic, 1874; Cantor, *Vorlesungen über Gesch. d. Math.*, i., Leipsic, 1880 Tannery, *Mém. de la Soc.*, etc., *à Bordeaux*; Allman, in *Hermathena*.

[3] Tannery, *Bull. des Sc. Math.*, [2], x. pp. 213-226.

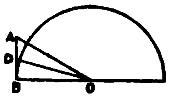

FIG. 1.

No advance of any importance was made upon the achievement of Archimedes until after the revival of learning. His immediate successors may have used his method to attain a greater degree of accuracy, but there is very little evidence pointing in this direction. Ptolemy (fl. 127–151), in the *Great Syntaxis*, gives 3.141552 as the ratio;[3] and the Hindus (*c.* 500 A.D.), who were very probably indebted to the Greeks, used 62832/20000, that is, the now familiar 3.1416.[4] It was not until the 15th century that attention in Europe began to be once more directed to the subject, and after the resuscitation a considerable length of time elapsed before any progress was made. The first advance in accuracy was due to a certain Adrian, son of Anthony, a native of Metz (1527), and father of the better-known Adrian Metius of Alkmaar. In refutation of Duchesne (Van der Eycke) he showed that the ratio was < $3\frac{17}{120}$ and > $3\frac{15}{106}$, and thence made the exceedingly lucky step of taking a mean between the two by the quite unjustifiable process of halving the sum of the two numerators for a new numerator and halving the sum of the two denominators for a new denominator, thus arriving at the now well-known approximation $3\frac{16}{113}$ or $\frac{355}{113}$, which, being equal to 3.1415929 . . ., is correct to the sixth fractional place.[5] The next to advance the calculation was Viète (De Viette, Vieta), the greatest mathematician of his age. By finding the perimeter of the inscribed and that of the circumscribed regular polygon of 393216 (*i.e.*, 6×2^{16}) sides, he proved that the ratio was > 3.1415926535 and < 3.1415926537, so that its value became known (in 1579) correctly to 10 fractional places. The theorem for angle-bisection which Viète used was not that of Archimedes, but that which would now appear in the form $1 - \cos\theta = 2\sin^2\frac{1}{2}\theta$. With Viète, by reason of the advance in arithmetic, the style of treatment becomes more strictly trigonometrical; indeed, the *Universales Inspectiones*, in which the calculation occurs, would now be called plane and spherical trigonometry, and the accompanying *Canon Mathematicus*, a table of sines, tangents, and secants.[6] Further, in comparing the labors of Archimedes and Viète, the effect of increased power of symbolical expression is very noticeable. Archimedes's process of unending cycles of arithmetical operations could at best have been expressed in his time by a "rule" in words; in the 16th century it could be condensed into a "formula." Accordingly we find in Viète a formula for the ratio of diameter to circumference, viz., the interminate product[7]—

$$\tfrac{1}{2}\sqrt{\tfrac{1}{2}}\cdot\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}}}\cdot\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}+\tfrac{1}{2}\sqrt{\tfrac{1}{2}}}}\cdots\cdot$$

From this point onwards, therefore, no knowledge whatever of geometry was necessary in any one who aspired to determine the ratio to any required degree of accuracy: the mere arithmetician's art and length of days were the only requisites. Thus in connection with the subject a genus of workers became possible who may be styled "π-computers,"—a name which, if it connotes anything uncomplimentary, does so because of the almost entirely fruitless character of their labors. Passing over Adriaan van Roomen (Adrianus Romanus) of Louvain, who published the value of the ratio correct to 15 places in his *Idea Mathematica* (1593),[8] we come to the notable computer Ludolph van Ceulen (d. 1610), a native of Germany, long resident in Holland. His book, *Van den Circkel* (Delf, 1596), gave the ratio correct to 20 places, but he continued his calculations as long as he lived, and his best result was published on his tombstone in St. Peter's church, Leyden. The inscription, which is not known to be now in existence,[9] is in part as follows:

> . . . Qui in vita sua multo labore circumferentiae circuli proximam rationem ad diametrum invenit sequentem—
>
> quando diameter est 1
> tum circuli circumferentia plus est
> quam $\frac{314159265358979323846264338327950288}{100000000000000000000000000000000000}$
> et minus
> quam $\frac{314159265358979323846264338327950289}{100000000000000000000000000000000000}$ . .

This gives the ratio correct to 35 places. Van Ceulen's process was essentially identical with that of Viète. Its numerous root extractions amply justify a stronger expression than "multo labore," especially in an epitaph. In Germany the "Ludolphische Zahl" is still a common name for the ratio.[10]

Up to this point the credit of most that had been done may be set down to Archimedes. A new departure, however, was made by Willebrord Snell of Leyden in his *Cyclometria* published in 1621. His achievement was a closely approximate geometrical solution of the problem of rectification (see Fig. 2).

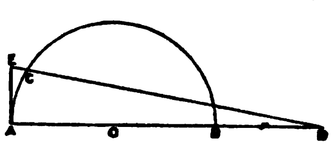

FIG. 2.

ACB being a semicircle whose centre is O, and AC the arc to be rectified, he produced AB to D, making BD equal to the radius, joined DC, and produced it to meet the tangent at A in E; and then his assertion (not established by him) was that AE was nearly equal to the arc AC, the error being in defect. For the purposes of the calculator a solution erring in excess was also required, and this Snell gave by slightly varying the former construction. Instead of producing AB (see Fig. 3) so that BD was equal to r, he produced it only so far that when the extremity D′ was joined with C, the part of D′C outside the circle was equal to r; in other words, by a non-Euclidean construction he trisected the angle AOC, for it is readily seen that since FD′ = FO = OC, the angle FOB = $\frac{1}{3}$AOC.[1] This couplet of constructions is as important from the calculator's point of view as it is interesting geometrically. To compare it on this score with the fundamental proposition of Archimedes, the latter must be put into a form similar to Snell's. AMC being an arc of a circle (see Fig. 4) whose centre is O, AC its chord, and HK the tangent drawn at the middle point of the arc and bounded by OA, OC produced, then, according to Archimedes, AMC < HK but > AC. In modern trigonometrical notation the propositions to be compared stand as follows:

---

[1] In modern trignometrical notation, $1 + \sec\theta : \tan\theta : : 1 : \tan\frac{1}{2}\theta$.

[2] Tannery, "Sur la mesure du cercle d'Archimède," in *Mém. . . . Bordeaux*, [2], iv. pp. 313–339; Menge, *Des Archimedes Kreismessung*, Coblentz, 1874.

[3] De Morgan, in *Penny Cyclop.*, xix. p. 186.

[4] Kern, *Āryabhaṭṭiyam*, Leyden, 1874, trans. by Rodet, Paris, 1879.

[5] De Morgan, art. "Quadrature of the Circle," in *English Cyclop.*; Glaisher, *Mess. of Math.*, ii. pp. 119–128, iii. pp. 27–46; De Haan, *Nieuw Archief v. Wisk.*, i. pp. 70–86, 206–211.

[6] Vieta, *Opera Math.*, Leyden, 1646; Marie, *Hist. des Sciences Math.*, iii. p. 27 *sq.*, Paris, 1884.

[7] Klügel, *Math. Wörterb.*, ii. pp. 606, 607.

[8] Kästner, *Gesch. d. Math.*, i., Göttingen, 1796–1800.

[9] But see *Les Délices de Leide*, Leyden, 1712; or De Haan, *Mess. of Math.*, iii. pp. 24–26.

[10] For minute and lengthy details regarding the quadrature of the circle in the Low Countries, see De Haan, "Bouwstoffen voor de geschiedenis, etc.," in *Versl. en Mededeel. der K. Akad. van Wetensch.*, ix., x., xi., xii., Amsterdam; also his "Notice sur quelques quadrateurs, etc.," in *Bull. di Bibliogr. e di Storia delle Sci. Mat. e Fis.*, vii. pp. 99–144.

$$2\tan\tfrac{1}{2}\theta > \theta > 2\sin\tfrac{1}{2}\theta \quad \text{(Archimedes)};$$

$$\tan\tfrac{1}{3}\theta + 2\sin\tfrac{1}{3}\theta > \theta > \frac{3\sin\theta}{2+\cos\theta} \quad \text{(Snell)}.$$

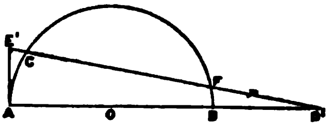

FIG. 3.

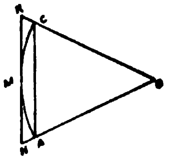

FIG. 4.

It is readily shown that the latter gives the best approximation to θ; but, while the former requires for its application a knowledge of the trigonometrical ratios of only one angle (in other words, the ratios of the sides of only one right-angled triangle), the latter requires the same for two angles, θ and $\frac{1}{3}\theta$. Grienberger, using Snell's method, calculated the ratio correct to 39 fractional places.[2] Huygens, in his *De Circuli Magnitudine Inventa*, 1654, proved the propositions of Snell, giving at the same time a number of other interesting theorems, for example, two inequalities which may be written as follows[3]—

$$\text{chd}\,\theta + \frac{4\,\text{chd}\,\theta + \sin\theta}{2\,\text{chd}\,\theta + 3\sin\theta}\cdot\tfrac{1}{3}(\text{chd}\,\theta - \sin\theta) > \theta > \text{chd}\,\theta + \tfrac{1}{3}(\text{chd}\,\theta - \sin\theta).$$

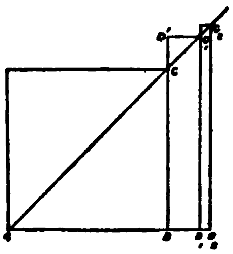

FIG. 5.

As might be expected, a fresh view of the matter was taken by Descartes. The problem he set himself was the exact converse of that of Archimedes. A given straight line being viewed as equal in length to the circumference of a circle, he sought to find the diameter of the circle. His construction is as follows (see Fig. 5). Take AB equal to one-fourth of the given line; on AB describe a square ABCD; join AC; in AC produced find, by a known process, a point C_1 such that, when C_1B_1 is drawn perpendicular to AB produced and C_1D_1 perpendicular to BC produced, the rectangle BC_1 will be equal to $\frac{1}{4}$ABCD; by the same process find a point C_2 such that the rectangle B_1C_2 will be equal to $\frac{1}{4}BC_1$; and so on *ad infinitum*. The diameter sought is the straight line from A to the limiting position of the series of B's, say the straight line AB_∞. As in the case of the process of Archimedes, we may direct our attention either to the infinite series of geometrical operations, or to the corresponding infinite series of arithmetical operations. Denoting the number of units in AB by $\frac{1}{4}c$, we can express BB_1, B_1B_2, . . . in terms of $\frac{1}{4}c$, and the identity $AB_\infty = AB + BB_1 + B_1B_2 + \ldots$ gives us at once an expression for the diameter in terms of the circumference by means of an infinite series.[4] The proof of the correctness of the construction is seen to be involved in the following theorem, which serves likewise to throw new light on the subject: AB being any straight line whatever, and the above construction being made, then AB is the diameter of the circle circumscribed by the square ABCD (self-evident), AB_1 is the diameter of the circle circumscribed by the regular 8-gon having the same perimeter as the square, AB_2 is the diameter of the circle circumscribed by the regular 16-gon having the same perimeter as the square, and so on. Essentially, therefore, Descartes's process is that known later as the process of *isoperimeters*, and often attributed wholly to Schwab.[5]

In 1655 appeared the *Arithmetica Infinitorum* of Wallis, where numerous problems of quadrature are dealt with, the curves being now represented in Cartesian co-ordinates, and algebra playing an important part. In a very curious manner, by viewing the circle $y = (1-x^2)^{\frac{1}{2}}$ as a member of the series of curves $y = (1-x^2)^1$, $y = (1-x^2)^2$, etc., he was led to the proposition that four times the reciprocal of the ratio of the circumference to the diameter is equal to

$$\frac{3.3.5.5.7.7.9\ldots}{2.4.4.6.6.8.8\ldots};$$

and, the result having been communicated to Lord Brounker, the latter discovered the equally curious equivalent expression

$$1 + \cfrac{1^2}{2 + \cfrac{3^2}{2 + \cfrac{5^2}{2 + \cfrac{7^2}{2 + \cdots}}}}$$

The work of Wallis had evidently an important influence on the next notable personality in the history of the subject, James Gregory, who lived during the period when the higher algebraic analysis was coming into power, and whose genius helped materially to develop it. He had, however, in a certain sense one eye fixed on the past and the other towards the future. His first contribution[6] was a variation of the method of Archimedes. The latter, as we know, calculated the perimeters of successive polygons, passing from one polygon to another of double the number of sides; in a similar manner Gregory calculated the areas. The general theorems which enabled him to do this, after a start had been made, are

$$A_{2n} = \sqrt{A_n A'_n} \quad \text{(Snell's \textit{Cyclom.})},$$

$$A'_{2n} = \frac{2A_n A'_n}{A_n + A_{2n}} \text{ or } \frac{2A'_n A_{2n}}{A'_n + A_{2n}} \quad \text{(Gregory)},$$

where A_n, A'_n are the areas of the inscribed and the circumscribed regular n-gons respectively. He also gave approximate rectifications of circular arcs after the manner of Huygens; and, what is very notable, he made an ingenious and, according to Montucla, successful attempt to show that quadrature of the circle by a Euclidean construction was impossible.[7] Besides all this, however, and far beyond it in importance, was his use of infinite series. This merit he shares with his contemporaries Mercator, Newton, and Leibnitz, and the exact dates of discovery are a little uncertain. As far as the circle-squaring functions are concerned, it would seem that Gregory was the first (in 1670) to make known the series for the arc in terms of the tangent, the series for the tangent in terms of the arc, and the secant in terms of the arc; and in 1669 Newton showed to Barrow a little treatise in manuscript containing the series for the arc in terms of the sine, for the sine in terms of the arc, and for the cosine in terms of the arc. These discoveries formed an epoch in the history of mathematics generally, and had, of course, a marked influence on after investigations regarding circle-quadrature. Even among the mere computers the series

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[1] It is thus manifest that by his first construction Snell gave an approximate solution of two great problems of antiquity.

[2] *Elementa Trigonometrica*, Rome, 1630; Glaisher, *Messenger of Math.*, iii. p. 35 *sq.*

[3] See Kiessling's edition of the *De Circ. Magn. Inv.*, Flensburg, 1869; or Pirie's tract on *Geometrical Methods of Approx. to the Value of π*, London, 1877.

[4] See Euler, "Annotationes in Locum quendam Cartesii," in *Nov. Comm. Acad. Petrop.*, viii.

[5] Gergonne, *Annales de Math.*, vi.

[6] See *Vera Circuli et Hyperbolæ Quadratura*, Padua, 1667; and the *Appendicula* to the same in his *Exercitationes Geometricæ*, London, 1668.

[7] *Penny Cyclop.*, xix. p. 187.

$$\theta = \tan\theta - \tfrac{1}{3}\tan^3\theta + \tfrac{1}{5}\tan^5\theta - \ldots,$$

specially known as Gregory's series, has ever since been a necessity of their calling.

The calculator's work having now become easier and more mechanical, calculation went on apace. In 1699 Abraham Sharp, on the suggestion of Halley, took Gregory's series, and, putting $\tan\theta = \frac{1}{3}\sqrt{3}$, found the ratio equal to

$$\sqrt{12}\left(1 - \frac{1}{3.3} + \frac{1}{5.3^2} - \frac{1}{7.3^3} + \cdots\right),$$

from which he calculated it correct to 71 fractional places.[1] About the same time Machin calculated it correct to 100 places, and, what was of more importance, gave for the ratio the rapidly converging expression,

$$\frac{16}{5}\left(1 - \frac{1}{3.5^2} + \frac{1}{5.5^4} - \frac{1}{7.5^6} + \cdots\right) - \frac{4}{239}\left(1 - \frac{1}{3.239^2} + \frac{1}{5.239^4} - \cdots\right),$$

which long remained without explanation.[2] Fautet de Lagny, still using tan 30°, advanced to the 127th place.[3]

Euler took up the subject several times during his life, effecting mainly improvements in the theory of the various series.[4] With him, apparently, began the usage of denoting by π the ratio of the circumference to the diameter.[5] The most important publication, however, on the subject in the 18th century was a paper by Lambert,[6] read before the Berlin Academy in 1761, in which he demonstrated the irrationality of π. The general test of irrationality which he established is that, if

$$\cfrac{a_1}{b_1 \pm \cfrac{a_2}{b_2 \pm \cfrac{a_3}{b_3 \pm \ldots}}}$$

be an interminate continued fraction, $a_1, a_2, \ldots b_1, b_2 \ldots$ be integers, $\frac{a_1}{b_1}, \frac{a_2}{b_2}, \ldots$ be proper fractions, and the value of every one of the interminate continued fractions $\cfrac{a_1}{b_1 \pm \ldots}$, $\cfrac{a_2}{b_2 \pm \ldots}$, ... be < 1, then the given continued fraction represents an irrational quantity. If this be applied to the right-hand side of the identity

$$\tan\frac{m}{n} = \cfrac{m}{n - \cfrac{m^2}{3n - \cfrac{m^2}{5n - \ldots}}},$$

it follows that the tangent of every arc commensurable with the radius is irrational, so that, as a particular case, an arc of 45°, having its tangent rational, must be incommensurable with the radius; that is to say, $\frac{\pi}{4}$ is an incommensurable number.[7] This incontestable result had no effect, apparently, in repressing the π computers. Vega in 1789, using series like Machin's, viz., Gregory's series and the identities

$$\frac{\pi}{4} = 5\tan^{-1}\tfrac{1}{7} + 2\tan^{-1}\tfrac{3}{79} \text{ (Euler, 1779)},$$

$$\frac{\pi}{4} = \tan^{-1}\tfrac{1}{7} + 2\tan^{-1}\tfrac{1}{3} \text{ (Hutton, 1776)}.$$

neither of which was nearly so advantageous as several found by Hutton, calculated π correct to 136 places.[8] This achievement was anticipated or outdone by an unknown calculator, whose manuscript was seen in the Radcliffe Library, Oxford, by Baron von Zach towards the end of the century, and contained the ratio correct to 152 places. More astonishing still have been the deeds of the π-computers of the 19th century. A condensed record compiled by Mr. Glaisher (*Messenger of Math.*, ii. p. 122) is as follows:

Date.	Computer.	No. of fr. digits calcd.	No. of fr. digits correct.	Place of Publication.
1842	Rutherford..	208	152	*Trans. Roy. Soc.*, Lond., 1841, p. 283.
1844	Dase..........	205	200	*Crelle's Journ.*, xxvii. p. 198.
1847	Clausen	250	248	*Astron. Nachr.*, xxv. col. 207.
1853	Shanks......	318	318	*Pro.Roy.Soc.*,Lon.,1853,p.273.
1853	Rutherford..	440	440	*Ibid.*
1853	Shanks	530	...	*Ibid.*
1853	Shanks	607	...	W. Shanks, *Rectification of the Circle*, London, 1853.
1853	Richter	333	330	*Grunert's Archiv*, xxi. p. 119.
1854	Richter	400	330	*Ibid*, xxii. p. 473.
1854	Richter	400	400	*Ibid*, xxiii. p. 476.
1854	Richter	500	500	*Ibid*, xxv. p. 472.
1873	Shanks	707	...	*Proc. Roy. Soc.*, Lond., xxi.

By these computers Machin's identity, or identities analogous to it, *e.g.*,

$$\frac{\pi}{4} = \tan^{-1}\tfrac{1}{2} + \tan^{-1}\tfrac{1}{5} + \tan^{-1}\tfrac{1}{8},$$

$$\frac{\pi}{4} = 4\tan^{-1}\tfrac{1}{5} - \tan^{-1}\tfrac{1}{70} + \tan^{-1}\tfrac{1}{99},$$

and Gregory's series were employed.[9]

A much less wise class than the π-computers of the 19th century are the pseudo-circle-squarers, or circle-squarers technically so called, that is to say, persons who, having obtained by illegitimate means a Euclidean construction for the quadrature or a finitely expressible value for π, insist on using faulty reasoning and defective mathematics to establish their assertions. Such persons have flourished at all times in the history of mathematics; but the interest attaching to them is more psychological than mathematical.[10]

It is of recent years that the most important advances in the theory of circle-quadrature have been made. In 1873 Hermite proved that the base e of the Napierean logarithms cannot be a root of a rational algebraical equation of any degree.[11] To prove the same proposition regarding π is to prove that a Euclidean construction for circle-quadrature is impossible. For in such a construction every point of the figure is obtained by the intersection of two straight lines, a straight line and a circle, or two circles; and, as this implies that, when a unit of length is introduced, numbers employed, and the problem transformed into one of algebraic geometry, the equations to be solved can only be of the first or second degree, it follows that the equation to which we must be finally led is a rational equation of even degree. Hermite[12] did not succeed in his attempt on π; but in 1882 Lindemann, following exactly in Hermite's steps, accomplished the desired result.[1] Mathematicians are agreed that the full demonstration leaves something to be desired in the matter of simplicity, and attempts at simplification have already been made by Markoff and Rouché.[2]

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[1] See Sherwin's *Math. Tables*, London, 1705. p. 59.

[2] See W. Jones, *Synopsis Palmariorum Matheseos*, London, 1706; Maseres, *Scriptores Logarithmici*, London, 1791-96, vol. iii. p. 159 *sq.*; Hutton, *Tracts*, vol. i. p. 266.

[3] See *Hist. de l'Acad.*, Paris, 1719; 7 appears instead of 8 in the 113th place.

[4] *Comment. Acad. Petrop.*, ix., xi.; *Nov. Comm. Ac. Pet.*, xvi.; *Nova Acta Acad. Pet.*, xi.

[5] *Introd. in Analysin Infin.*, Lausanne, 1748, chap. viii.

[6] *Mém. sur quelques propriétés remarquables des quantités transcendantes, circulaires, et logarithmiques.*

[7] See Legendre, *Éléments de Géometrie*, Paris, 1794, note iv.; Schlömilch, *Handbuch d. algeb. Analysis*, Jena, 1851, chap. xiii.

[8] *Nova Acta Petrop.*, ix. p. 41; *Thesaurus Logarithm. Completus*, p. 633.

[9] On the calculations made before Shanks, see Lehmann, "Beitrag zur Berechnung der Zahl π," in *Grunert's Archiv*, xxi. pp. 121-174.

[10] See Montucla, *Hist. des rech. sur la quad. du cercle*, Paris, 1754, 2d ed. 1831; De Morgan, *Budget of Paradoxes*, London, 1872.

[11] "Sur la fonction exponentielle," *Comptes Rendus*, Paris, lxxvii. pp. 18, 74, 226, 285.

[12] See *Crelle's Journal*, lxxvi. p. 342.

Besides the various writings mentioned, see for the early history of the subject, Montucla, *Hist. des Math.*, 6 vols., Paris, 1758, 2d ed. 1799–1802; Murhard, *Bibliotheca Mathematica*, ii. pp. 106–123, Leipsic, 1798; Reuss, *Repertorium Comment.*, vii. pp. 42–44, Göttingen, 1808. For a few approximate geometrical solutions, see Leybourn's *Math. Repository*, vi. pp. 151–154; *Grunert's Archiv*, xii. p. 98, xlix. p. 3; *Nieuw Archief v. Wisk.*, iv. pp. 200–204. For experimental determinations of π dependent on the theory of probability, see *Mess. of Math.*, ii. pp. 113, 119; *Časopis pro pěstování math. a fys.*, x. pp. 272–275; *Analyst*, ix. p. 176. (T. MU.)

SQUASH (*Cucurbita Melopepo*). See GOURD, vol. xi. p. 5.

SQUILL, the name under which the bulbous root of *Urginea maritima*, Baker, is used in medicine. The plant was formerly placed in the genus *Scilla*, from which it has been separated because the seeds are flat and discoid instead of triquetrous, as in the latter genus. The name of "squill" is also applied by gardeners to the various species of *Scilla*. The medicinal squill is a native of the countries bordering the Mediterranean, and grows from the sea-level up to an elevation of 3000 feet. The bulbs are globular and of large size, often weighing more than 4 ℔. Two varieties are met with, the one having white and the other pink scales. They are collected in August, when they are leafless, the membranous outer scales being removed and the fleshy portion cut transversely into slices and dried in the sun. These are then packed in casks for exportation. They are chiefly imported into the United Kingdom from Malta. When reduced to powder and exposed to the air the drug rapidly absorbs moisture and cakes together into a hard mass. Squill has been used in medicine from a very early period. The ancient Greek physicians prescribed it with vinegar and honey almost in the same manner as it is used at present. Its medicinal properties are expectorant and diuretic. It is chiefly prescribed in bronchitis when the phlegm is tenacious and expectorated with difficulty, and in cardiac dropsy. When given in large doses it acts as an irritant poison, and its use is therefore contra-indicated in active inflammatory conditions of the mucous membrane or of the kidneys. The fresh bulb rubbed on the skin causes redness and irritation, due in part to the presence of minute crystals of oxalate of calcium.

The activity of the drug appears to be due to the active principles, scillipicrin, scillitoxin, and scillin, which were first obtained by Merck in 1878. The first has a bitter and burning taste, powerfully irritating the mucous membrane of the nose. It is soluble in alcohol and ether and partly in alkalies, but insoluble in water; if mixed with sugar it dissolves readily and can then be absorbed if injected subcutaneously. Scillitoxin is hygroscopic, very soluble in water, and has a bitter taste. These two principles have an action on the heart resembling that of *Digitalis*; in large doses the former stops its action in systole and the latter in diastole. Scillin is crystalline, tasteless, and soluble in alcohol, though only with difficulty in water. It is present only in very small quantity in squill, and appears to be the cause of the subsidiary effects of that drug, such as vomiting, etc.

An allied species, *Urginea indica*, Baker, is used in India in the same manner as the European species. The true squills are represented in Great Britain by two species, *Scilla autumnalis* and *S. verna*. The former has a racemose inflorescence; the latter has the flowers arranged in a corymbose manner, and is confined to the sea-coast. Several species are cultivated in gardens, *S. bifolia* and *S. siblica* being remarkable for their beautiful blue flowers, which are produced in early spring. The name of Chinese squill is applied by gardeners to *Barnardia scilloides* and that of Roman squill to species of *Bellevalia*.

SQUINT. See OPHTHALMOLOGY, vol. xvii. pp. 807–8.

SQUIRREL. In the article MARMOT (vol. xv. p. 566) an account was given of the three genera forming the *Arctomyina*, or Marmot sub-family of the large family *Sciuridæ*, and in the present article the members of the other and more typical sub-family, the *Sciurina*, are noticed. The systematic position of the *Sciuridæ* as a whole and their relations to other rodents are shown in the article MAMMALIA (vol. xv. p. 422); so it is merely with the component genera of the group that we now have to deal.

Of the *Sciurina* six genera are commonly recognized, the first being the typical one, *Sciurus*, in which the common English squirrel is included. The characters of the genus are—form slender and agile; tail long and bushy; ears generally well developed, pointed, often tufted; feet adapted for climbing, the anterior pair with four toes and a rudimentary thumb, and the posterior pair with five toes, all the toes having long, curved, and sharp-pointed claws; mammæ from four to six in number; skull (see Fig. 1) lightly built, very similar in shape throughout the genus; post-orbital processes long and curved; incisors narrow and compressed; premolars either one or two above and one below; when two are present above, the anterior one is quite minute and very different from the corresponding tooth in the marmots; molars three on each side above and below.

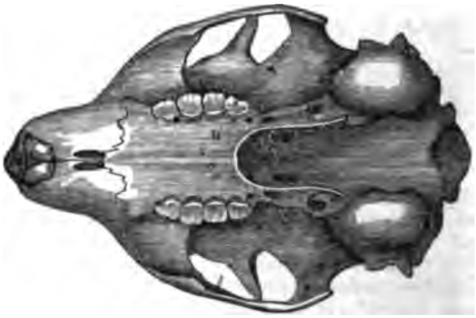

FIG. 1.—Skull of *Sciurus bicolor*; natural size.

True squirrels are found throughout the greater part of the tropical and temperate regions of both hemispheres, although they are absent both from Madagascar and the Australian region. The species are both largest and most numerous in the tropics, and reach their greatest development in the Malay parts of the Oriental region.

Squirrels vary in size from animals no larger than a mouse, such as *Sciurus soricinus* of Borneo, or *S. minutus* of West Africa, to others as large as a cat, such as the black and yellow *S. bicolor* of Malaysia (see Fig. 1). The very large squirrels, as might be expected from their heavier build, are somewhat less strictly arboreal in their habits than the smaller ones, of which the common English species may be looked upon as typical. The common squirrel, *S. vulgaris*, whose general habits are too well known to need special description, ranges over the whole of the Palæarctic region, from Ireland to Japan, from Lapland to North Italy; but specimens from different parts of this wide range differ so much in color as to have been often looked upon as different species. Thus, while the common squirrels of north and west Europe are of the bright red color we are accustomed to see in England, those of the mountainous regions of southern Europe are nearly always of a deep blackish gray; those from Siberia again are a clear gray color, with scarcely a tinge of rufous. These last supply the squirrel fur used for lining cloaks. The pairing time of the squirrel is from February to April, and after a period of gestation of about thirty days it brings forth from three to nine young. In addition to all sorts of vegetables and fruits the squirrel is exceedingly fond of animal food, greedily devouring mice, small birds, and eggs.

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[1] See "Ueber die Zahl π," in *Math. Annalen*, xx. p. 213.

[2] *Nouv. Annales*, 3d ser., ii. p. 5.

Although the English squirrel is a most beautiful little animal, it is far surpassed by many of the tropical members of the group, and especially by those of the Malayan region, where nearly all the numerous species are brilliantly marked, and many are ornamented with variously colored longitudinal stripes along their bodies. One of the commonest and best known of the striped species is the little Indian Palm Squirrel (*S. palmarum*), which in large numbers runs about every Indian village. Another Oriental species (*S. caniceps*) presents almost the only known instance among mammals of the temporary assumption during the breeding season of a distinctly ornamental coat, corresponding to the breeding plumage of birds. For the greater part of the year the animal is of a uniform gray color, but about December its back becomes a brilliant orange-yellow, which lasts until about March, when it is again replaced by gray.

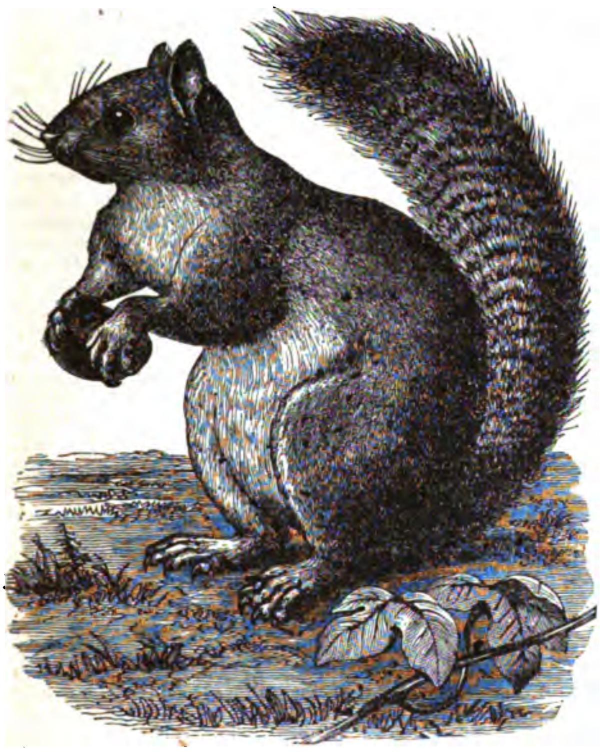

FIG. 2.—Burmese Squirrel.

The squirrel shown in Fig. 2 is a native of Burmah and Tenasserim, and is closely allied to *S. caniceps*, but goes through no seasonal change of color.

The number of species in the genus *Sciurus* is about 75, of which 3 belong to the Palæarctic, 15 to the Ethiopian, about 40 to the Oriental, and 16 to the combined Nearctic and Neotropical regions.

Genus Rheithrosciurus.

A single very striking species of squirrel, confined to Borneo, and as yet only known from three or four examples, has been separated generically under the above name. The general shape of its skull is very different from that of other squirrels; but its most peculiar characteristic is the presence of from seven to ten minute parallel vertical grooves running down the front face of its incisors, both above and below, no other squirrel having really grooved incisors at all, and no other member of the whole order of rodents incisor grooves resembling these. Its premolars only number $\frac{1}{1}$, and its molars are simpler and less ridged than in the other genera. This squirrel (*Rh. macrotis*) is a magnificent animal, far larger than the English species with an enormously long bushy tail, long tufted ears, and black and white bands down its sides.

Genus Xerus.

Fur coarse and spiny. Claws long and comparatively straight. Ear-conches minute or entirely absent. Skull with the post-orbital processes short and directed backwards, the bony palate prolonged considerably behind the tooth-row, and the external ridge on the front face of the anterior zygoma-root more developed, and continued much further upwards, than in *Sciurus*. Premolars $\frac{2}{1}$; molars as in *Sciurus*. This genus contains four well-marked species, known as Spiny Squirrels, all natives of Africa. They are terrestrial in their habits, living in burrows which they dig for themselves. *X. getulus*, a striped species of North Africa, has much the size and appearance of the Indian palm squirrel; the others are all a little larger than the English squirrel.

Genus Tamias.

The members of this genus are characterized by the possession of internal cheek-pouches, and by their style of coloration, all being ornamented on the back with alternate bands of light and dark color. Their skulls are slenderer and lighter than those of the true squirrels, from which they differ in several unimportant details. There is only one functional premolar,—the small anterior one usually found in *Sciurus* being either absent altogether or quite small and functionless. There are four species, all found in North America, one extending also through Siberia into eastern Europe. They are known in America as "Chipmunks," and are among the commonest and best known of the indigenous rodents. The members of this group seem rather to lead into the genus *Spermophilus* (see MARMOT) of the sub-family *Arctomyinæ*, so that the division of the *Sciuridæ* into two sub-families, although very convenient for classification and description, is rather of an artificial nature, there being no well-defined line of separation between them.

Genera Pteromys and Sciuropterus.

The Flying Squirrels, although they cannot fly in the true sense of the word, can yet float through the air for considerable distances by the aid of an extension of skin connecting their fore and hind limbs, and forming a sort of parachute. This parachute is merely a lateral extension of the ordinary skin of the body, which passes outwards between the limbs and terminates at the wrists and ankles. In addition to the lateral membrane there is a narrow and inconspicuous one passing from the cheek along the front of the shoulder to the front of the wrist, and another—at least in the larger species—stretching across behind the body from ankle to ankle and involving the base of the tail. The flying squirrels are divided into two genera, of which *Pteromys* contains the larger and *Sciuropterus* the smaller species. The two differ in certain details of dentition, and in the greater development in the former of the expanded membranes, especially of the "interfemoral" or posterior membrane, which is in the latter almost wholly absent. In *Pteromys* the tail is cylindrical and comparatively thin, while in *Sciuropterus* it is broad, flat, and laterally expanded, and evidently compensates for the absence of the interfemoral membrane by acting as a supplementary parachute. In appearance flying squirrels resemble the non-flying forms, although they are even more beautifully colored than the latter. Their habits, food, etc., are also very similar to those of the true squirrels, except that they are more decidedly nocturnal, and are therefore less often seen by the ordinary observer. Their method of leaping from tree to tree and floating long distances on their extended parachutes is precisely similar to that of the flying phalangers of Australia, a graphic description of which is quoted in PHALANGER (vol. xviii. p. 742). Of each of the two genera there are about thirteen or fourteen species, all natives of the Oriental region, except that one of *Sciuropterus* is found in North America, and another in Siberia and eastern Europe,—the latter, the *Sciurus volans* of Linnæus's *Systema Naturæ*, being the first flying squirrel that was known to European naturalists. (O. T.)

SRINAGAR. See KASHMIR, vol. xiv. p. 13.

SRIRANGAM, or SERINGHAM, a town of India, in Trichinopoli district, Madras presidency, situated in 10° 51′ 50″ N. lat. and 78° 43′ 55″ E. long., 2 miles north of Trichinopoli city and almost in the centre of the island of Srírangam. The island is formed by the bifurcation of the river Káveri (Cauvery) and by the channel of the Colerun. The town is celebrated for its great temple dedicated to Vishnu, composed of seven square enclosures, 350 feet distant from each other. Each enclosure has four gates with high towers, placed one in the centre of each side opposite to the four cardinal points. The outer wall of the temple is not less than 4 miles in circumference. From 1751 to 1755 the island and its pagodas were the object of frequent contests between the French and the British. Srírangam was constituted a municipality in 1871, and since then much has been done to improve the place. In 1881 the population was 19,773 (9330 males and 10,443 females).

SRIRANGAPATAM. See Seringapatam, vol. xxi. p. 714.

STAAL, Marguerite Jeanne Cordier Delaunay, Baronne de (1684–1750)—often called in history and literature Madame de Staal-Delaunay, to distinguish her more completely from Madame de Stael-Holstein—was born at Paris on May 30, 1684. Her father was a painter named Cordier. He seems to have deserted her mother, whose name was Delaunay, and who made her daughter take that surname instead of Cordier. She was well-educated, and entered the household of the Duchesse du Maine at Sceaux, at first in no higher capacity than that of *femme de chambre*. She was, however, promoted before long to the office of amanuensis and (practically) companion to her mistress. Her literary talent soon manifested itself in the literary court of the duchess, who is said, but chiefly on the waiting lady's own authority, to have been not a little jealous of her attendant. Enough, however, is known of the duchess's imperious and capricious temper to make it improbable that her service was agreeable. Madame Delaunay, however, was a sufficiently devoted *suivante*, and in the affair of the Cellamare conspiracy had to endure a visit to the Bastille, where she remained for two years. Even here, however, she represents herself as having made conquests, though she was far from beautiful. She returned on her liberation to the service of the duchess, refused, it is said, Dacier, the widower of a wife more famous than herself, and in 1735, being then more than fifty, married the Baron de Staal. She continued, however, to form part of the duchess's household. She died on June 16, 1750. Her *Memoirs* appeared about five years later, and have often been reprinted, both separately and in collections of the memoirs of the 17th and 18th centuries, to both of which the author belonged both in style and character. She has much of the frankness and seductive verve of Madame de Sévigné and her contemporaries, but a little alloyed with the *sensibilité* of a later time. It may be doubted whether she does not somewhat exaggerate the discomforts of her position and her sense of them. But her book is an extremely amusing one to read, as well as not a little instructive. The humors of the "court of Sceaux" are depicted as hardly any other society of the kind has ever been. Besides her *Memoirs* Madame de Staal left two comedies and some letters, the answers to which are in some cases extant, and show, as well as the references of contemporaries, that the writer did not exaggerate her power of attracting men.

STADE, a small commercial town in the province of Hanover, Prussia, is situated on the navigable Schwinge, 3½ miles above its confluence with the Elbe, and 20 miles to the northwest of Hamburg. It carries on a number of small manufactures and has some shipping trade, chiefly with Hamburg, but the rise of Harburg has deposed it from its former position as the chief port of Hanover. There are several brickfields in the neighborhood, and deposits of gypsum and salt. The fortifications, erected in 1755 and strengthened in 1816, began to be demolished in 1882. Population in 1885, 10,003.

According to the legend, Stade was the oldest town of the Saxons and was built in 321 B.C. Historically it cannot be traced farther back than the 10th century, when it was the capital of a line of counts. In the 12th century it passed to the archbishopric of Bremen. Subsequently entering the Hanseatic League, it rose to some commercial importance.[1] In 1648 Stade became the capital of the principality of Bremen under the Swedes; and in 1719 it was ceded to Hanover, the fate of which it has since shared. The Prussians occupied it without resistance in 1866.

STAEL, Madame de (by her proper name and title **Anne Louise Germaine Necker, Baroness of Stael-Holstein**), was born at Paris on April 22, 1766, and died there on July 14, 1817. Her father was the famous financier Necker, her mother Suzanne Curchod, who is almost equally famous as the early love of Gibbon, as the wife of Necker, as the mistress of one of the most popular salons of Paris, and as the mother of Madame de Stael. Between mother and daughter there was, however, little sympathy. Madame Necker, despite her talents, her beauty, and her fondness for *philosophe* society, was strictly decorous, somewhat reserved, and disposed to carry out in her daughter's case the rigorous discipline of her own childhood. The future Madame de Stael was from her earliest years a romp, a coquette, and passionately desirous of prominence and attention. There seems moreover to have been a sort of rivalry between mother and daughter for the chief place in Necker's affections, and it is not probable that the daughter's love for her mother was increased by the consciousness of her own inferiority in personal charms. Madame Necker, if her portraits as well as verbal descriptions may be trusted, was of a most refined though somewhat lackadaisical style of beauty, while her daughter was a plain child and a plainer woman, whose sole attractions were large and striking eyes and a buxom figure. She was, however, a child of unusual intellectual power, and she began very early to write though not to publish. She is said to have written her father a letter on his famous *Compte-Rendu* and other matters when she was not fifteen, and to have injured her health by excessive study and intellectual excitement. But in reading all the accounts of Madame de Stael's life which come from herself or her intimate friends it must be carefully remembered that she was the most distinguished and characteristic product of the period of *sensibilité*—the singular fashion of ultra-sentiment which required that both men and women, but especially women, should be always palpitating with excitement, steeped in melancholy, or dissolved in tears. Still, there is no doubt that her father's dismissal from the ministry, which followed the presentation of the *Compte*, and the consequent removal of the family from the busy life of Paris, were beneficial to her. During part of the next few years they resided at Coppet, her father's estate on the Lake of Geneva, which she herself made famous. But other parts were spent in travelling about, chiefly in the south of France. They returned to Paris, or at least to its neighborhood, in 1785, and Mademoiselle Necker resumed literary work of a miscellaneous kind, including two plays, *Sophie* and *Jane Grey*, which were printed sooner or later. It became, however, a question of marrying her. Her want of beauty was compensated by her fortune, for she was the only child of one of the richest bankers in Europe. But her parents are said to have objected to her marrying a Roman Catholic, which, in France, considerably limited her choice. There is a legend that William Pitt the younger thought of her; the somewhat notorious lover of Mademoiselle de Lespinasse, Guibert, a cold-hearted coxcomb of some talent, certainly paid her addresses. But she finally married Eric Magnus, Baron of Stael-Holstein, who was first an attaché of the Swedish legation, and then minister. For a great heiress and a very ambitious girl the marriage scarcely seemed brilliant, for Stael had no fortune and no very great personal distinction. A singular series of negotiations, however, secured from the king of Sweden a promise of the ambassadorship for twelve years and a pension in case of its withdrawal, and the marriage took place on January 14, 1786. The husband was thirty-seven, the wife twenty. Madam de Stael was accused of extravagance, and latterly an amicable separation of goods had to be effected between the pair. But this was a mere legal formality, and on the whole the marriage seems to have met the views of both parties, neither of whom had any affection for the other. They had three children; there was no scandal between them; the baron obtained money and the lady obtained, as a guaranteed ambassadress of a foreign power of consideration, a much higher position at court and in society than she could have secured by marrying almost any Frenchman, without the inconveniences which might have been expected had she married a Frenchman superior to herself in rank. The particular fancy of Marie Antoinette for Sweden, caused by the fantastic devotion of Count Fersen and the king himself to her, secured moreover a reception which might have been otherwise difficult to gain. Madame de Stael was not a *persona grata* at court, but she seems to have played the part of ambassadress, as she played most parts, in a rather noisy and exaggerated manner, but not ill. Then in 1788 she appeared as an author under her own name (*Sophie* had been already published, but anonymously) with some *Lettres sur J. J. Rousseau*, a fervid panegyric showing a good deal of talent but no power of criticism. She was at this time, and indeed generally, enthusiastic for a mixture of Rousseauism and constitutionalism in politics, and her father's restoration to power excited extravagant hopes in her, though Necker himself knew better. She exulted more than ever in the meeting of the states-general, and most of all when her father, after being driven to Brussels by a state intrigue, was once more recalled and triumphally escorted into Paris. Every one knows what followed. Her first child, a boy, was born the week before Necker finally left France in unpopularity and disgrace; and the increasing disturbances of the Revolution made her privileges as ambassadress no mere matters of ornamental distinction gratifying to vanity, but very important safeguards. She visited Coppet once or twice, but for the most part in the early days of the revolutionary period she was in Paris taking an interest and, as she thought, a part in the councils and efforts of the Moderates. At last, the day before the September massacres, she fled, befriended by Manuel and Tallien. Her own account of her escape is, as usual, so florid that it provokes the question whether she was really in any danger. Directly it does not seem that she was; but she had generously strained the privileges of the embassy to protect some threatened friends, and this was a serious matter.

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[1] The Stade Elbe-dues (Stader Elbezoll) were an ancient impost upon all goods carried up the Elbe, and were levied at the village of Brunshausen, at the mouth of the Schwinge. The tax was abolished in 1267 by the Hanseatic League, but it was revived by the Swedes in 1688, and confirmed by Hanover. The dues were fostered by the growing trade of Hamburg, and in 1861, when they were redeemed (for £427,600 [$2,078,136]) by the nations trading in the Elbe, the exchequer of Hanover was in the yearly receipt of about £45,000 [$218,700] from this source. Hamburg and Great Britain each paid more than a third of the redemption money.

She betook herself to Coppet, and there gathered round her a considerable number of friends and fellow-refugees, the beginning of the quasi-court which at intervals during the next five-and-twenty years made the place so famous. In 1793, however, she made a visit of some length to England, and established herself at Mickleham in Surrey as the centre of the Moderate Liberal emigrants,—Talleyrand, Narbonne, Jaucourt, Guibert, and others. There was not a little scandal about her relations with Narbonne; and it is very much to be doubted whether this can safely be set down, as her panegyrists usually set it, to the mere spite of the first or royalist emigrants, to whom she and her party were almost more obnoxious than the Jacobins. It is certain that this Mickleham sojourn (the details of which are known from, among other sources, the letters of Fanny Burney) has never been altogether satisfactorily accounted for. In the summer she returned to Coppet and wrote a pamphlet on the queen's execution. The next year her mother died, and the fall of Robespierre opened the way back to Paris. M. de Stael (whose mission had been in abeyance and himself in Holland for three years) was accredited to the French republic by the regent of Sweden; his wife reopened her salon and for a time was conspicuous in the motley and eccentric society of the Directory. She also published several small works, the chief being an essay *De l'Influence des Passions* (1796) and another *De la Littérature Considérée dans ses Rapports avec les Institutions Sociales* (1800). It was during these years that Madame de Stael was of chief political importance. Narbonne's place had been supplied by Benjamin Constant, who had a very great influence over her, as in return she had over him. During the Directory she had some real and more imaginary power as a politician, and both personal and political reasons threw her into opposition to Bonaparte. Her own preference for a moderate republic or a constitutional monarchy was quite sincere, and, even if it had not been so, her own character and Napoleon's were too much alike in some points to admit of their getting on together. For some years, however, she was able to alternate between Coppet and Paris without difficulty, though not without knowing that the first Consul disliked her. In 1797 she, as above mentioned, separated formally from her husband. In 1799 he was recalled by the king of Sweden, and in 1802 he died duly attended by her. Besides the eldest son Auguste Louis, they had two other children,—a son Albert, and a daughter Albertine, who afterwards became the Duchesse de Broglie.

The exact date of the beginning of what Madame de Stael's admirers call her duel with Napoleon is not easy to determine. Judging from the title of her book, *Dix Années d'Exil*, it should be put at 1804; judging from the time at which it became pretty clear that the first man in France and she who wished to be the first woman in France were not likely to get on together, it might be put several years earlier. The whole question of this duel, however (marked as it was by Napoleon's unscrupulous exercises of power, which reached a climax in the suppression of the *De l'Allemagne* after it had been carefully submitted to his censorship), requires consideration from the point of view of common sense. It displeased Napoleon no doubt that Madame de Stael should show herself recalcitrant to his influence. But it probably pleased Madame de Stael to quite an equal degree that Napoleon should apparently put forth his power to crush her and fail. Both personages had the curious touch of *charlatanerie* so common in the late 18th century, and "made believe" in a fashion bewildering and a little incredible to posterity. If Madame de Stael had really desired to take up her parable against Napoleon seriously, she need only have established herself in England at the peace of Amiens and have lived quietly there. She did nothing of the kind. She lingered on at Coppet, constantly hankering after Paris, and acknowledging the hankering quite honestly. In 1802 she published the first of her really noteworthy books, the novel of *Delphine*, in which the "femme incomprise" was in a manner introduced to French literature, and in which she herself and not a few of her intimates appeared in transparent disguise. In the autumn of 1803 she returned to Paris. Whether, if she had not displayed such extraordinary anxiety not to be exiled, Napoleon would have exiled her remains a question; but, as she began at once appealing to all sorts of persons to protect her, he seems to have thought it better that she should not be protected. She was directed not to reside within forty leagues of Paris, and after considerable delay she determined to go to Germany. She journeyed by Metz and Frankfort to Weimar, and arrived there in December. There she stayed during the winter, and then went to Berlin, where she made the acquaintance of August Wilhelm Schlegel, who afterwards became one of her intimates at Coppet. Thence she travelled to Vienna, where, in April, the news of her father's dangerous illness and shortly of his death (April 8) reached her. She returned to Coppet, and found herself its wealthy and independent mistress, but her sorrow for her father was deep and certainly sincere. She spent the summer at the chateau with a brilliant company; in the autumn she journeyed to Italy accompanied by Schlegel and Sismondi, and there gathered the materials of her most famous work, *Corinne*. She returned in the summer of 1805, and spent nearly a year in writing *Corinne;* in 1806 she broke the decree of exile and lived for a time undisturbed near Paris. In 1807 *Corinne*, the first æsthetic romance not written in German, appeared. It is in fact, what it was described as being at the time of its appearance "a picturesque tour couched in the form of a novel." The publication was taken as a reminder of her existence, and the police of the empire sent her back to Coppet. She stayed there as usual for the summer, and then set out once more for Germany, visiting Mainz, Frankfort, Berlin, and Vienna. She was again at Coppet in the summer of 1808, and set to work at her book *De l'Allemagne*. It took her nearly the whole of the next two years, during which she did not travel much or far from her own house. She had bought property in America and thought of moving thither, but chance or fatality made her determine to publish *De l'Allemagne* in Paris. The submission to censorship which this entailed was sufficiently inconsistent, and she wrote to the emperor one of the unfortunate letters, at once undignified and provoking, of which she had the secret. A man less tyrannical or less mean-spirited than Napoleon would, of course, have let her alone, but Napoleon was Napoleon, and she perfectly well knew him. The reply to her letter was the condemnation of the whole edition of her book (ten thousand copies) as "not French," and her own exile, not as before to a certain distance from Paris, but from France altogether. The act was unquestionably one of odious tyranny, but it is impossible not to ask why she had put herself within reach of it when her fortune enabled her to reside anywhere and to publish what she pleased. She retired once more to Coppet, where she was not at first interfered with, and she found consolation in a young officer of Swiss origin named Rocca, twenty-three years her junior, whom she married privately in 1811. The intimacy of their relations could escape no one at Coppet, but the fact of the marriage was not certainly known till after her death.

The operations of the imperial police in regard to Madame de Stael are rather obscure. She was at first left undisturbed, but by degrees the chateau itself became taboo, and her visitors found themselves punished heavily. Mathieu de Montmorency and Madame Récamier were exiled for the crime of seeing her; and she at last began to think of doing what she ought to have done years before and withdrawing herself entirely from Napoleon's sphere. In the complete subjection of the Continent which preceded the Russian War this was not so easy as it would have been earlier, and she remained at home during the winter of 1811, writing and planning. On May 23, she left Coppet almost secretly, and journeyed by Bern, Innsbruck, and Salzburg to Vienna. There she obtained an Austrian passport to the frontier, and after some fears and trouble, receiving a Russian passport in Galicia. she at last escaped from the dungeon of Napoleonic Europe, swearing never to return thither. It seemed likely that the proclamation of war between France and Russia, on June 22, would help her to keep the vow.

She journeyed slowly through Russia and Finland to Sweden, making some stay at St. Petersburg, spent the winter in Stockholm, and then set out for England. Here she received a brilliant reception and was much lionized during the season of 1813. She published *De l'Allemagne* (a book much more really remarkable than *Corinne*) in the autumn, was saddened by the death of her second son Albert, who had entered the Swedish army and fell in a duel brought on by gambling, undertook her *Considérations sur la Révolution Française*, and when Louis XVIII. had been restored returned to Paris. Both in the summer and in the winter of 1814 she visited Coppet, and was meanwhile a prominent figure in Parisian society. She was in Paris when the news of Napoleon's landing arrived and at once fled to Coppet, but a singular story, much discussed, is current of her having approved Napoleon's return. There is no direct evidence of it, but the conduct of her close ally Constant may be quoted in its support, and it is certain that she had no affection for the Bourbons. In October, after Waterloo, she set out for Italy, not only for the advantage of her own health but for that of her second husband, Rocca, who was dying of consumption. Her daughter married Duke Victor de Broglie on February 20, 1816, at Pisa, and became the wife and mother of French statesmen of distinction. The whole family returned to Coppet in June, and Byron now frequently visited Madame de Stael there. He had quizzed her a good deal in London, but liked her better in her own house, though even there he noticed her constant straining to be something different from herself. Despite her increasing ill-health she returned to Paris for the winter of 1816–17, and her salon was much frequented. But in March she is spoken of as "dying," and she had already become confined to her room, if not to her bed. She died on the 14th of July, and Rocca survived her little more than six months. Nor was her eldest son long-lived. After editing a collected edition of his mother's works he died at the age of thirty-seven in 1827.

Madame de Stael occupies a singular position in French literature. The men of her own time exalted her to the skies, and the most extravagant estimates of her (as "the greatest woman in literary history," as the "foundress of the romantic movement," as representing "ideas," while her contemporary Chateaubriand only represented words, colors, and images, and so forth) are to be found in those histories of literature which faithfully repeat second-hand and traditional opinions. On the other hand, it is acknowledged that she is now very little read. Sainte-Beuve, who professes a "culte" for her, and who has treated her at great length and with much indulgence; M. Scherer, a compatriot and co-religionist, who is strongly prejudiced in her favor; Doudan, a kind of literary retainer of her connections,—all allow this, and any one who speaks with an intimate knowledge of current French literature must agree that since they spoke neglect of her has increased. No writer of such eminence is so rarely quoted; none is so entirely destitute of that tribute of new and splendid editions which France pays to her favorite classics more lavishly than any other nation; none is so seldom the subject of a literary *causerie*. The abundant documents in the hands of her descendants, the families of Broglie and Haussonville, have indeed furnished material for papers recently, but these are almost wholly on the social aspect of Madame de Stael, not on her literary merit. Nor when the life and works come to be examined independently is the neglect seen to be without excuse. An ugly coquette, an old woman who made a ridiculous marriage, a blue-stocking who spent much of her time in pestering men of genius, and drawing from them sarcastic comment behind her back,—these things are not attractive. Her books are seen to be in large part merely clever reflections of other people's views, or views current at the time, and the famous "ideas" turn out to be chiefly the ideas of the books or the men with whom she was from time to time in contact. The sentimentality of her sentiment and the florid magniloquence of her style equally disgust the reader; and, when it is suggested to him that the revolution of taste and manners hurts novels more than anything else, he is tempted to reply that if it has not hurt *Don Quixote*, or *Gil Blas*, or *Robinson Crusoe*, or *Tom Jones*, or *Manon Lescaut*, or *The Antiquary*, and that if it has hurt *Corinne* it is simply because these are great books and *Corinne* is not a great book. There is truth in this, but to state it alone would be in the highest degree unfair. Madame de Stael's faults are great; her style is of an age not for all time; her ideas are mostly second-hand and frequently superficial. But nothing save a very great talent could have shown itself so receptive. Take away her assiduous frequentation of society, from the later *philosophe* coteries to the age of Byron,—take away the influence of Constant and Schlegel and her other literary friends,—and probably little of her will remain. But to have caught from all sides in this manner the floating notions of society and of individuals, to reflect them with such vigor and clearness, to combine them with such not inconsiderable skill into connected books, is not anybody's task. Her two best books, *Corinne* and *De l'Allemagne*, are in all probability almost wholly unoriginal, a little sentiment in the first and a little constitutionalism in the second being all that she can claim. But *Corinne* is still a very remarkable exposition of a certain kind of æstheticism, and *De l'Allemagne* is still perhaps the most remarkable account of one country by a native and inhabitant of another which exists in literature. This praise, and it is very high praise, can be given to Madame de Stael. But the merits which it allows are not merits of the class which secure readers forever. Neither in style nor in thought was she of the first class or perhaps of the second; and besides thought and style nothing will save books.

Baron Auguste de Stael edited, as has been said, the complete works of his mother in seventeen volumes (Paris, 1820–1), and the edition was afterwards republished in a compacter form, and, supplemented by some *Œuvres Inédites*, is still obtainable in 3 vols. large 8vo (Didot). The *Considérations* and the *Dix Années d'Exil* had been published after Madame de Stael's death. There is no recent re-issue of the whole, and the minor works have not been reprinted, but *Corinne*, *Delphine*, *De l'Allemagne* are easily accessible in cheap and separate forms. Of recent works on Madame de Stael, or rather on Coppet and its society, those of M. M. Caro and Othenin d'Haussonville may be mentioned. In English there is an elaborate biography by A. Stevens (London, 1880), full of information, but unluckily not at all critical. (G. SA.)

STAFFORD, an inland county of England, is bounded on the S.E. by Warwickshire, S. by Worcestershire, W. by Shropshire, N.-W. by Cheshire, and E. by Derbyshire, just touching Leicestershire. It is of irregular outline, and has been likened to an elongated and compressed pear, somewhat tapering at both ends. Its greatest length from north to south is 53 miles, and its greatest breadth is 35 miles. The area is 748,443 acres—about 1170 square miles.

See vol. xxi. Plate VIII.

Surface and Geology.—Although the general aspect of the county is that of a plain, it has been pronounced "rather a subalpine or hilly district"; but its highest hill, Axe Edge, is only 1756 feet above the level of the sea. In the north the land is undulating and very picturesque; the hills here are the loftiest in the county, as Axe Edge, Cloud Thorpe, Mow Cop, and other hillocks and mounds called "edges." These are mostly composed of millstone grit. In the south we have sandstone, gravel, limestone, and basalt, represented respectively by Kinfare Edge, Barr and Cannock Chase, Sedgley, and Clent. The principal rivers are the Trent, the Tame, the Sow, the Penk, the Stour, the Blythe, the Tern, the Churnet, the Lyme, the Smestow, and the Manyfold; of these the Trent is the most important. The Severn has a short part of its course within the county, traversing the coal-field at Arley. The Dove separates Staffordshire from Derbyshire. Several of the rivers are well supplied with fish.

Geologically the county is included in the New Red Sandstone district of England, and is of the Carboniferous, Permian, and Triassic systems of formation. It is rich in limestone and coal. According to Mr. Garner (*Natural History of the County of Stafford*), the following is a summary of its geological characters: the Polley coal-field occupies 51 square miles; the South Staffordshire coal-field (excluding about 11 miles of it situated in other counties), 65; the Silurian limestone, etc., in the south of the county, 16; the Rowley basalt, 1; the Clent basalt, 2; the Arley coal-field, basalt, cornstone, etc., 7; the mountain limestone, 40; the Cheadle coal-field, 18; the Chiddleton coal-field, 1; the Meerbrook coal-field, 4; the millstone grit, 100; the New Red Sandstone (marl, gravel, rock, sand, and peat), 825.

The county is very rich in fossils. In the coal, the limestone, and the Silurian deposits the remains of marine animals and plants are especially numerous. The museums in several towns have good collections of corals, calamites, and ferns; and probably the finest examples of trilobites and encrinites have been found in this part of England. The teeth of the *Megalichthys* have been found in the coal strata, and the Dudley museum contains a specimen of *M. hibberti*, nearly entire. The county is very rich in mineral productions. In a single year 12,000,000 tons of coal and 1,173,866 tons of iron have been obtained. The greatest quantity of iron is raised in the north and of coal in the south. Of the places at which the various products are found may be named—Birch Hills for anthracite coal; Hanley Green for peacock coal; Longton for cannel coal; Wednesbury for hæmatite iron ore; Langley Close for gray marble; the Rowley Hills for basalt. At Bilston casting sand, at Kingswinford fire-clay and fire bricks, at Tutbury alabaster, at Powke Hill black marble, and at Hemley Green red ochre are produced. In December, 1885, an important discovery of coal was made near Dudley. Mr. Blewitt has driven from the Grace Mary pits about 250 yards towards the Ivy House estate, through the igneous rocks, and come upon a large area of the best hard coal, about thirty feet in thickness, and some thirty acres in area.

Climate and Agriculture.—As regards climate the county shares the characteristics common to the midland district of England. Agriculture, though not its distinctive feature, forms a very important item in the industry and wealth of Staffordshire. The returns for 1886 furnish the following report: in corn crops there were 94,273 acres; roots, artificial grasses, etc., 43,343; clover and grasses, 46,832; permanent pasture, 412,566; fallow, 7203; orchards, 1188; market gardens, 866; nursery grounds, 233; woods and plantations, 34,911. From the same returns we learn that the number of horses employed in agriculture was 16,031; unbroken horses and brood mares, 7802; cows in milk or in calf, 74,868; cattle under two years old, 56,224; two years and upward, 25,922; one-year-old sheep, 142,955; sheep under one year, 106,950; and pigs, 48,569. The total number of proprietors in the county was returned in 1873 as 43,371, possessing 638,084 acres, producing an annual rental of £3,630,254 [$17,643,034.44]. The estimated extent of waste or common land was 7809 acres. Of the owners 33,672 owned less than one acre each. Eight proprietors were owners of more than 10,000 acres each, viz., Earl of Lichfield, 21,433; Earl of Shrewsbury, 18,954; Lord Hatherton, 14,901; Marquis of Auglesey, 14,344; Sir J. H. Crewe, 14,256; Duke of Sutherland, 12,744; Lord Bagot, 10,993; Sir T. F. F. Boughey, 10,505.

Manufactures.—The manufactures of Staffordshire are of a very varied character. Almost everything which is made of iron is manufactured in one town or another; and it would only be tedious to enumerate the almost infinite variety of goods produced. Wolverhampton and Willenhall are famous for locks, Cradley for nails, Oldbury for railway carriages, Walsall for spurs, bits, and saddlery, Tipton for anchors, Smethwick for glass, Soho for steam engines and hydraulic jacks, Wednesfield for keys, Bilston for tinplate wares, and Bloxwich for bits. Thanks to the labors of Josiah Wedgwood and Flaxman, the pottery work of Staffordshire ranks among the most famous manufactures of the kingdom, and Etruria is a household word wherever the admirable and artistic Wedgwood ware is known. The ale produced at Burton-on-Trent finds a market in almost every civilized country in the world, and in some that can scarcely be so described.

Communication.—The county is admirably provided with railways, canals, and tramways. The main roads are excellent, and are well maintained and kept in capital condition.

Administration and Population.—The population in 1861 was 746,943; in 1871 858,326; and in 1881 981,013 (males 492,009, females 489,004), an average of 1.31 persons to an acre. Staffordshire is in the Oxford circuit, and is nearly all in the diocese of Lichfield. The seat of the bishopric and the will courts are at Lichfield. The assize town is Stafford. There are five hundreds, each having two divisions: North Totmonslow (Leek) and South Totmonslow (Cheadle), North Pirehill (Potteries), and South Pirehill (Stone), North Offlow (Burton-on-Trent), and South Offlow (Walsall), East Cuttlestone (Rugeley) and West Cuttlestone (Gnosall), North Seisdon (Sedgley) and South Seisdon (Kinfare). The county has one court of quarter sessions, and is divided into twenty-two petty and special sessional divisions; and there are 247 civil parishes and sixteen poor law unions. The municipal boroughs number twelve: Burslem, population 26,522; Burton-on-Trent (partly in Derbyshire), 39,288; Hanley, 48,361; Lichfield, 8349; Longton, 18,620; Newcastle-under-Lyme, 17,508; Stafford, 19,977; Stoke-on-Trent, 19,261; Tamworth (partly in Warwickshire), 4891; Walsall, 58,795; West Bromwich, 56,295; Wolverhampton, 75,766.

By the Redistribution of Seats Act, 1885, the parliamentary representation of Staffordshire was arranged as follows: seven boroughs each returning one member, one borough returning three, and seven county divisions with one member to each,—making seventeen members for the whole county. The county divisions are named respectively Burton, Handsworth, Kingswinford, Leek, Lichfield, North-West, and West. The following is a list of the boroughs, with populations given by or based on the census of 1881: Wolverhampton (three members), 164,332; Hanley, 75,912; Newcastle-under-Lyme, 49,293; Stafford, 19,977; Stoke-on-Trent, 64,091; Walsall, 59,402; Wednesbury, 68,142; West Bromwich, 56,295.

History and Antiquities.—Much antiquarian learning has been employed in showing that Staffordshire was in early ante-Roman days famous for the presence and powers of the Druids. Cannock Chase has been described as their headquarters in Britain; and Bar Beacon has been generally accepted as one of their principal places of worship, of which Drood or Druid Heath by its name still preserves the tradition. At the time of Cæsar's arrival in the island this part of England was peopled by tribes whom the Roman authors designate as Cornavii or Carnabii. The conquerors named the central part of the country, which included Staffordshire, Flavia Cæsariensis. Two of their most famous roads, Watling Street and Icknield Street, passed through the county,—the first-named from Fazeley through Wall (*Etocetum*) to Wroxeter (*Uriconium*), and the Icknield Street through Birmingham to Wall, and by Burton-on-Trent to Derby. In Saxon times Staffordshire formed part of the great kingdom of Mercia, which was remarkable for the tenacity with which the people clung to their old faith and resisted the introduction of Christianity. The new faith, however, prevailed over paganism, and a cathedral was founded at Lichfield. Through the influence of Offa, Pope Adrian in 786 made the see an independent archbishopric, but this honor was only possessed for a short period. Mercia was frequently invaded by the Danes, and several battles were fought in Staffordshire, notably at Tettenhall and Wednesfield (Woden's Field), and a large number of Danes settled in this part. So rapidly did they occupy the land that in 1016, when the Danish king Canute divided his conquests into four earldoms, Mercia was believed to have as many Danish as Saxon inhabitants. After the Norman Conquest the county was divided among the Conqueror's retainers, the barons De Torri, De Montgomery, Fitz-Ansculf and de Ferrers coming in for the lion's share. Of after historical events the most noted are the defeat and execution of the earl of Lancaster by Edward II. in 1322, and the battle at Blore Heath in 1459, in which the Yorkists were victorious over the Lancasterians. During the Civil War Lichfield cathedral was besieged in 1643, and Lord Brook was killed by a shot fired from the battlements of the great tower. Mary queen of Scots was imprisoned in Tutbury Castle from 1569 to 1572. In 1745 Charles Edward, the Young Pretender, in his attempt to win the crown of England, penetrated as far as Leek.

Early British remains exist in various parts of the county; and a large number of barrows have been opened in which human bones, urns, fibulæ, stone hammers, armlets, pins, pottery, and other articles have been found. In the neighborhood of Wetton no fewer than twenty-three barrows have been opened, and British ornaments have been found in Needwood Forest. Several Roman camps also exist in different parts. But of mediæval times the chief legacy is the cathedral at LICHFIELD (*q. v.*), one of the most beautiful in the kingdom. Of other interesting places the most worthy of notice are Beaudesert, Bentley Hall, Chillington, Dudley Castle, Enville Hall, Ingestre, Stafford Castle, Tamworth Castle, Tixall, and Wrottesley Hall. More modern mansions are Ilam Hall, Alton Towers, Shugborough, Patteshull, Keele Hall, and Trentham. Of famous personages belonging to the county are John Dudley (duke of Northumberland), Cardinal Pole, Archbishop Sheldon, Col. John Lane, General Harrison, Lord Anson, Earl St. Vincent, Izaak Walton, Dr. Samuel Johnson, David Garrick, Josiah Wedgwood, Miss Seward, Mary Howitt.

See Plot, *Natural History of Staffordshire*, 1686; Erdeswick, *Survey of Staffordshire*, 1717; Shaw, *History and Antiquities of Staffordshire*, 1798-1801; Pitt, *Topographical History of Staffordshire*, 1817; Garner, *Natural History of the County of Stafford*, 1844; Langford, *Staffordshire and Warwickshire*, 1874; and the publications of the Salt Archæological Society.

STAFFORD, a parliamentary and municipal borough of England, and the county town of Staffordshire, is situated on the left bank of the river Sow, almost in the heart of England. It is 123 miles from London and 29¼ from Birmingham, and is in the southern division of the hundred of Pirehill. The principal trades of the town are tanning and the manufacture of boots and shoes, more especially for ladies. The oldest church is that of St. Chad, said to be originally of Saxon origin. It was formerly a large and beautiful church, with chancel, nave, aisles, transepts, and a central tower, but has suffered severely from time, neglect, and rough treatment. Restoration was begun in 1855, and the operations led to the discovery of some fine interlacing Norman arches and a beautiful Norman archway with some rich sculptured work between the nave and tower. These were restored in 1856 and a new roof was put on the chancel in memory of Izaak Walton. In 1874, the nave, arcades, and open-timbered roof were restored in memory of Mr. Thomas Salt; in 1874–75 the south aisle was rebuilt, and in 1884–85 the tower. The finest of the churches in Stafford is undoubtedly St. Mary's, which was admirably restored in 1844–45 by Sir Gilbert Scott, at a cost of £30,000 [$145,800]. It contains some good monuments, and several very fine memorial windows of stained glass. Other churches worthy of mention are Christ Church, St. Paul's, and St. Thomas's. The grammar school is a very old foundation, enlarged by Edward VI.; the present building was erected in 1862. The free library was opened in 1882, and is now fairly well supplied with books. The William Salt library contains a unique collection of books, deeds, autographs, engravings, and drawings relating to the county, collected by Mr. Salt and presented by his widow. It contains some 7000 volumes, between 2000 and 3000 deeds, and more than 9000 drawings, autographs, and valuable MSS., mostly relating to the history, topography, etc., of the county. The town also possesses a good museum, collected principally by Mr. Clement L. Wragge, and called by his name; specially interesting is its almost perfect collection of fossils. Stafford also contains a good school of art and a mechanics' institute. Other prominent buildings are the shire hall, in which the assizes and quarter sessions are held, and the borough hall; the latter contains the municipal offices, and also has a large hall for public meetings. Stafford is well supplied with charitable institutions, among which may be mentioned the general infirmary, built in 1766; the county lunatic asylum in 1818; and the Coton Hill institution for the insane in 1854, beautifully situated on rising ground, which commands extensive views of some of the loveliest country in the county, while its own grounds are tastefully laid out. The householders of Stafford formerly possessed the right of using some very extensive common land situated north of the town; in 1880, however, all that remained (134 acres) was inclosed, and is now held for the people by a committee of householders elected annually. A part of this land, called Stone Flat, is preserved as a public recreation ground. Of another common named Coton Field, consisting of about 180 acres, 70 acres were in 1884 transferred absolutely to the freemen, and have been divided into 401 garden allotments, which are let at a small rental to resident freemen or their widows. The parliamentary borough (area 774 acres, with population of 18,904 in 1881) was extended in 1885, and is now identical with the municipal borough. The area of this is 1012 acres, and the population, 14,437 in 1871, was in 1881 19,977. The

Act of 1885 reduced the parliamentary representation from two members to one.

Stafford was of considerable importance before the Conquest. The site was at first known as Berteliney or Betheney, from the island on which the earliest houses were built. As the town grew its name was changed into that of Statford or Stadford. In 913 Ethelfleda, sister of Edward the Elder, erected a fortification here, generally called a castle, but doubtless one of those defensive mounds which from their admirable positions were afterwards selected by the Normans as the sites of their castles and strongholds. About a year and a half afterwards Edward the Elder built a tower, with walls and a fosse round it. Pennant says this was on the mount called Castle Hill by Speed. Stafford is mentioned in Domesday as a city paying £9 in customs. There were 18 royal burgesses, and the earls of Mercia possessed twenty mansions. The number of houses entered is 178. William built a castle on the old site, of which he appointed Robert de Torri governor, who took the name De Stafford from that of the town, and was the originator of the great family of the Staffords. At this time it contained a royal mint; some of the coins are still extant, bearing on the obverse the head and name of the king, and on the reverse "Godwinne on Staef." Godwinne was the "king's moneyer." The castle of Robert de Torri was rebuilt by Ralph de Stafford in the reign of Edward III.; during the Civil War it was held for the Royalists by the earl of Northampton, but was taken for the Parliament by Sir William Brereton in May, 1643. The castle was soon afterwards demolished by order of the Parliament. When fortified, Stafford had four gates. That on the south, near the river bridge, called the Green-gate, was taken down in 1780. The arch of the East-gate was standing a few years ago. The Gaol-gate was in ruins in 1680. The site of the fourth gate is unknown. King John confirmed and enlarged the privileges granted by the old charter. This was again confirmed by Edward VI., and on August 6, 1575, Elizabeth visited the town. Stafford adopted the Local Government Act, 1858, on April 23, 1872; and in 1876 an Act was obtained for extending the borough boundaries. The corporation now consists of a mayor, eight aldermen, and twenty-four councillors.

STAG. See DEER.

STAHL, GEORG ERNST (1660–1734), chemist, was born on 21st October, 1660, at Ansbach, studied at Jena, and became court-physician to the duke of Weimar in 1687. In 1694 he was appointed professor of medicine in Halle and in 1716 physician to the king of Prussia. He died at Berlin on May 14, 1734. His *Theoria Medica Vera* appeared at Halle in 1707 (see MEDICINE, vol. xv. p. 822), and his *Experimenta et Observationes Chemicæ* at Berlin in 1731 (see CHEMISTRY, vol. v. p. 399).

STAIR, JAMES DALRYMPLE, FIRST VISCOUNT (1619–1695), was born in May, 1619, at Drummurchie in Ayrshire. He was descended from a family for several generations inclined to the principles of the Reformation, and had ancestors both on the father's and the mother's side amongst the Lollards of Kyle. His father James Dalrymple, laird of the small estate of Stair in Kyle, died when he was an infant; his mother, Janet Kennedy of Knockdaw, is described as "a woman of excellent spirit," who took care to have him well educated. From the grammar school at Mauchline he went in 1633 to the university of Glasgow, where he graduated in arts on July 26, 1637. Next year he went to Edinburgh, probably with the intention of studying law, but the troubles of the times then approaching a crisis led him to change his course, and we next find him serving in the earl of Glencairn's regiment in the war of the Covenant. What part he took in it is not certainly known, but he was in command of a troop when recalled in 1641 to compete for a regency (as a tutorship or professorship was then called) in the university of Glasgow. He was elected in March. Mathematics, logic, ethics, and politics were the chief subjects of his lectures, and a notebook on logic by one of his students has been preserved. His activity and skill in matters of college business were praised by his colleagues, who numbered amongst them some of the leading Covenanting divines, and his zeal in teaching was gratefully acknowledged by his students. After nearly seven years' service he resigned his regency, and removed to Edinburgh, where he was admitted to the bar on February 17, 1648. This step had probably been rendered easier by his marriage four years before to Margaret Ross, co-heiress of Balneil in Wigtown. Stair's practice at the bar does not appear to have been large; his talents lay rather in the direction of learning and business than of oratory or advocacy. His reputation and the confidence reposed in him were shown by his appointment in 1649 as secretary to the commission sent to The Hague to treat with Charles II. by the parliament of Scotland. The negotiation having been broken off through the unwillingness of the young king to accept the terms of the Covenanters, Stair was again sent in the following year to Breda, where the failure of Montrose's expedition forced Charles to change his attitude, and to return to Scotland as the covenanted king. Stair had preceded him, and met him on his landing in Aberdeenshire, probably carrying with him the news of the execution of Montrose, which he had witnessed.

During the Commonwealth Stair continued to practice at the bar; but like most of his brethren he refused in 1654 to take the oath of allegiance to the Commonwealth and abjuration of royalty. Three years later, on the death of Lord Balcomie, Stair was appointed one of the commissioners for the administration of justice in Scotland on the recommendation of Monk. His appointment to the bench on 1st July, 1657, by Monk was confirmed by Cromwell on the 26th. Stair's association with the English judges at this time must have enlarged his acquaintance with English law, as his travels had extended his knowledge of the civil law and the modern European systems which followed it. He thus acquired a singular advantage when he came to write on law, regarding it from a cosmopolitan or international rather than a merely local or national point of view. His actual discharge of judicial duty at this time was short, for after the death of Cromwell the courts in Scotland were shut,—a new commission issued in 1660 not having taken effect, it being uncertain in whose name the commission ought to run. It was during this period that Stair became intimate with Monk, who is said to have been advised by him when he left Scotland to call a full and free parliament. Soon after the Restoration Stair went to London, where he was received with favor by Charles, knighted, and included in the new nomination of judges in the Court of Session on 13th February, 1661. He was also put on various important commissions, busied himself with local and agricultural affairs, and, like most of the Scottish judges of this and the following century, acted with zest and credit the part of a good country gentleman.

In 1662 he was one of the judges who refused to take the declaration that the National Covenant and the Solemn League and Covenant were unlawful oaths, and, forestalling the deposition which had been threatened as the penalty of continued non-compliance, he placed his resignation in the king's hands. The king, however, summoned him to London, and allowed him to take the declaration under an implied reservation. The next five years of Stair's life were comparatively uneventful, but in 1669 a family calamity, the exact facts of which will probably never be ascertained, overtook him. His daughter Janet, who had been betrothed to Lord Rutherfurd, was married to Dunbar of Baldoon, and some tragic incident occurred on the wedding night, from the effects of which she never recovered. As the traditions vary on the central fact, whether it was the bride who stabbed her husband, or the husband who stabbed the bride, no credence can be given to the mass of superstitions and spiteful slander which surrounded it, principally levelled at Lady Stair. In 1670 Stair served as one of the Scottish commissioners who went to London to treat of the Union; but the project, not seriously pressed by Charles and his ministers, broke down through a claim on the part of the Scots to what was deemed an excessive representation in the British parliament. In January, 1671, Stair was appointed president of the Court of Session. In the following year, and again in 1673, he was returned to parliament for Wigtownshire, and took part in the important legislation of those years in the department of private law. During the bad time of Lauderdale's government Stair used his influence in the privy council and with Lauderdale to mitigate the severity of the orders passed against ecclesiastical offenders, but for the most part he abstained from attending a board whose policy he could not approve. In 1679 he went to London to defend the court against charges of partiality and injustice which had been made against it, and was thanked by his brethren for his success. When in the following year the duke of York came to Scotland, Stair distinguished himself by a bold speech, in which he congratulated the duke on his coming amongst a nation which was entirely Protestant. This speech can have been little relished, and the duke was henceforth his implacable enemy. His influence prevented Stair from being made chancellor in 1681, on the death of the duke of Rothes.

The parliament of this year, in which Stair again sat, was memorable for two statutes, one in private and the other in public law. The former, relating to the testing of deeds, was drawn by Stair, and is sometimes called by his name. Although it is susceptible of some improvement, the two centuries during which it has regulated this important branch of practical conveyancing is a testimony to the skill of the draftsman. The other was the infamous Test Act, probably the worst of the many measures devised at this period with the object of fettering the conscience by oaths. Stair also had a minor share in the form which this law finally took, but it was confined to the insertion of a definition of "the Protestant religion"; by this he hoped to make the test harmless, but his expectation was disappointed, and the form in which it emerged from parliament was such that no honest man could take it. Yet, self-contradictory and absurd as it was, the Test Act was at once rigidly enforced. Argyll, who declared he took it only in so far as it was consistent with itself and the Protestant religion, was tried and condemned for treason, and narrowly saved his life by escaping from Edinburgh Castle the day before that fixed for his execution. Stair, dreading a similar fate, went to London to seek a personal interview with the king, who had more than once befriended him, perhaps remembering his services in Holland; but the duke of York intercepted his access to the royal ear, and when he returned to Scotland he found a new commission of judges issued, from which his name was omitted. He retired to his wife's estate in Galloway, and occupied himself with preparing for the press his great work, *The Institutions of the Law of Scotland*, which he published in the autumn of 1681, with a dedication to the king.

He was not, however, allowed to pursue his legal studies in peaceful retirement. His wife was charged with attending conventicles, his factor and tenants severely fined, and he was himself not safe from prosecution at any moment. A fierce dispute arose between Claverhouse and his son, the master of Stair, relative to the regality of Glenluce; and, both having appealed to the privy council, Claverhouse, as might have been expected, was absolved from all the charges brought against him, and the master was deprived of the regality. Stair had still powerful friends, but his opponents were more powerful, and he received advice to quit the country. He repaired to Holland in October, 1684, took up his residence, along with his wife, some of his younger children, and his grandchild, afterwards the field-marshal Stair, at Leyden. While there he published the *Decisions of the Court of Session between* 1666 *and* 1671, of which he had kept a daily record, and a small treatise on natural philosophy, entitled *Physiologia Nova Experimentalis*.

In his absence a prosecution for treason was raised against him and others of the exiles by Sir G. Mackenzie, the lord advocate. He was charged with accession to the rebellion of 1679, the Ryehouse plot, and the expedition of Argyll. With the first two he had no connection; with Argyll's unfortunate attempt he had no doubt sympathized, but the only proof of his complicity was slight, and was obtained by torture. The proceedings against him were never brought to an issue, having been continued by successive adjournments until 1687, when they were dropped. The cause of their abandonment was the appointment of his son, the master of Stair, who had made his peace with James II., as lord advocate in room of Mackenzie, who was dismissed from office for refusing to relax the penal laws against the Catholics. The master only held office as lord advocate for a year, when he was "degraded to be justice clerk"—the king and his advisers finding him not a fit tool for their purpose. Stair remained in Holland till the following year, when he returned under happier auspices in the suite of William of Orange. William, who had made his acquaintance through the pensionary Fagel, was ever afterwards the firm friend of Stair and his family. The master was made lord advocate; and, on the murder of President Lockhart in the following year, Stair was again placed at the head of the Court of Session. An unscrupulous opposition, headed by Montgomery of Skelmorlie, who coveted the office of secretary for Scotland, and Lord Ross, who aimed at the presidency of the court, sprang up in the Scottish parliament; and an anonymous pamphleteer, perhaps Montgomery himself or Ferguson the Plotter, attacked Stair in a pamphlet entitled *The Late Proceedings of the Parliament of Scotland Stated and Vindicated*. He defended himself by publishing an *Apology*, which, in the opinion of impartial judges, was a complete vindication. Shortly after its issue he was created Viscount Stair. He had now reached the summit of his prosperity, and the few years which remained of his old age were saddened by private and public cares. In 1692 he lost his wife, the faithful partner of his good and evil fortune for nearly fifty years. The massacre of Glencoe, which has marked the master of Stair with a stain which his great services to the state cannot efface,—for he was undoubtedly the principal adviser of William in that treacherous and cruel deed,—was used as an opportunity by his adversaries of renewing their attack on the old president. His own share in the crime was remote; it was alleged that he had as a privy councillor declined to receive Glencoe's oath of allegiance, though tendered, on the technical ground that it was emitted after the day fixed, but even this was not clearly proved. But some share of the odium which attached to his son was naturally reflected on him. Other grounds of complaint were not difficult to make up, which found willing supporters in the opposition members of parliament. A disappointed suitor brought in a bill in 1693 complaining of his partiality. He was also accused of domineering over the other judges and of favoring the clients of his sons. Two bills were introduced without naming him but really aimed at him,—one to disqualify peers from being judges and the other to confer on the crown a power to appoint temporary presidents of the court. The complaint against him was remitted to a committee, which after full inquiry completely exculpated him; and the two bills, whose incompetency he demonstrated in an able paper addressed to the commission and parliament, were allowed to drop. He was also one of a parliamentary commission which prepared a report on the regulation of the judicatures, afterwards made the basis of a statute in 1695 supplementary to that of 1672, and forming the foundation of the judicial procedure in the Scottish courts down to the present century. On November 29, 1695, Stair, who had been for some time in failing health, died in Edinburgh, and was buried in the church of St. Giles.

In the same year there was published in London a small volume with the title *A Vindication of the Divine Perfections, Illustrating the Glory of God in them by Reason and Revelation, methodically digested,—By a Person of Honor.* It was edited by the two Nonconformist divines, William Bates and John Howe, who had been in exile in Holland along with Stair, and is undoubtedly his work. Perhaps it had been a sketch of the "Inquiry Concerning Natural Theology" which he had contemplated writing in 1681. It is of no value as a theological work, for Stair was no more a theologian than he was a man of science, but it is of interest as showing the serious bent of his thoughts and the genuine piety of his character.

It is as a legal writer and a judge that he holds a preeminent place amongst many distinguished countrymen belonging to his profession. The full title of his great work, which runs as follows—*The Institutions of the Law of Scotland, deduced from its Originals, and collated with the Civil, Canon, and Feudal Laws, and with the Customs of Neighboring Nations*—is fully borne out by the contents, and affords evidence of the advantage Stair had enjoyed from his philosophical training, his foreign travels, and his intercourse with Continental jurists as well as English lawyers. It is no narrow technical treatise, but a comprehensive view of jurisprudence as based on philosophical principles and derived from a Divine Author. But neither does it lose itself in generalities; for it is the work of a lawyer and judge intimately acquainted with every detail in the practical application of law in his native country. Unfortunately for its permanent fame and use, much of the law elucidated in it has now become antiquated through the decay of the feudal part of Scottish law and the large introduction of English law, especially in the departments of commercial law and equity. But its spirit still animates Scottish law and educates Scottish lawyers, and it may be hoped will continue to do so, saving them from being the slaves of precedent or the victims of the utilitarian philosophy which regards all positive law as conventional, and destitute of necessary principles derived from the nature of the world and man.

The *Physiologia* was favorably noticed by Boyle, and is interesting as showing the activity of mind of the exiled judge, who returned to the studies of his youth with fresh zest when physical science was approaching its new birth. But he was not able to emancipate himself from formulæ which had cramped the education of his generation, and had not caught the light which Newton spread at this very time by the communication of his *Principia* to the Royal Society of London.

Stair was fortunate in his descendants. "The family of Dalrymple," observes Sir Walter Scott, "produced within two centuries as many men of talent, civil and military, of literary, political, and professional eminence, as any house in Scotland." His five sons were all remarkable in their professions. The master of Stair, who became the first earl, was an able lawyer, but still abler politician. Sir James Dalrymple of Borthwick, one of the principal clerks of session, was a very thorough and accurate historical antiquary. Sir Hew Dalrymple of North Berwick succeeded his father as president, and was reckoned one of the best lawyers and speakers of his time. Thomas Dalrymple became physician to Queen Anne. Sir David Dalrymple of Hailes was lord advocate under Anne and George I. Stair's grandson, the field-marshal and second earl, gained equal credit in war and diplomacy. His great grandson, Sir David Dalrymple, Lord Hailes, also rose to the bench, where he had an honorable character for learning as a civil and humanity as a criminal judge. But his literary exceeded his legal fame. As an honest and impartial historian he laid the foundations of the true narrative of Scottish history, from which all his successors have largely borrowed.

For a fuller account of the life of Stair see *Annals of the Viscount and First and Second Earls of Stair*, by J. Murray Graham, and *Memoir of Sir James Dalrymple, First Viscount Stair*, 1875, by Æ. J. G. Mackay. (Æ. M.)

STALYBRIDGE, a municipal and parliamentary borough of England, partly in Lancashire but principally in Cheshire, is situated on the Tame, 1 mile east of Ashton-under-Lyne, and 7½ east of Manchester. The Tame is crossed by bridges connecting the counties of Chester and Lancaster. The principal public buildings are the town-hall (1831), the Foresters' hall (1836), the district infirmary, the mechanics' institute (1861), the people's institute (1864), the market-hall (1866), and the Oddfellows' hall (1878). Stamford park, extending to about 60 acres, and lying between Stalybridge and Ashton, was opened 12th July, 1873. The town is one of the oldest seats of the cotton manufacture, the first cotton mill having been erected in 1776, and the first steam engine in 1795. In addition to extensive cotton mills, it possesses woollen factories, iron and brass foundries, machine works, nail works, and paper mills. Stalybridge was created a market-town in 1828, was incorporated as a municipal borough in 1857, and obtained the privilege of returning a member to parliament in 1867. The municipal borough (area 806 acres) had a population of 21,092 in 1871, and 22,785 in 1881; its limits were extended in 1881 to 3120 acres, with a population of 25,977. The population of the parliamentary borough (area 2214 acres) in 1871 was 35,114, and in 1881 it was 39,671. The area added to the municipal borough in 1881 was in 1885 included in the parliamentary borough also,—the population of this extended area being 42,863 at the census of 1881.

STAMFORD, a municipal borough and market-town, chiefly in Lincolnshire but partly in Northamptonshire, is situated on the river Welland, and on branches of the Midland, the London and North Western, and the Great Northern railway lines, 89 miles north of London, and 55 south of Lincoln. The ancient bridge over the Welland was in 1849 superseded by a new structure of stone, erected at a cost of £8500 [$41,310]. The town formerly possessed fourteen parish churches, but now has only six, viz., St. Mary's, erected at the end of the 13th century, possessing an Early English tower, with Decorated spire, the principal other parts of the building being Perpendicular; All Saints, also of the 13th century, the steeple being built at the expense of John Brown, merchant of the staple at Calais, in the beginning of the 15th century; St. Michael's, rebuilt in 1836 on the site of one erected in 1269; St. George's, Early English, Decorated, and Perpendicular, for the most part rebuilt in 1450, at the expense of William Bruges, first garter king-at-arms; St. John Baptist's, Perpendicular, erected about 1452; and St. Martin's, Perpendicular, in which Lord Treasurer Burghley is buried. Formerly there were several religious houses: the Benedictine monastery of St. Leonard's, founded in the 7th century, of which there are still some remains; the Carmelite monastery (1291), of which the west gate still stands; the houses for gray friars (time of Henry III.), Dominicans (1240), Gilbertines (1291), and Augustinians (1316). The principal secular buildings are the town-hall (rebuilt 1776), the corn exchange (1859), and the literary and scientific institute (1842), with a library of 6000 volumes. There are a large number of charitable institutions, including the Stamford and Rutland infirmary (1828), Browne's hospital, founded in the time of Richard III., Snowden's almshouses (1604), Truesdale's almshouses (1700), and Burghley hospital, founded by Lord Treasurer Burghley (1597). Ratcliffe's and Browne's high school for boys was lately erected at a cost of £7000 [$34,020], on the site of Ratcliffe's free school; and Brown's school for girls in St. Martin's was erected in 1876 at a cost of £5000 [$24,300]. The prosperity of the town depends chiefly on its connection with agriculture. It possesses iron foundries, agricultural implement works, wagon factories, and breweries. There is also some trade in coal, timber, stones, and slates. The population of the municipal borough (area 1766 acres) in 1871 was 7846, and in 1881 it was 8773; that of the parliamentary borough (area 1894 acres) in the same years was 8086 and 8993. The latter was merged in the counties in 1885, giving its name to a parliamentary division of Lincolnshire.

The town is of very remote antiquity, and is supposed to have grown into importance after the decay of the Roman village of Bridge Casterton, two miles distant. Its name, an early form of which was Staenford, was derived from a passage at the town across the Welland by stone. It was the scene of the first battle of the Picts and Scots against the Britons and Saxons in 449, and subsequently became one of the five great Danish boroughs. A castle was built early in the 10th century on the south bank of the river opposite the town, but has long disappeared; and of another on the northwest of the town, fortified by Stephen, only the foundations now remain. The town was at one time enclosed by walls, and there are still traces of gateways on the east and west sides. In the reign of Henry III. the lectures of the Carmelites on divinity and the liberal arts led to the erection of colleges, and Stamford became celebrated as a place of education. When dissensions arose among the students of Oxford in the reign of Edward III., many removed thither, and ultimately the universities both of Oxford and Cambridge thought it necessary to pass statutes prohibiting their students from proceeding to other places for any part of their education, Stamford being specially mentioned in the Oxford statute. At the time of the Conquest, Stamford was governed by aldermen. It was incorporated by charter in the reign of Edward IV. In 1663 it received a charter from Charles II. constituting its chief magistrate a mayor. It returned two members to parliament from the reign of Edward I. till 1867, and one from 1867 to 1885. The deanery of Stamford is an ancient peculiar, the appointment being vested in the bishop of Lincoln.

STAMFORD, a borough of the United States, in Fairfield county, Connecticut, is situated on Long Island Sound, 35 miles northeast of New York city, on the New York, New Haven and Hartford Railroad. It has a small harbor accessible to steamboats by means of a canal; and among its public buildings are the town-hall and several handsome churches. Locks, carriages, stoves, fire-bricks, edge-tools, cranes, hardware, hosiery, and especially logwood extract and liquorice are manufactured in the borough. The population was 9714 in 1870 and 11,297 in 1880.

STAMMERING, or STUTTERING, designates a spasmodic affection of the organs of speech in which the articulation of words is suddenly checked and a pause ensues, often followed by a repetition in rapid sequence of the particular sound at which the stoppage occurred. Of this painful affection there are many grades, from a slight inability to pronounce with ease certain letters or syllables, or a tendency to hesitate and to interject unmeaning sounds in a spoken sentence, to the more severe condition in which there is a paroxysm of spasms of the muscles, not only of the tongue and throat and face, but even of those of respiration and of the body generally. To understand in some degree the explanation of stammering it is necessary to consider shortly the physiological mechanism of articulate speech. Speech is the result of various muscular movements affecting the current of air as it passes in expiration from the larynx through the mouth. If the vocal cords are called into action, and the sounds thus produced are modified by the muscular movements of the tongue, cheeks, and lips, we have vocal speech; but if the glottis is widely open and the vocal cords relaxed, the current of air may still be moulded by the muscular apparatus so as to produce speech without voice, or whispering (see VOICE). In both cases, however, the mechanism is very complicated, requiring a series of nervous and muscular actions, all of which must be executed with precision and in accordance. In vocal speech, for example, it is necessary that the respiratory movements, more especially those of expiration, occur regularly and with nice adjustment to the kind of articulate expression required; that the vocal cords be approximated and tightened by the muscles of the larynx acting with delicate precision, so as to produce the sound of the pitch desired; that the *rima glottidis* (or aperture of the larynx) be opened so as to produce prolonged sounds, or suddenly closed so as to cut off the current of air; that the movements of the muscles of the tongue, of the soft palate, of the jaws, of the cheeks, and of the lips occur precisely at the right time and to the requisite extent; and finally that all of these muscular adjustments take place with rapidity and smoothness, gliding into each other without effort and without loss of time. Exquisite co-ordination of muscular movement is therefore necessary, involving also complicated nervous actions. Hence is it that speech is acquired by long and laborious effort. A child possesses voice from the beginning; it is born with the capacity for speech; but articulate expression is the result of education. In infancy, not only is knowledge acquired of external objects, and signs attached in the form of words to the ideas thus awakened, but the nervous and muscular mechanisms by which these signs or words receive vocal expression are trained by long practice to work harmoniously.

It is not surprising, therefore, that in certain cases, owing to some obscure congenital defect, the co-ordination is not effected with sufficient precision, and that stammering is the result. Even in severe cases no appreciable lesion can be detected either in the nervous or muscular mechanisms, and the condition is similar to what may affect all varieties of finely co-ordinated movements. The mechanism does not work smoothly, but the pathologist is unable to show any organic defect. Thus the co-ordinated movements necessary in writing are disturbed in scrivener's palsy, and the skilful performer on the piano or on any instrument requiring minute manipulation may find that he is losing the power of delicate adjustment. Stammering is occasionally hereditary. It rarely shows itself before the age of four or five years, and as a rule it is developed between this age and puberty. Men stammer in a much larger proportion than women. It may occur during the course of nervous affections, such as hysteria, epilepsy, or tabes dorsalis; sometimes it follows febrile disorders; often it develops in a child in a feeble state of heath, without any special disease. In some cases a child may imitate a stammerer and thus acquire the habit. Any general enfeeblement of the health, and especially nervous excitement, aggravates the condition of a confirmed stammerer.

Stammerers, as a rule, find the explosive consonants *b*, *p*, *d*, *t*, *k*, and hard *g* the most difficult to articulate, but many also are unable easily to deal with the more continuous consonants, such as *v*, *f*, *th*, *s*, *z*, *sh*, *m*, *n*, *y*, and in severe cases even the vowels may cause a certain amount of spasm. Usually the defect is not observed in whispering or singing; but there are exceptions to this statement. In pronouncing the explosive sounds the part of the oral apparatus that ought suddenly to open or close remains spasmodically closed, and the stammerer remains for a moment voiceless or strives pitifully to overcome the obstruction, uttering a few successive puffs or sounds like the beginning of the sound he wishes to utter. The lips thus remain closed at the attempted utterance of *b* and *p*; the tip of the tongue is pressed against the hard palate or the back of the upper front teeth in *d* and *t*; and the back of the tongue presses against the posterior part of the palate in pronouncing *g* hard and *k*. In attempting the continuous consonants, in which naturally the passage is not completely obstructed, the stammerer does not close the passage spasmodically, but the parts become fixed in the half-opened condition, or there are intermittent attempts to open or close them, causing either a drawling sound or coming to a full stop. In severe cases, where even vowels cannot be freely uttered, the spasm appears to be at the *rima glottidis* (opening of the larynx). Again, in some cases, the spasm may affect the respiratory muscles, giving rise to a curious barking articulation, in consequence of spasm of the expiratory muscles, and in such cases the patient utters the first part of the sentence slowly, gradually accelerates the speed, and makes a rush towards the close. In the great majority of cases the spasm affects the muscles of articulation proper, that is, those of the pharynx, tongue, cheeks, and lips. In the most aggravated cases the condition of the patient is pitiable. It has thus been well described by Dr. Bristow in an article full of interesting details:

"The most distressing cases are those in which the spasm extends to parts unconnected with speech,—it may be to nearly the whole muscular organism. In such a case the spasm commences, let us assume, at the base of the tongue; the mouth opens widely and remains in that position; the muscles of expiration work convulsively; the glottis contracts; respiration becomes arrested; the face becomes congested and the veins dilated; violent spasmodic movements involve the trunk and limbs; and only after some time, either when the patient becomes exhausted, or when he resolutely restrains his attempts to articulate, does his paroxysm come to an end."—*Quain's Dictionary of Medicine*, p. 1513.

Such a case is not common; it is more paroxysmal than habitual; and in ordinary conversation, when the patient is free from nervous excitement, the defect may be scarcely observed. A condition named *aphthongia* is even more distressing. It totally prevents speech, and may, at intervals, come on when the person attempts to speak; but fortunately it is only of temporary duration, and is usually caused by exceptional nervous excitement. It is characterized by spasm of the muscles supplied by the hypoglossal nerve, including the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles. In almost all cases of stuttering it is noticed that the defect is most apparent when the person is obliged to make a sudden transition from one class of sounds to another, and the patient soon discovers this for himself and chooses his words so as to avoid dangerous muscular combinations. When one considers the delicate nature of the adjustments necessary in articulate speech, this is what may be expected. It is well known that a quickly diffusible stimulant, such as alcohol, temporarily removes the difficulty in speech.

Stuttering may be successfully overcome in some cases by a careful process of education under a competent tutor. Not a few able public speakers were at first stutterers, but a prolonged course of vocal gymnastics has remedied the defect. The patient should be encouraged to read and speak slowly and deliberately, carefully pronouncing each syllable, and when he feels the tendency to stammer, he should be advised to pause for a short time, and then by a strong voluntary effort to attempt to pronounce the word. He should also be taught how to regulate respiration during speech, so that he may not fail for want of breath. In some cases aid may be obtained by raising the voice towards the close of the sentence. Sounds or combinations of sounds that present special difficulties should be made the subject of careful study, and the defect may be largely overcome by a series of graduated exercises in reading. The practice of intoning is useful in many cases. In ordinary conversation it is often important to have some one present who may by a look put the stammerer on his guard when he is observed to be talking too quickly or indistinctly. Thus by patience and determination many stammerers have so far overcome the defect that it can scarcely be noticed in conversation; but even in such cases mental excitement or slovenly inattention to the rules of speech suitable for the condition may cause a relapse. In very severe cases, where the spasmodic seizures affect other muscles than those of articulation, special medical treatment is necessary, as such are on the borderland of serious nervous disturbance. All measures tending to improve the general health, the removal of any affection of the mouth or gums that may aggravate habitual stammering, the avoidance of great emotional excitement, a steady determination to overcome the defect by voluntary control, and a system of education such as has been sketched will do much in the great majority of cases to remedy stammering. (J. G. M.)

STAMPS. The stamp duty is a tax imposed upon a great variety of legal and other documents, and forms a branch of the national revenue. The stamp is a cheap and convenient mode of certifying that the revenue regulations have been complied with. Stamp duties appear to have been invented by the Dutch in 1624. They were first imposed in England in 1694 by 5 and 6 Will. and Mary, c. 21, as a temporary means of raising funds for carrying on the war with France. They now depend upon a very large number of statutes, the principal one being the Stamp Act, 1870, 33 and 34 Vict. c. 97 (which extends to the United Kingdom). The amount of stamp duty varies from one halfpenny (postage) to thousands of pounds (probate or succession). It appears scarcely necessary in this place to set out at length the various stamp duties payable in the United Kingdom, inasmuch as those of the most usual occurrence will readily be found in ordinary books of reference.

Stamp duties are either fixed, such as the duty of one penny on every cheque irrespective of its amount, or *ad valorem*, as the duty on a conveyance, which varies according to the amount of the purchase money. The duty is denoted generally by an impressed, less frequently by an adhesive, stamp, sometimes by either at the option of the person stamping. Thus an inland bill of exchange (unless payable on demand) must have an impressed stamp, a foreign bill of exchange an adhesive stamp, while an agreement or receipt stamp may be of either kind. It should be noticed that certain documents falling within a class which as a rule is subject to stamp duty are for reasons of public policy or encouragement of trade exempted from the duty by special legislation. Examples of such documents are Bank of England notes, agreements within § 17 (but not those within § 4) of the Statute of Frauds (see FRAUD), agreements between a master of a ship and his crew, transfers of ships or shares in ships, indentures of apprenticeship for the sea service, petitions forwarded by post to the crown or a House of Parliament, and most instruments relating to the business of building and friendly societies.

As a general rule a document must be stamped at the time of execution, or a penalty (remissible by the commissioners of inland revenue) is incurred. The penalty is in most cases £10 [$48.60], sometimes much more; in the case of policies of marine insurance it is £100 [$486]. Some instruments cannot be stamped at all after execution, even with payment of the penalty. Such are bills of exchange and promissory notes (where an impressed stamp is necessary), bills of lading, proxies for voting at meetings of proprietors of joint-stock companies, and receipts after a month from date. An unstamped instrument cannot be pleaded or given in evidence except in criminal proceedings or for a collateral purpose. If an instrument chargeable with duty be produced as evidence in a court, the officer whose duty it is to read the instrument is to call the attention of the judge to any omission or insufficiency of the stamp, and if the instrument is one which may legally be stamped after execution, it may, on payment of the amount of the unpaid duty and the penalty payable by law, and a further sum of £1 [$4.86], be received in evidence, saving all just exceptions on other grounds. The rules of the Supreme Court, 1883 (Ord. xxxix. r. 8, re-enacting a provision of the Common Law Procedure Act), provide that a new trial is not to be granted by reason of the ruling of a judge that the stamp upon any document is sufficient or that the document does not require a stamp. The stamp upon a document subject to the stamp laws of a foreign state is usually admissible in evidence in a court of the United Kingdom if it conform in other respects to the rules governing the admissibility of such documents, even though it be improperly stamped according to the law of the foreign country. The admissibility of documents belongs to the *ordinatoria litis* rather than the *decisoria litis*, and is governed by the *lex fori* rather than the *lex loci contractus*, unless indeed that law makes a stamp necessary to the validity of the instrument. As to bills of exchange, the Bills of Exchange Act, 1882, 45 and 46 Vict. c. 61, § 72, provides that where a bill is issued out of the United Kingdom it is not invalid by reason only that it is not stamped in accordance with the law of the place of issue, and that where a bill issued out of the United Kingdom conforms as regards requisites in form to the law of the United Kingdom it may for the purpose of enforcing payment thereof be treated as valid as between all persons who negotiate, hold, or become parties to it in the United Kingdom.

By the Stamp Duties Management Act, 1870, 33 and 34 Vict. c. 98, the stamp duties are put under the management of the commissioners of inland revenue, who are empowered to grant licenses to deal in stamps, and to make allowance for spoiled or misused stamps. Certain offences, such as forging a die or stamp, selling or using a forged stamp, etc., are made felonies punishable with penal servitude for life as a maximum.

United States.—The subject of stamp duties is of unusual historical interest, as the passing of Grenville's Stamp Act of 1765 (5 Geo. III. c. 12) directly led to the American revolution. The Act was, indeed, repealed the next year as a matter of expediency by 6 Geo. III. c. 11, but 6 Geo. III. c. 12 declared the right of the British legislature to bind the colonies by its Acts. The actual yield of the stamp duties under the Act of 1765 was, owing to the opposition in the American colonies, only £4000 [$19,440]—less than the expenses of putting the Act into force. The stamp duties of the United States are now under the superintendence of the commissioner of internal revenue. These duties, which depend upon a great body of statutory law, will be found in the Revised Statutes, tit. xxxv.

The principal authorities on the subject of this article are Tilsley, *Stamp Laws*, and Dowell, *Stamp Duties*.

STANDARDS. See WEIGHTS AND MEASURES.

STANFIELD, WILLIAM CLARKSON (1794–1867), marine painter, was born of Irish parentage at Sunderland in 1794. As a youth he was a sailor, and during many long voyages he acquired that intimate acquaintance with the sea and shipping which was admirably displayed in his subsequent works. In his spare time he diligently occupied himself in sketching marine subjects, and so much skill did he acquire that, after having been incapacitated by an accident from active service, he received an engagement, about 1818, to paint scenery for the "Old Royalty," a sailor's theatre in Wellclose Square, London. Along with David Roberts he was afterwards employed at the Cobourg theatre, Lambeth; and in 1826 he became scene-painter to Drury Lane theatre, where he executed some admirable work, especially distinguishing himself by the production of a drop-scene, and by decorations for the Christmas pieces for which the house was celebrated. Meanwhile he had been at work upon some easel pictures of small dimensions, and was elected a member of the Society of British Artists. Encouraged by his success at the British Institution, where in 1827 he exhibited his first important picture—Wreckers off Fort Rouge—and in 1828 gained a premium of 50 guineas [$255.15], he before 1830 abandoned scene-painting, and in that year made an extended tour on the Continent. He now produced his Mount St. Michael, which ranks as one of his finest works; in 1832 he exhibited his Opening of New London Bridge and Portsmouth Harbor—commissions from William IV.—in the Royal Academy, of which he was elected an associate in 1832 and an academician in 1835; and until his death on the 18th of May, 1867, he contributed to its exhibitions a long series of powerful and highly popular works, dealing mainly with marine subjects, but occasionally with scenes of a more purely landscape character.

Among these may be named—the Battle of Trafalgar (1836), executed for the United Service Club; the Castle of Ischia (1841), Isola Bella (1841), among the results of a visit to Italy in 1839; French Troops Fording the Margra (1847), the "Victory" Bearing the Body of Nelson Towed into Gibraltar (1853), the Abandoned (1856). He also executed two notable series of Venetian subjects, one for the banqueting-hall at Bowood, the other for Trentham. He was much employed on the illustrations for *The Picturesque Annual*, and published a collection of lithographic views on the Rhine, Moselle, and Meuse; and forty of his works were engraved in line under the title of "Stanfield's Coast Scenery." Four of his engraved pictures are in the National Gallery, and his works may also be studied in the South Kensington Museum. A large collection of his productions were included in the Royal Academy's Winter Exhibition for 1870. The whole course of Stanfield's art was powerfully influenced by his early practice as a scene-painter. But, though there is always a touch of the spectacular and the scenic in his works, and though their color is apt to be rather dry and hard, they are large and effective in handling, powerful in their treatment of broad atmospheric effects, and telling in composition, and they evince the most complete knowledge of the artistic materials with which their painter deals.

STANHOPE, CHARLES STANHOPE, THIRD EARL (1753–1816), was born on 3d August, 1753, and educated under the opposing influences of Eton and Geneva, devoting himself whilst resident in the Swiss city to the study of mathematics, and acquiring from the associations connected with Switzerland an intense love of liberty. He contested the representation of the city of Westminster without success in 1774, when only just of age; but from the general election of 1780 until his accession to the peerage on the 7th of March, 1786, he represented through the influence of Lord Shelburne the Buckinghamshire borough of High Wycombe, and during the sessions of 1783 and 1784 he gave his support to the administration of William Pitt, whose sister Lady Hester Pitt he married on 19th December, 1774. When Pitt ceased to be inspired by the Liberal principles of his early days, his brother-in-law severed their political connection and opposed with all the impetuosity of his fiery heart the arbitrary measures which the ministry favored. Lord Stanhope's character was without any taint of meanness, and his conduct was marked by a lofty consistency never influenced by any petty motives; but his speeches, able as they were, had no weight on the minds of his compeers in the upper chamber, and, from a disregard of their prejudices, too often drove them into the opposite lobby. He was the chairman of the "Revolution Society" founded in honor of the Revolution of 1688, the members of which in 1790 expressed their sympathy with the aims of the French republicans. He brought forward in 1794 the case of Muir, one of the Edinburgh politicians who were transported to Botany Bay, and in 1795 he introduced into the Lords a motion deprecating any interference with the internal affairs of France. In all of these points he was hopelessly beaten, and in the last of them he was in a "minority of one"—a sobriquet which stuck to him throughout life,—whereupon he seceded from parliamentary life for five years. The lean and awkward figure of Lord Stanhope figured in a host of the caricatures of Sayers and Gillray, reflecting on his political opinions and his personal relations with his children. His first wife died on 20th July, 1780, and he married on 17th March, 1781, Louisa, daughter and sole heiress of the Hon. Henry Grenville (governor of Barbados in 1746 and ambassador to the Porte in 1762), a younger brother of the first Earl Temple and George Grenville. Through his union with this lady, who survived until March, 1829, he was doubly connected with the family of Grenville. By his first wife he had three daughters, one of whom was Lady Hester Stanhope (see below), and his second wife was the mother of three sons. Lord Stanhope died at the family seat of Chevening, Kent, on 15th December, 1816.

Earl Stanhope was elected a fellow of the Royal Society so early as November, 1772, and devoted a large part of his income to experiments in science and philosophy. He invented a method of securing buildings from fire (which, however, proved impracticable), the printing press and the lens which bear his name, and a monochord for tuning musical instruments, suggested improvements in canal locks, made experiments in steam navigation in 1795–97, and contrived two calculating machines. When he acquired an extensive property in Devonshire, he projected a canal through that county from the Bristol to the English Channel and took the levels himself. Electricity was another of the subjects which he studied, and the volume of *Principles of Electricity* which he issued in 1779 contained the rudiments of his theory on the "return stroke" resulting from the contact with the earth of the electric current of lightning, which were afterwards amplified in a contribution to the *Philosophical Transactions* for 1787. His principal labors in literature consisted of a reply to Burke's *Reflections on the French Revolution* (1790) and an *Essay* on the rights of juries (1792), and he long meditated the compilation of a digest of the statutes. His scientific theories, his mechanical experiments, and his studies in music absorbed all his thoughts, and for them he neglected his wives and his children. His youngest daughter, Lady Lucy Rachael Stanhope, eloped with Mr. Thomas Taylor of Sevenoaks, the family apothecary, and her father refused to be reconciled to her, an inconsistency in a republican which subjected him to a caricature from Gillray. Lady Hester Stanhope abandoned her home and went to live with her mother's relations. Lord Stanhope's high qualities were marred by an impracticable disposition.

STANHOPE, Lady Hester Lucy (1776–1839), the eldest child of the third Earl Stanhope (noticed above), by his first wife Lady Hester Pitt, eldest daughter of the first earl of Chatham, lived for the earlier part of her life amid the surroundings of a noble mansion, or in close communion with her uncle William Pitt, the most prominent minister of his age, and on his early death withdrew whilst still young to brood over the past in the solitudes of Palestine. She was born on 12th March, 1776, and dwelt at her father's seat of Chevening in Kent until early in 1800, when his excitable and wayward disposition drove her to her grandmother's house at Burton Pynsent. A year or two later she travelled abroad, but her cravings after distinction, were not satisfied until she became the chief of her uncle's household in August, 1803. She sat at the head of his table and assisted in welcoming his guests, gracing the board with her stately beauty and enlivening the company by her quickness and keenness of conversation. Although her brightness of style cheered the declining days of Pitt and amused most of his political friends, her satirical remarks sometimes created enemies when more consideration for the feelings of her associates would have converted them into friends. Lady Hester Stanhope possessed great business talents, and when Pitt was out of office she acted as his private secretary. She was with him in his dying illness, and some of his last thoughts were concerned with her future, but any anxiety which might have arisen in her mind on this point was dispelled through the grant by a nation grateful for her uncle's qualities of a pension of £1200 [$5832] a year, dating from 30th January, 1806, which Lady Hester Stanhope enjoyed for the rest of her days. On her uncle's death she lived in Montague Square, London, but life in London without the interest caused by associating with the principal politicians of the Tory party proved irksome to her, and she sought relief from lassitude in the fastnesses of Wales. Whilst she remained on English soil happiness found no place in her heart, and her native land was finally abandoned for the East in February, 1810. After many wanderings she settled on Mount Lebanon, and from this solitary position she wielded an almost absolute authority over the surrounding districts. Her control over the natives was sufficiently commanding to induce Ibrahim Pasha, when about to invade Syria in 1832, to solicit her neutrality, and this supremacy was maintained by her commanding character and by the belief that she possessed the gift of divination. Her cherished companion Miss Williams, and her trusted physician Dr. Charles Lewis Meryon, dwelt with her for some time; but the former died in 1828, and the latter was not with Lady Hester when she died. In this lonely residence, the villa of Djoun, 8 miles from Sidon, in a house "hemmed in by arid mountains," and with the troubles of a household of twenty-three servants, unregulated by a single English attendant or friend and only waiting for her death to plunder the house, Lady Hester Stanhope's strength slowly wasted away, and at last she died on 23d June, 1839, aged sixty-three. The disappointments of her life, and the necessity of overawing her servants as well as the chiefs who surrounded Djoun, had intensified a temper naturally imperious. In appearance as in voice she resembled her grandfather, the first Lord Chatham, and like him she domineered over the circle, large or small, in which she was placed.

Some years after her death there appeared three volumes of *Memoirs of the Lady Hester Stanhope as related by herself in Conversations with her Physician* (*i.e.*, Dr. Meryon), 1845, and these were followed in the succeeding year by three volumes of *Travels of Lady Hester Stanhope, forming the Completion of her Memoirs narrated by her Physician.* They presented a lively picture of this strange woman's life and character, and contained many anecdotes of Pitt and his colleagues in political life for a quarter of a century before his death.

STANHOPE, Philip Dormer, fourth earl of Chesterfield. See Chesterfield.

STANISLAU (Pol. *Stanislavoff*), the chief town in the district of the same name in Galicia, Austria, on the Albrecht and Lemberg-Czernowitz railways, in 49° 4′ N. lat., 24° 30′ E. long., has two real-schools, a gymnasium, and large ironworks. It has also a good trade in corn. The population (1885) numbers 18,626.

STANISLAUS (1677–1766), king of Poland. Stanislaw Leszczynski or Leszinski was born at Lemberg on October 20, 1677. His father, Raphael Leszczynski, was a Polish nobleman, distinguished by his rank and the important offices which he held, but still more by his personal qualities. Stanislaus, after visiting the courts of Vienna, Paris and Rome, was raised to the dignity of voivode of Posen, and in 1704 was sent as ambassador by the assembly of Warsaw to Charles XII. of Sweden, who had just declared the deposition of the recently elected Augustus II. The king was so greatly taken with the ambassador that he recommended him to the diet as a suitable candidate for the vacant throne; the election accordingly followed on 12th July, 1704, but the coronation of Stanislaus and his wife Catharina Opalinska did not take place until 4th October of the following year (compare Poland, vol. xix. p. 308. After the reverse of Poltava in 1709 Augustus returned to Poland, and, assisted by the Russians, compelled Stanislaus to leave the country. The next five years saw him leading a wandering and somewhat adventurous life in Europe, one of his objects being to procure a favorable peace for Charles (compare Charles XII.). He then settled on Charles's estate at Zweibrücken, and after Charles's death in 1718 had a residence assigned to him by the French court at Weissenburg in Alsace. In 1725 his daughter Maria became the wife of Louis XV. of France. On the death of Augustus in 1733 Stanislaus once more returned to Poland, where a majority declared for him, but his competitor, the young elector of Saxony, had the advantage of the support of the emperor Charles VI., and also of the empress of Russia. Dantzic, to which Stanislaus had retired, was quickly taken by the Russians and the Saxons, and with great difficulty the unfortunate prince succeeded in making good his escape in disguise, after hearing that the Russians had set a price on his head. In 1736, when peace was concluded between the emperor and France, it was agreed that Stanislaus should abdicate the throne, but that he should be acknowledged king of Poland and grand-duke of Lithuania, and continue to bear these titles during life, and further, that he should be put in peaceable possession of the duchies of Lorraine and Bar, but that immediately after his death those duchies should be united forever to the crown of France. The remaining years of his life were prosperous and happy. He died at Lunéville on February 23, 1766, in consequence of injuries received from his nightdress accidentally taking fire.

Stanislaus, who was a patron of the arts and sciences, wrote several works in politics and philosophy, which were collected and published at Paris in 1763, in 2 vols. 8vo, under the title *Œuvres du Philosophe Bienfaisant*. The *Œuvres Choisies de Stanislas, Roi de Pologne, Duc de Lorraine et de Bar*, with an historical notice by Madame de Saint-Ouen, were published in an 8vo volume at Paris in 1825.

STANISLAUS AUGUSTUS, the last king of Poland, was born at Wolczyn in Lithuania in 1732, and died at St. Petersburg in 1798. See Poniatowski, vol. xix. pp. 467–8, and Poland, vol. xix. pp. 309–10.

STANLEY, Arthur Penrhyn (1815–1881), dean of Westminster from 1863, was born at Alderley in Cheshire on December 13, 1815. His father the Rev. E. Stanley, rector of Alderley, bishop of Norwich from 1837 to 1849, was the younger brother of Sir John Stanley of Alderley Park, seventh baronet, who in

1839 was created Baron Stanley of Alderley, and was the representative of a branch of the same family as that of the earls of Derby. His mother, Catherine Stanley, was the daughter of the Rev. Oswald Leycester, rector of Stoke-on-Tern. Both parents were persons of remarkable force and individuality of character. The influence of each is to be traced in the career of their son. It was his father's prayer as bishop of Norwich "that he might be an instrument in God's providence of extending more enlarged and more Christian views among the clergy, and thus the means of disseminating a wider and more comprehensive spirit of Christianity throughout the land." Of his mother her son not only spoke, after her death in 1862, as "the guardian genius" that "had nursed his very mind and heart," but described her as "gifted with a spiritual insight which belonged to that larger sphere of religion which is above and beyond the passing controversies of the day." Arthur was their third child. His elder brother, Owen, died in 1850 at Sydney, after concluding as commander of the "Rattlesnake" frigate, the survey of the Coral Sea. His sister Mary, well known for her work in the hospitals at Scutari and among the poor in London, died in 1880. Arthur was a child of highly sensitive organization and precocious intellectual activity. His boyish letters, journals, and poems were singularly like in their characteristic points to his later writings. But his extreme shyness and silence gave no promise of the social gifts which afterwards added so largely to his influence. At the age of fourteen his health, at one time alarmingly delicate, so far improved as to warrant his parents in sending him to Rugby, where Dr. Arnold had been recently appointed head master. He remained at Rugby from 1829 to 1834, and of all Arnold's pupils may be said to have been the one who most fully responded to the influence of his master's teaching and character. In 1834 he became an undergraduate of Balliol College, Oxford, having obtained a scholarship in the previous year. Among his tutors at Balliol was Mr. Tait, afterwards archbishop of Canterbury, and among his junior fellow scholars Benjamin Jowett, afterwards professor of Greek and master of Balliol. Arthur Stanley, after obtaining the Ireland scholarship and Newdigate prize for a remarkable English poem (on the Gypsies), was placed in the first class in 1837. In 1839, after a period of residence and study at Oxford, he was elected fellow of University College, and in the same year was admitted to holy orders. In 1840 he left England for a prolonged tour in Greece and Italy, and on his return settled at Oxford, where he resided from October, 1841, for the next ten years, being actively engaged during term time as tutor of his college. He very shortly became an influential element in university life. His personal relations to his pupils were of a singularly close and affectionate nature, and the charm of his social gifts and genial character won him friends on all sides. His literary reputation was early established by the profound impression made by his *Life of Arnold*, whose sudden death had occurred in 1842, and whose biography, published in 1844, at once secured for its young author a high place among English writers. In 1845 he was appointed select preacher, and published in 1847 a volume of *Sermons and Essays on the Apostolic Age*, which not only laid the foundation of his fame as a preacher, but also marked has future position as a theologian. In university politics, which at that time wore mainly the form of theological controversy, he from the first took the place which he always retained of an uncompromising advocate of comprehension and toleration. As an undergraduate he had entirely sympathized with Dr. Arnold in resenting the agitation led by, but not confined to, the High Church party in 1836 against the appointment of Dr. Hampden to the regius professorship of divinity. As a young M.A., during the long-continued agitation which followed the publication in 1841 of Tract No. 90, and which ended in the withdrawal of the present Cardinal Newman from the English church, he used all his influence to protect from formal condemnation the leaders and tenets of the "Tractarian" party. In 1847 he did his utmost to resist the movement set on foot at Oxford against Dr. Hampden's appointment to the bishopric of Hereford. Finally, in 1850, in an article published in the *Edinburgh Review* in defence of the "Gorham judgment," which had secured the position in the English Church of the Evangelical clergy, he asserted two principles which he maintained to the end of his life,—first, "that the so-called supremacy of the crown in religious matters was in reality nothing else than the supremacy of law," and, secondly, "that the Church of England, by the very condition of its being, was not High, or Low, but Broad, and had always included, and been meant to include, opposite and contradictory opinions on points even more important than those at present under discussion."

It was not only in theological but in academical matters that his sympathies were on the liberal side. Though on many points of essentially conservative tendencies, he was greatly interested in university reform, and towards the end of his residence at Oxford acted as secretary to the royal commission appointed in 1850 to report on and to suggest improvements in the administrative and educational system of the university. Of the important changes in both these respects which, in the face of much opposition at the university, were carried out in due time under the sanction of parliament by an executive commision, Stanley, who took the principal share in drafting the report printed in 1852, was a strenuous advocate. These changes included the transference of the initiative in university legislation from the sole authority of the heads of houses to an elected and representative body, the opening of college fellowships and scholarships to competition by the removal of local and other restrictions, the nonenforcement at matriculation of subscription to the Thirty-nine Articles, and various steps taken to increase the usefulness and influence of the professoriate.

Before the report was issued, Stanley, who had lost his father in 1849, and both his brothers, Captain Stanley mentioned above, and Charles, secretary to the governor of Van Diemen's Land, within a few months of the same date, was appointed to a canonry in Canterbury Cathedral. He held the office from 1851 till his return to Oxford. During his residence at Canterbury he published his *Memoir* of his father Bishop Stanley (1851), and completed his *Commentary on the Epistles to the Corinthians* (1855). In the winter and spring of 1852–53 he made the tour in Egypt and the Holy Land, the result of which was his well-known volume on *Sinai and Palestine*, first published in 1856. In 1857 he travelled in Russia, and collected much of the materials for his subsequent *Lectures on the Greek Church*, published in 1861. His *Memorials of Canterbury*, published in 1855, displayed the full maturity of his power of dealing with the events, scenes, and characters of past history which had marked him from childhood. Towards the close of the same period he accepted the office of examining chaplain to Dr. Tait, his former tutor at Balliol and afterwards successor to Arnold at Rugby, on his transference from the deanery of Carlisle to the see of London.

At the close of 1856 Stanley was appointed by the crown to the professorship of ecclesiastical history, a post which, with the canonry at Christ Church attached to the office, he held till 1863. In the first of three inaugural lectures the new professor announced his intention of beginning his treatment of the subject with "the first dawn of the history of the church," the call of Abraham; and the first two volumes of his *History of the Jewish Church*, published in 1863 and 1865, consist of the substance of lectures delivered by him in his capacity as professor. In 1861 he published the volume on the Greek Church already referred to. His second residence at Oxford was marked by the same power of winning personal influence which had distinguished him as a college tutor, and by the efforts which he made, in his wider sphere as professor, to bring together in social intercourse the leaders of the divergent and hostile parties between which the residents at the university were mainly divided.

Much, however, of his time and efforts was given to religious controversy. From 1860 to 1864 academical and clerical circles were agitated by the storm which followed the publication of *Essays and Reviews*, a volume to which two of his most valued friends—Benjamin Jowett and Mr. Temple, the former professor of Greek at Oxford, the latter head master of Rugby and afterwards bishop in succession of Exeter and London—had been contributors. For the exceedingly prominent part taken by Stanley in this exciting controversy the reader is referred to the second and third of his *Essays on Church and State*, collected and published in 1870. The result of his action was greatly to alienate the leaders of the High Church party, who had joined a large portion of the clergy in their efforts to procure the formal condemnation of the views advanced in *Essays and Reviews*. In this and other questions, such as in the growing controversy on the position of Professor Maurice at King's College, Cambridge, and on that caused by Bishop Colenso's work on the Pentateuch, he had taken up a position which brought him into conflict with a large portion of the religious public. It should be added that in the last year of his professoriate (1863) he had published a *Letter to the Bishop of London*, strongly advocating a large relaxation of the terms of clerical subscription to the Thirty-nine Articles and Prayer-book. An important act amending the Act of Uniformity, and carrying out in some degree Stanley's proposals, was passed in the year 1865.

In the spring of 1862 Stanley, at the queen's desire, had accompanied the Prince of Wales on a tour in Egypt and the Holy Land. During his absence he lost his mother, the heaviest domestic bereavement that had yet befallen him. His sense of his debt towards her has been already indicated. It stands recorded in his volume of *Memorials of Edward and Catherine Stanley*.

Towards the close of the following year he was appointed by the crown to the deanery of Westminster, in succession to Dean Trench, raised to the see of Dublin. In December he married Lady Augusta Bruce, sister of Lord Elgin, then governor-general of India, herself one of the queen's most trusted friends. In January, 1864, he entered on the duties of his new post.

His tenure of the deanery of Westminster was memorable in many ways. He recognized from the first two important disqualifications,—his indifference to music and his slight knowledge of architecture. On both these subjects he availed himself largely of the aid of others, and threw himself with characteristic energy and entire success into the task of rescuing from neglect, preserving from decay, and commending to the interest of all classes of his countrymen the treasure of historic monuments in which the abbey is so rich. No visitor can pass through the building, now so often thronged with crowds of the working classes, the mere possibility of attracting whom was spoken of before a royal commission so lately as 1841, as quite chimerical, without recognizing the successful result of his indefatigable labors. The monument to the brothers Wesley, the inscription on the gravestone of Livingstone, and the restored altar in her husband's chantry in which he placed the neglected remains of Catherine of Valois, the queen of Henry V., may be named among the innumerable and ubiquitous records of his wide sympathy and historic ardor. Within three years of his appointment he published his *Memorials of Westminster Abbey*, a work which, although not free from occasional inaccuracies, is a mine of information conveyed in the most picturesque and impressive form. He was a constant preacher, and gave a great impulse to the practice already begun of inviting distinguished preachers to the abbey pulpit, especially to the evening services in the nave, which had been established under his predecessor. It is to him that is largely due the vast increase in the number not of visitors only but of worshippers in the abbey. He began the practice, since continued by others of the abbey clergy, of devoting his Saturday afternoons to conducting parties of working men round the abbey and collegiate buildings. His social and personal influence, already unique of its kind, was enormously increased by his removal to London. His circle of friends was constantly widening, and extended from the queen and royal family to the working men of London and elsewhere, some of whom he inspired with a singular devotion. It included men of every denomination, every class, every part of the United Kingdom, and almost of every nation. He was untiring in literary work, and, though this consisted very largely of occasional papers, lectures, articles in reviews, addresses, and sermons, it included a third volume of his *History of the Jewish Church*, a volume on the *Church of Scotland*, another of *Addresses and Sermons* preached in America, and an exceedingly important volume, completed within a few months of his death, on *Christian Institutions*.

He was continually engaged in theological controversy, and, if his advocacy of all efforts to promote the social, moral, and religious amelioration of the poorer classes and his chivalrous courage in defending those whom he held to be unjustly denounced won him the warm admiration of many of his countrymen, he undoubtedly incurred much and growing odium in influential circles. Among the causes of offence might be enumerated, not only his vigorous defence of one from whom he greatly differed, Bishop Colenso, but his invitation to the holy communion of all the revisers of the translation of the Bible, including a Unitarian among other Nonconformists, as well as the whole tone and teaching of almost every page of his publications. Still stronger was the feeling caused by his efforts to make the recital of the Athanasian Creed optional instead of imperative in the English Church.

In 1874 he spent part of the winter in Russia, whither he and Lady Augusta had gone to take part in the marriage of the duke of Edinburgh. In the spring of 1876, after a long and lingering illness, he lost his wife, the zealous partner of all his social and charitable efforts, and the constant cheerer and sympathizer in his many labors and conflicts. It was a terrible blow, and one from which he never entirely recovered. But in 1878 he was deeply interested by a tour in America, and in the following autumn visited for the last time, with his sister, Mary Stanley, who died before the close of the same year, northern Italy and Venice.

In the spring of 1881 he preached funeral sermons in the abbey on Mr. Carlyle and Lord Beaconsfield, winding up with the latter a series of *Sermons preached on Public Occasions*, mainly on the death or funeral of eminent Englishmen, which form a volume singularly characteristic of his special gifts. He saw also the completion of the latest of his volumes, that already mentioned on *Christian Institutions*, and was in the course of the summer correcting for the press a paper on the *Westminster Confession*, and preaching in the abbey a course of Saturday *Lectures on the Beatitudes*. On July 10 he was attacked by a sudden illness, which in a few days assumed a more alarming character, and ended fatally on the 18th. The sensation caused by his death was profound and widespread. He was buried in Henry VII.'s chapel, in the same grave as his wife. His pall-bearers comprised representatives of literature, of science, of both Houses of Parliament, of theology, Anglican and Nonconformist, and of the universities of Oxford and Cambridge. The recumbent monument placed upon the spot, and the windows in the chapter house of the abbey, one of them a gift from the queen, were a tribute to his memory from friends of every class in England and America.

The influence of Dean Stanley was no doubt largely due to his marvellous social gifts. His affectionate nature, his quick and ready sympathy, his keen interest in almost every field of knowledge, his own mental resources, drawn from incessant reading and enriched by travel, observation, and conversation, his familiarity with the persons, places, events, and scenes of history, his tenacious yet discriminating memory, his vivacity and humor, the very charm of his countenance and manner, the delicately sensitive face, "the eye now beaming with sympathy, now twinkling with humor," acted like a spell in winning friends and even in conciliating opponents. The courage and fearlessness with which he was always ready to uphold the cause of those whom he held to be unjustly attacked by a powerful or dominant majority was duly appreciated by his countrymen. It may probably be said that no one in the present century was so endeared to so large a circle of personal friends in all parts of the civilized world. His writings also, apart from their controversial aspect, were of a singularly attractive kind. His *Life of Arnold*, his *Sinai and Palestine*, his *Lectures on the Jewish Church*, his *Memorials* of Canterbury and of Westminster Abbey, would alone have made him one of the most delightful and popular of English authors. His sermons, always interesting and attractive, were at times singularly eloquent and impressive. His occasional hymns and short poems, full of grace and force, and occasionally of a profound pathos, were fully worthy of his literary position. Throughout all that he ever wrote there is an individuality and a characteristic flavor which is saved from mannerism by an inexhaustible freshness of view and a marvellous fertility of illustration. His power of painting the scenes, events, and persons of past history, "the picturesque sensibility," to use a phrase applied to him by Lord Beaconsfield, with which he at once fastened on the main features of an historic building or a famous locality, amounted to genius; they were as marked at the close of his life as in the earliest of his schoolboy letters. They won him readers of every class.

But it would be impossible to speak even briefly of his literary position by itself. To write his life in full would be to give a sketch of English ecclesiastical history for a long generation. Though he resolutely stood aloof from all connection with party, it is impossible not to recognize even in his least controversial writings the position which he held as, in the eyes of the greatest portion of his countrymen, the leading liberal theologian of his time in England. Throughout his writings in prose or poetry, on almost every subject which he touched, we see the impress, not only of his distinctive genius and of his extraordinary gifts, but also of his special views, aims, and aspirations. It may be well to describe these as nearly as possible in his own words. He looked on the age in which he lived as one of mingled hope and gloom, as a period of transition, to be followed either by an "eclipse of faith"—a "winter of unbelief"—or by a "revival of Christianity in a wider aspect," a "catholic, comprehensive, all-embracing Christianity" that "might yet overcome the world." He believed, and was never tired of asserting his belief, "that the Christian church had not yet presented its final or its most perfect aspect to the world"; that "the belief of each successive age of Christendom had as a matter of fact varied enormously from the belief of its predecessor"; that "all confessions and similar documents are, if taken as final expressions of absolute truth, misleading"; that each "successive form of theology is but the approximation to the truth, not the whole truth itself"; that it was "the glory of the church to be always advancing to perfection"; and that "there still remained, behind all the controversies of the past, a higher Christianity which neither assailants nor defenders had fully exhausted."

Already even in his early *Sermons on the Apostolic Age*, as in *Sinai and Palestine*, as in the volumes on the *Jewish Church*, "one increasing purpose" may be recognized. Everywhere we see the sustained effort to "bring the events, places, and characters of sacred history within the domain of actual observation and history," and to rescue them from "the conventional haze in which they had been veiled by a misplaced reverence." "The first duty of a modern theologian" he held to be "to study the Bible, not for the sake of making or defending systems out of it, but for the sake of discovering what it actually contains." "In a faithful study of that virgin mine, the yet insufficiently explored records of the Old and New Testament, lay," he held, "the best hope of the church of Christ," and another and a different estimate "of the points on which Scripture lays its most emphatic stress." To this study he looked for the best hope of such a progressive development of Christian theology as should avert the danger arising from "the apparently increasing divergence between the intelligence and the faith of our time," "and should enable the church to deal wisely with new questions which ancient theology had for the most part not even considered." On the direction which this development of theology should assume the last word had not, he knew, been spoken; but he enforced the duty "of placing in the background whatever was accidental, temporary, or secondary, and of bringing into due prominence what was primary and essential." In the former group Stanley would, without doubt or hesitation, have placed all questions connected with Episcopal or Presbyterian orders, or that deal only with the outward forms or ceremonies of religion, or with the authorship or age of the books of the Old Testament. Even to the question of miraculous and external evidence he would have been inclined to assign a secondary place, as well as to the most elaborate statements of Christian doctrine.

The foremost and highest place, that of the "essential and supernatural" elements of religion, he would have reserved for its moral and spiritual truths, "its chief evidence and chief essence," "the truths to be drawn from the teaching and from the life of Christ," in whose character he did not hesitate to recognize "the greatest of all miracles." On a large development of Christian teaching in this direction he based all his hopes alike of the progress of the world and of the restitution to Christian theology—"as something greater and vaster than all the theology of each particular church or age," "as comprehending the wholesome elements of thought at work in the world"—of "its natural ascendency over the minds of educated men."

With such views it was not to be wondered at that, from first to last, he never lost an opportunity of supporting a policy of width, toleration, and comprehension in the Church of England. The view which he took in his earliest directly controversial work, his *Essay on the Gorham Judgment* (1850), as regards both the protection offered by the law to the clergy against "the inquisition of arbitrary prelates and of tumultuous synods," and "on the designedly mixed and comprehensive character of the English formularies and English Church," has already been fully indicated. The same spirit and the same aims guided his line of conduct in other controversies, such as in that on the *Essays and Reviews*, on the ritualistic movement, on the question of subscription, on the successive attacks made on men so wholly different from each other as Prof. Maurice, whose influence on the mind of his generation has yet to be fully estimated, and Bishop Colenso, and in his vain but earnest advocacy of the optional instead of the compulsory use of the Athanasian Creed. So again he was always eager to insist on the essential points of union between various denominations of Christians, however apparently divided or estranged; and to recognize the special services conferred on the world, not only by the Eastern, the Roman, the Lutheran, and the Reformed Churches, not only by the Presbyterian Churches of Scotland, but also by the Baptist and Congregational Churches of England and America, and by the community of Quakers. And, while in this respect he was keen almost to excess to note points of agreement, so in the very latest volume which he published one of his main aims was "to look the facts of history in the face" and to point out "the almost universal departure from primitive usage," "the transformation both of letter and spirit through which the greatest Christian ordinances had already passed," and "to fix the eye steadily on the germs of truth that were common to the different forms which the ordinances wore, the moral and spiritual realities for the sake of which alone (if Christianity be the universal religion) such forms exist." He was throughout his life an unflinching advocate of the connection between church and state. By this he understood—(1) "the recognition and support on the part of the state of the religious expression of the faith of the community," and (2) "that this religious expression of the faith of the community on the most sacred and most vital of all its interests should be controlled and guided by the whole community through the supremacy of law." In the supremacy of the crown, *i.e.*, of law, "over all causes and all persons, ecclesiastical as well as civil," so far from finding "galling chains" or "ignominious bondage," he welcomed it not only as being "the most powerful and intelligent organ of the whole community," but on two other grounds. First, he considered that supremacy more likely "to be truly wise and truly just and therefore truly Christian than the headship either of a bishop or of a synod of any clerical or sectional body," and, secondly, "as the best security for that gradual growth of religious forms and religious opinions, and for that free expression of individual belief, which is indispensable to any healthy development of religious life and religious truth." At the same time he was in favor of making the creed of the church as wide as possible,—"not narrower than that which is even now the test of its membership, the Apostles' Creed,"—and of throwing down all barriers which could be wisely dispensed with to admission to its ministry. As an immediate step he even advocated as "an unmixed good" "the admission under due restrictions of our nonconforming brethren of England, and our Presbyterian brethren of the Scottish Church," to preach in Anglican pulpits. To the last hour of his life he looked with dismay to the prospect of a combined assault by a triple alliance of the representatives "of the Puritans, of Voltaire, and of Laud" on "that rare combination which with all its shortcomings exhibits one of the noblest works which God's providence, through a long course of years, has raised up in Europe," "on the most venerable growth of English history, the framework which has sheltered down to this time the freedom of the freest, the teaching of the most learned, and the reason of the most rational church in Christendom." He believed that the "success of such an attack would result in throwing away the best opportunity which the world affords for the growth side by side of intellectual activity and religious earnestness"; that to destroy it would be, as he said of the Established Church of Scotland, "to destroy, so far as human efforts can destroy, the special ideas of freedom, of growth, of comprehension, which are inherent in the very existence of a national church"; that its destruction would only produce "an enslaved clergy amidst an indifferent laity," and tend to degrade the Church of England from its historic position "to that of an illiterate sect, or a satellite of the Church of Rome."

With such views it was impossible that Stanley could have found much sympathy from either of the two great parties among the English clergy. Indeed it was impossible that any party, or any community, which placed the essence of Christianity in the careful guardianship of any circle of theological doctrines could feel in harmony with one who dwelt with such exceeding and growing emphasis on the secondary nature, not only of all that was ceremonial, but on much that was dogmatic, as compared with that which was spiritual and moral.

By the "Evangelical" section of the religious world the biographer of Arnold had been looked on from the first with more than suspicion. Later on, even the mode and form of his defence of their own side in the Gorham controversy, his avowed advocacy of a wide freedom of thought on many questions, especially those connected with Biblical criticism, his attitude towards such subjects as inspiration, justification, and future punishment, were more than distasteful. His loud acknowledgment of the debt owed by Christendom to German theology, "to the most laborious, truth-seeking, and conscientious of Continental nations," his persistent claims for a place within the Church of England for views that "went to the verge of Rome," the more than width—the universality—of his religious sympathies, his delight in placing, not Walter Scott only, or Tennyson, or the author of *Ecce Homo*, but Goethe, and Burns, and Matthew Arnold, and J. Stuart Mill in the ranks of religious teachers, were naturally repugnant to those who cared to read his works, and were not content to shrink in silent dismay from the warm sympathizer with Professor Maurice, the enthusiastic admirer of F. W. Robertson, and the apologist in turn of *Essays and Reviews* and of Bishop Colenso.

Against the feelings provoked by this aspect of his theological position, neither his acknowledged services to Biblical study, nor his profound and entire belief in the true key to the difficulties of the future being involved in the prosecution of that study, nor his sympathy with their own views as to the relation of the individual soul to God, nor his repeated, his almost daily assertions of the sacredness and value of the gospel history, or of the regenerative power of the Divine life and person of Christ as the "one Master worth living for, worth dying for," could avail much. Whatever the feelings of individuals, the organs of the party of whose once imperilled claim to remain within the fold of the Church of England he had been the stanchest upholder spoke of him from first to last with almost unqualified aversion. He was, or became in due time, even more obnoxious to at least the more advanced section of the High Church party. Nor was this to be wondered at. The differences between him and them were vital and fundamental; and, even where he defended their right—at one time repeatedly challenged—to maintain their distinctive views and observances in the Church of England, he rested their claim on grounds which would hardly win their approval or gratitude. The more clear-sighted of their leaders felt that, if the points of ceremonial, of dress, posture, attitude, ritual, on which they laid exceeding stress, were treated by him with toleration, they were regarded with an indifference that verged upon contempt, as *tolerabiles ineptiæ*, and that he delighted to trace their historical development, and to strip them of all that was essential, significant, or primitive. They felt even more strongly that in that which, to the leaders at least, gave their real interest and importance to all questions of vestments or observances, and even underlay some of the most important questions of religious doctrine,—the very existence of an order of priesthood as the divinely and exclusively commissioned channel of communication between God and man,—the rejection on the part of Stanley of their most cherished and central dogma was absolute and uncompromising. And the difference of view was vital. Much else in his writings might have been welcomed or condoned. His love for the past, his deep and full sympathy with much in the mediæval church, his warm admiration for many of its saints and heroes, his aversion to mere iconoclasm, his poetic and imaginative sensibility, had much to attract them. Even in his treatment of many important religious subjects it was often not so much his actual sentiments as the tendency—the more than tendency, the avowed aim—of all his writings to promote freedom of inquiry and of thought, rather than submission to church authority, which provoked hostility. But on this question there was no room for compromise. That which they and he alike recognized as the fundamental tenet to which all their distinctive teaching pointed he spoke of as a belief "that they (the clergy) were the depositaries of mystical, supernatural, almost magical influence, independent of any moral or spiritual graces," and on this point he spoke with no doubtful voice. It was, he said, this belief in a "fixed, external, necessary medium on earth between the soul and God which, if he had rightly read the Psalms of David, the epistles of Paul, and the gospel of Christ, true religion is always striving to dispense with," and "the more it can be dispensed with, the nearer and the higher is the communion of the human spirit with its Maker and its Redeemer." And this language (used in 1867) was in entire accordance with the manner in which in his latest volume (1881) he hinted at the possibility of "the growing materialism of the ecclesiastic sacristy so undermining the spiritual element of almost the only external ordinance of Christianity (the Eucharist), unquestionably the greatest religious ordinance in the world," "as even to endanger the ordinance itself." In addition to this fundamental divergence of view, it must be remembered that it was to this party, as the representatives of one "always forgetful in its gratitude and implacable in its vengeance," that he looked for the main danger to freedom of thought and width of comprehension in the future, and that he did not hesitate to remind them, even as he supported their claims to the largest possible interpretation of the Articles, that they "claimed a latitude themselves which they constantly refused to others." It will be easily understood therefore that whatever influence Stanley wielded in the church was wholly independent of either of the two great parties into which he found it mainly divided, above all of that which at the time of his death appeared to be every year growing in power and confidence.

What was the extent, what the permanent force of his own influence, is a question not easily answered at present. "Dean Stanley," said Dr. Story, "stood higher in the respect and affection of a larger and more varied circle of members of many churches than any ecclesiastic in the world." It is not easy to disengage his personal and social charm, the affection borne him by all who had even momentarily passed within the circle of his striking and attractive individuality, the warm feelings which much in his life, much in his writings, had called forth from multitudes who never saw him, from the more abiding impression made during his lifetime and after his death by the writings which he has left behind him. Yet if, setting aside one single name, that of Prof. Maurice, he be taken as the most prominent, the most fertile, the most gifted, and the most impressive exponent and defender of liberal theology, some estimate may be formed even now of the mark which he made upon his age. It would be easy to undervalue the effect of the work which he did. It might seem at first sight as if his own gloomier anticipations had been fulfilled. He spoke from time to time of a danger of the age being overwhelmed, now by "a general return of forgotten superstitions," now "by a general chaos of incredulity," and of himself as "having perhaps done no more than make good a starting point for those who come after us, perhaps in the 20th or 21st century." He might have seemed to enter into the spirit of his father's words, "My only hope and consolation is that I am a pioneer for better days, and that the seed which I aim, as far as can be at sowing may bring forth fruit when I am gone to a better and more peaceful world." But such a view would be to a large extent superficial. If the success achieved by the cause of which Stanley was the main representative is carefully weighed, it will be found to be great in solid and direct results, far greater probably in those which are less easily summed up and tabulated. On the question which he had most at heart, the real and careful and critical study of the sacred records, the progress made since he first lectured as a tutor at Oxford on the Old and New Testaments has been enormous. The large majority of the works published have been written more or less in the spirit in which he would have largely or entirely sympathized. It may be added that of these there are few which would not have encountered, if not fierce criticism, yet at least grave suspicion, some forty years ago. The combination of a reverent treatment of Holy Scripture with fearless inquiry into all questions connected with its criticism is a new birth in English literature. It is one in which he took a leading part, and in the defence of which he bore, sometimes in his own behalf, oftener in chivalrous defence of others, much of the brunt of the earlier and later contests. The impulse which he gave to the study alike of the Bible and church history was a great one. In each he may be recognized, not of course as the originator, but as the representative, of a new school of thought and of treatment, and those who are most familiar with his writings can hardly open a new book by any English theologian, hardly read a sermon of many preachers, above all on any portion of the Old Testament, in which they do not trace his immediate influence. He may be said in a very true sense to color the writings of many of those who most differ from him. The subjects to which he looked as the most essential of all —the universality of the Divine love, the supreme importance of the moral and spiritual elements of religion, the supremacy of conscience, the sense of the central citadel of Christianity as being contained in the character, the history, the spirit of its Divine Founder—have beyond doubt, if not yet taken fully the place which he claimed for them, yet impressed themselves more and more on the teaching and the preaching of every class of clergy in the church. They have lifted the teaching of those who most differed from him far above the level of a mechanical or merely ceremonial form of medieval worship. The great cause too for which he strove so hard, that of comprehension and mutual toleration, the true "enlargement of Christ's church," has gained much from his efforts,—much in the present, and perhaps, in spite of some appearances to the contrary, more in the future. Whatever storms of party strife may be in store for the church, active and energetic Christians of opposite parties no longer waste their energies in mutual attacks, but have learned to work together in Christian teaching and in works of Christian beneficence. His surviving friends may rejoice to remember that no one person had, for, it may be, many generations, done so much as Stanley to draw together in friendly and social intercourse the leaders of various religious parties and of different denominations of Christians.

Those who live, and feel that they live, in an age of transition cannot venture to prophesy the precise form and color of the religious movement which will in due time succeed that which now seems to be the most prevalent and the most outwardly active. But they may be permitted to hold that its main features were described and anticipated, even if dwelt on with excessive emphasis, by Stanley,—to believe that the next phase of a Christian theology which shall regain a due ascendency over the thought and intelligence of the civilized world will be embodied in some larger realization of "the one unchangeable element in Christianity," of the witness borne by the teaching and life of Christ to the higher and spiritual nature and destinies of man and to the "principles of freedom, justice, toleration, beneficence, self-denial, universal sympathy, and fearless love of truth, in which all the hopes of a true and permanent development of Christian theology must take their stand." None will have labored more earnestly in this cause than Arthur Stanley. (G. G. B.)

STANTON, Edwin M'Masters (1814–1869), American statesman, was born in Ohio, December 19, 1814, graduated at Kenyon College in 1833, and was admitted to the bar of his native State. Just at the end of Buchanan's administration in 1860–61, Stanton was called upon to act as attorney-general. In 1862, after the inauguration of Lincoln, the new president, who had had great difficulties with his war office, placed Stanton at its head, where he was at home at last. His intense vigor, excellent organizing powers, and scrupulous honesty were the life of the Federal war department throughout the Civil War; and it may be worth while to note that, after living through boundless opportunities of peculation, he died, like most of the public servants of the United States, a poor man. In spite of his many services to the country, it was not always easy for his associates to get on with him comfortably; and his quarrels with President Johnson were especially bitter in 1867–1868, ending in the impeachment of Johnson by the House of Representatives. On the acquittal of the president Stanton resigned, and resumed the practice of law. President Grant, in 1869, made him a justice of the supreme court; but his work during the war had worn him out, and he died December 24, 1869.

STARAYA RUSSA, a district town of Russia, in the government of Novgorod, 62 miles to the south of that city, on the river Polist, by means of which and Lake Ilmeñ it is brought into easy steamer communication with St. Petersburg. Some brine springs, of no great strength, on the eastern side of the town, were used as a source for the supply of salt as late as 1865, yielding about 50,000 cwts. annually; at present they are used only as mineral waters, having a great resemblance to those of Kreuznach. Some thousands of visitors resort to them every summer, and owing to this circumstance Staraya Russa is better built and kept than any other town in Novgorod. The 13,100 inhabitants are supported chiefly by the summer-visitors. About 100 individuals in all employ themselves in brick-making, tanning, and sawing timber, and there is a trade in rye, oats, and flax shipped to St. Petersburg to the value of about £50,000 [$243,000] per annum.

The name of Staraya Russa occurs in the Russian annals as far back as 1167. It was one of the minor towns of the republic of Novgorod, and suffered continually in the wars for possession of the region between Russia, Lithuania, and Livonia. It was afterwards annexed to Moscow.

STARCH is an organized product of the vegetable kingdom, forming one of the most important and characteristic elements of plant life, and an abundantly stored reserve material for the discharge of vegetative functions. It originates within the living vegetable cell through the formative activity of chlorophyll under the influence of light, and is consequently an unfailing characteristic of all plants containing that body (compare PHYSIOLOGY, vol. xix. p. 61. Starch found within leaves and other green parts of plants is assimilated and transformed with great rapidity; accumulations of it are carried as starch-formers, and redeposited as starch in special reservoirs or portions of plants as the period of maturity approaches. In this way the body is found to gorge the stems of certain palms—the sago, etc.—just before these plants begin to form their fruit; it is the principal constituent of the underground organs of biennial and perennial plants, tap-roots, root-stocks, corms, bulbs, and tubers; and it is abundantly stored in many fruits and seeds, as in the cereals and pulses, in bananas, bread-fruit, etc. It occurs in minute granules, varying in diameter from 1 to 100 and even 200 micromillimetres; and the granules from different sources have each a distinct microscopic character, their forms and size being, however, affected according as they are aggregated in clusters or individually formed (see vol. ii. p. 552, Figs. 3 to 6). Under the microscope these granules are seen to consist of a nucleus or hilum surrounded by layers arranged concentrically or excentrically, and the relations of hilum and layers are the most distinctive features of individual starches. Whether the hilum point bears to the granule the relation of a nucleus is a matter of dispute, the general opinion being that the grains are formed from without inwards, the centre being invariably the softest and most soluble portion, while the outer layers are most closely related to cellulose. Starch consists of a white or yellowish-white glistening powder, which on being rubbed between the fingers emits a crackling sound. It is only slightly acted on by cold water, but under the influence of heat in water it swells up, forming according to the proportions of starch and water a clouded opalescent paste. Iodine acts on it in water by producing a brilliant blue coloration, this reaction forming a very delicate and characteristic test. Diastase and dilute boiling sulphuric acid convert starch into a form soluble in hot water, whence it passes into a series of easily soluble dextrins, and finally into the condition of the sugars, dextrose and maltose. In its chemical relations starch consists of an intimate mixture of two isomeric bodies,—granulose and starch cellulose,—or rather of a series of gradations from the one to the other, the starch cellulose being principally in the external layers, while the granulose is found in the central portions of the granules. Starch cellulose is a body intermediate between granulose and ordinary cellulose; from the latter it is distinguished by being reducible to soluble starch by boiling in water and by digesting in caustic alkali. Together, the substances consist of a combination of carbon with hydrogen and oxygen, the commonly received formula being $C_6H_{10}O_5 + 2H_2O$; but Nägeli, Sachsse, and many other recent investigators show reason why the molecule should be regarded as consisting of $C_{36}H_{62}O_{31} + 12H_2O$.

As an economic product starch in its separate condition is a most important alimentary substance, the chief pure food starches being ARROWROOT, SAGO, TAPIOCA (*qq.v.*), and corn-flour, the starch of the MAIZE (*q.v.*). In its combined condition, in cereals, etc., starch is certainly the greatest and foremost of all the elements of nutrition (compare DIETETICS and NUTRITION). In its other industrial relations starch is used—(1) directly, as a thickening material in calico printing, for the dressing and finishing of many textiles, for laundry purposes, adhesive paste, and powder; and (2) indirectly, for the preparation of dextrin and British gum and starch sugar. Maize, wheat, and rice starch are principally employed for the direct applications; and for the dextrin and starch-sugar manufacture potato starch is almost exclusively selected.

In the preparation of starch the object of the manufacturer is to burst the vegetable cell walls, to liberate the starch granules, and to free them from the other cell contents with which they are associated. When as in the case of the potato, the associated cell contents, etc., are readily separated by solution and levigation the manufacture is exceedingly simple. Potato starch is prepared principally by carefully washing the potatoes and in a kind of rasping machine reducing them to a fine pulp, which is deposited in water as raw starch. The impurities of this starch—cellulose, albuminoids, fragments of potato, etc.—are separated by washing it in fine sieves, through the meshes of which the pure starch alone passes. The sieves are variously formed, some revolving, others moving horizontally or in such manner as to keep the material in agitation. The starch is then received in tanks, in which it settles, and so separates from the soluble albuminoids and salts of the potatoes. The settling of the starch is much retarded by the dissolved allbuminoids, and to hasten the separation small quantities either of alum or of sulphuric acid are employed. Alum coagulates the albumen and to that extent contaminates the starch, while the acid acts on the starch itself and is difficult of neutralization. After the starch has settled, the brown-colored supernatant liquor is drawn off and the starch again washed either in tanks or in a centrifugal machine. Finally it is dried by spreading it in layers over porous bricks (a process not required in the case of starch washed in a centrifugal machine) and by exposure to the air, after which it still retains a large proportion of water, but is in a condition for making dextrin or starch-sugar. For further drying it is ground to a rough powder, and dried thoroughly in a hot chamber, then reduced to a powder and sifted. A method of reducing potatoes to a pulp by slicing and heaping them up till fermentation takes place is said to give a large yield of starch, but it is not much practiced.

In dealing with the starches of the cereals, there is greater difficulty, owing to the presence of gluten, which with water forms a tough elastic body difficult of solution and removal. The difficulty is experienced in greatest measure in dealing with wheat, which contains a large proportion of gluten. Wheat starch is separated in two different ways—(1) the fermentation method, which is the original process, and (2) by mechanical means without preliminary fermentation. In the fermentation process whole wheat or wheaten meal is softened and swollen by soaking in water. Wheat grains are, in this condition, ground, and the pulp, mixed to a thickish fluid with water, is placed in tanks, where it ferments, developing acetic and volatile acids which dissolve the gummy constituents of the wheat, with part of the gluten, and render the whole less tenacious. After full fermentation, the period of which varies with the weather and the process employed, the starch is separated in a washing drum. It is subsequently washed with water, which dissolves out the gluten, the starch settling in two layers,—one comparatively pure, the other mixed with gluten and some branny particles. These layers are separated, the second undergoing further washing to remove the gluten, etc., and the remaining operations are analogous to those employed in the preparation of potato-starch. By the mechanical process wheaten flour is kneaded into a stiff paste, which, after resting for an hour or two, is washed over a fine sieve so long as the water passing off continues milky, whereby the starch is liberated and the greater part of the gluten retained as a gluey elastic mass in the sieve. The starch is subsequently purified by fermentation, washing, and treatment in centrifugal machines. The gluten thus preserved is a useful food for diabetic patients, and is made with flour into artificial macaroni and pastes, besides being valuable for other industrial purposes.

Maize starch is obtained by analogous processes, but, the proportion of gluten in the grain being smaller, and less tenacious in its nature, the operations, whether chemical or mechanical, present fewer difficulties. Under one method the separation of maize starch is facilitated by steeping, swelling, and softening the grain in a weak solution of caustic soda, and favorable results are also obtained by a process in which the pulp from the crushing mill is treated with water acidulated with sulphurous acid.

In the preparation of rice-starch a weak solution of caustic soda is also employed for softening and swelling the grain. It is then washed with pure water, dried, ground, and sifted, and again treated with alkaline water, by which the whole of the nitrogenous constituents are taken up in soluble form. An acid process for obtaining rice-starch is also employed, under which the grain, swollen and ground, is treated repeatedly with a solution of hydrochloric acid, which also dissolves away the non-starchy constituents of the grain. The laundry starches now in use are principally made from rice and from pulse. (J. PA.)

STAR-CHAMBER, the name given in the 15th, 16th, and 17th centuries to an English high court of justice, consisting of the members of the ordinary council, or of the privy council only, with the addition of certain judges, and exercising jurisdiction, mainly criminal, in certain cases. The origin and early history of the court are somewhat obscure. The Curia Regis of the 12th century, combining judicial, deliberative, and administrative functions, had thrown off several offshoots in the Court of King's Bench and other courts, but the crown never parted with the supreme jurisdiction whence the subsidiary courts had emanated. When in the 13th century the council became a regular and permanent body, practically distinct from the parliament of estates, this jurisdiction continued to be exercised by the king in council. As the ordinary law-courts became more systematic and important, the indefinite character of the conciliar jurisdiction gave rise to frequent complaints; and efforts, for the most part fruitless, were made by the parliaments of the 14th century (*e.g.*, in 15 Edw. II. and 2 Edw. III.) to check it. The equitable jurisdiction of the chancellor, which grew up during the reign of Edward III., flowed from this supreme judicial power, like the common law-courts under Henry II., but without drying up the original source. It is in the reign of Edward III. that we first hear of the "chancellor, treasurer, justices, and others" exercising jurisdiction in the "star-chamber" or "chambre de estoiles" at Westminster. In Henry VI.'s reign one Danvers was acquitted of a certain charge by the king's council "in camera stellata." Hitherto such Acts of Parliament as had recognized this jurisdiction had done so only by way of limitation or prohibition, but in 1453, about the time when the distinction between the ordinary and the privy council first became apparent, an Act was passed by which the chancellor was empowered to enforce the attendance of all persons summoned by the privy seal before the king and his council in all cases not determinable by common law. At this time, then, the jurisdiction of the council was recognized as supplementary to that of the ordinary law-courts. But the anarchy of the Wars of the Roses, and the decay of provincial justice owing to the influence of great barons and the turbulence of the lower classes, obliged parliament to intrust wider powers to the council. This was the object of the famous Act of 3 Hen. VII., which was quoted by the lawyers of the Long Parliament as creating the court of star-chamber. This, however, as is shown above, it was far from doing. The act of 3 Hen. VII. empowered a committee of the council, consisting of the chancellor, treasurer, privy seal, or any two of them, with the chief justices, or in their absence two other justices, a bishop, and a temporal lord, to act as a court of justice for enforcing the law in cases where it was thwarted by bribery, intimidation or partiality. The jurisdiction thus entrusted to a committee of the council was not, therefore, like that granted in 1453, supplementary, but superseded the ordinary law-courts in cases where they were too weak to act. The Act simply supplied machinery for the exercise under special circumstances of that extraordinary penal jurisdiction which the council had never ceased to possess. This jurisdiction, Bacon tells us, was still further developed and organized by Wolsey. The court established by the Act 3 Hen. VII. continued to exist for about fifty years, but disappeared towards the end of Henry VIII.'s reign. Its powers were not lost, but fell back to the general body of the council, and were among the most important of those exercised by the council sitting in the star-chamber. A court not unlike that created in 3 Hen. VII. was erected in 1540. The Act of 31 Hen. VIII., which gave the king's proclamations the force of law, enacted that offenders against them might be punished by the usual officers of the council, together with some bishops and judges, "in the star-chamber or elsewhere." These powers also came after a time, like those granted in 1488, to be exercised by the council at large instead of by certain members of it. It is clear, however,—and this was one of the chief complaints against the court,—that the jurisdiction which belonged by law or custom to the whole body of the king's council was usurped at this time by the inner body of advisers called the privy council, which had engrossed all the other functions of the larger body. Sir T. Smith (temp. Eliz.) tells us that juries misbehaving "were many times commanded to appear in the star-chamber or before the privy council for the matter." The uncertain composition of the court is well displayed by Coke, who says that the star-chamber is or may be compounded of three several councils—(1) the lords and others of the privy council, (2) the judges of either bench and the barons of the exchequer, (3) the lords of parliament, who are not, however, standing judges of the court. Hudson (temp. Car. I.), on the other hand, considers that all peers had a right of sitting in the court. The latter class had, however, certainly given up sitting in the 17th century. The jurisdiction of the court was equally vague, and, as Hudson says, it was impossible to define it without offending the supporters of the prerogative by a limitation of its powers, or the common lawyers by attributing to it an excessive latitude. In practice its jurisdiction was almost unlimited. It took notice of maintenance and liveries, bribery or partiality of jurors, falsification of panels or of verdicts, routs and riots, murder, felony, forgery, perjury, fraud, libel and slander, offences against proclamations, duels, acts tending to treason, as well as of a few civil matters,—disputes as to land between great men or corporations, disputes between English and foreign merchants, testamentary cases, etc.,—in fact, "all offences may be here examined and punished if the king will" (Hudson). Its procedure was not according to the common law; it dispensed with the incumbrance of a jury; it could proceed on mere rumor or examine witnesses; it could apply torture; it could inflict any penalty short of death. It was thus admirably calculated to be the support of order against anarchy or of despotism against individual and national liberty. During the Tudor period it appeared in the former light, under the Stuarts in the latter. It was abolished by the Long Parliament in 1641, and was never afterwards revived.[1]

Authorities.—Smith, *Commonwealth of England;* Bacon, *Reign of Henry VII.;* Hudson, *Treatise of the Court of Star-Chamber* (*Collectanea Juridica*, vol. ii.); Hallam, *Const. Hist. of England;* Gneist. *Engl. Verfassungsgeschichte;* Dicey, *The Privy Council* (Arnold Prize Essay). The pleadings in the star-chamber are in the Record Office; the decrees appear to have been lost. (G. W. P.)

STARGARD, an ancient manufacturing town in eastern Pomerania, Prussia, is situated on the left bank of the navigable Ihna, 20 miles to the east of Stettin. Formerly a member of the Hanseatic League, the town retains memorials of its early importance in the large church of St. Mary, built in the 14th and 15th centuries, the 16th-century town-house, and the well-preserved walls with gateways and towers dating from the 14th century. The extensive new law-courts and three large barracks are among the modern buildings. Stargard has a considerable market for cattle and horses, and carries on trade in grain, spirits, and raw produce. Its manufactures include cigars, tobacco, wadding, and stockings; and there are also iron-foundries and linen and woollen factories in the town. The population in 1885 was 22,109 (in 1816 8706) of whom about 730 were Roman Catholics and about 560 Jews.

Stargard, mentioned as having been destroyed by the Poles in 1120, received town-rights in 1229, and became the capital of eastern Pomerania. As a Hanseatic town it enjoyed considerable commercial prosperity, but had also to undergo siege and capture in the Middle Ages and during the Thirty Years' War. In 1807 it was taken by Schill. The name Stargard (from the Slavonic Starograd or Starigrod, meaning "old town") is common to several other towns in the north of Germany, of which the chief are Prussian Stargard, near Dantzic, and Stargard-in-Mecklenburg.

STARLING (A.S. *Stær*, *Stearn*, and *Sterlyng;* Lat. *Sturnus;* Fr. *Étourneau*), a bird long time well-known in most parts of England, and now, through the extension of its range within the present century, in the rest of Great Britain, as well as in Ireland, where, though not generally distributed, it is very numerous in some districts. It is about the size of a Thrush, and, though at a distance it appears to be black, when near at hand its plumage is seen to be brightly shot with purple, green, and steel-blue, most of the feathers when freshly grown being tipped with buff. These markings wear off in the course of the winter, and in the breeding-season the bird is almost spotless. It is the *Sturnus vulgaris* of ornithologists.

To describe the habits of the Starling[2] within the limits here allotted is impossible. A more engaging bird scarcely exists, for its familiarity during some months of the year gives opportunities for observing its ways that few others afford, while its varied song, its sprightly gestures, its glossy plumage, and, above all, its character as an insecticide—which last makes it the friend of the agriculturist and the grazier—render it an almost universal favorite. The worst that can be said of it is that it occasionally pilfers fruit, and, as it flocks to roost in autumn and winter among reed-beds, does considerable damage by breaking down the stems.[1] The congregations of Starlings are indeed very marvellous, and no less than the aerial evolutions of the flocks, chiefly before settling for the night, have attracted attention from early times, being mentioned by Pliny (*Hist. Naturalis*, x. 24) in the 1st century. The extraordinary precision with which the crowd, often numbering several hundreds, not to say thousands, of birds, wheels, closes, opens out, rises, and descends, as if the whole body were a single living thing—all these movements being executed without a note or cry being uttered—must be seen to be appreciated, and may be seen repeatedly with pleasure. For a resident, the Starling is rather a late breeder. The nest is commonly placed in the hole of a tree or of a building, and its preparation is the work of some little time. The eggs, from 4 to 7 in number, are of a very pale blue, often tinged with green. As the young grow they become very noisy, and their parents, in their assiduous attendance, hardly less so, thus occasionally making themselves disagreeable in a quiet neighborhood. The Starling has a wide range over Europe and Asia, reaching India; but examples from Kashmir, Persia, and Armenia have been considered worthy of specific distinction, and the resident Starling of the countries bordering the Mediterranean is generally regarded as a good species, and called *S. unicolor* from its unspotted plumage.

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[1] The name is probably derived from the stars with which the roof of the chamber was painted; but it has also been derived from a Hebrew word *shetar*, or *sh'tar*, a bond, on the supposition that the room was that in which the legal documents connected with the Jews were kept prior to their expulsion by Edward I.

[2] They are dwelt on at some length in Yarrell's *British Birds*, ed. 4, vol. ii. pp. 229-241.

Of the many forms allied to the genus *Sturnus*, some of which have perhaps been needlessly separated therefrom, those known as GRACKLES (vol. xi. p. 24) have been already mentioned, and there is only room here to notice one other, *Pastor*, containing a beautiful species *P. roseus*, the Rose-colored Starling, which is not an unfrequent visitor to the British Islands. It is a bird of most irregular and erratic habits—a vast horde suddenly arriving at some place to which it may have hitherto been a stranger, and at once making a settlement there, leaving it wholly deserted as soon as the young are reared. This happened in the summer of 1875 at Villafranca, in the province of Verona, the castle of which was occupied in a single day by some 12,000 or 14,000 birds of this species, as has been graphically told by Sig. de Betta (*Atti del R. Ist. Veneto*, ser. 5, vol. ii.);[2] but similar instances have been before recorded,—as in Bulgaria in 1867, near Smyrna in 1856, and near Odessa in 1844, to mention only some of which particulars have been published.[3] (A. N.)

STARODUB, a district town of Russia, in the government of Tchernigoff, 116 miles to the northeast of that town, on the marshy banks of a small tributary of the navigable Sudost. It is regularly built, with broad straight streets, the houses being surrounded by large gardens. Its 23,890 inhabitants—Little Russian descendants of former Cossacks, with about 5000 Jews—support themselves chiefly by gardening and agriculture. Tanning is also carried on, and the trade in corn and hemp exported to Riga and St. Petersburg has some importance.

Starodub at one time played a prominent part in the history of the Ukraine. As early as the 11th and 12th centuries it was a bone of contention between different Russian princes, who appreciated the value of its strategic position. The Mongols seem to have destroyed it, and its name does not reappear till the 14th century. During the 15th and 16th centuries the Russians and Lithuanians were continually disputing the possession of its fortress, and at the beginning of the 17th century it became a stronghold of Poland.

STARO-KONSTANTINOFF, a district town of Russia, in the government of Volhynia, situated 121 miles to the west-southwest of Zhitomir. It is an old-fashioned, poorly built town, dating from the 16th century, and is often mentioned in history in connection with the rising of Cossacks under Bogdan Khmelnitzky. Owing to its excellent position close to the Austrian frontier and its railway communication with southwest Russia, it has a very active trade in corn, cattle, and salt with Austria, Prussia, and Poland. Its population (17,980 in 1884, of whom two-thirds were Jews) is rapidly increasing.

STASSFURT, a town in the Prussian province of Saxony, and one of the chief seats of the German salt-producing industry, is situated on both sides of the Bode, 19 miles to the southwest of Magdeburg. Although saline springs are mentioned here as early as the 13th century, the first attempt to bore for salt was not made until 1839, while the systematic exploitation of the salt-beds, to which the town is indebted for its prosperity, dates only from 1856. The shafts reached deposits of salt at a depth of 850 feet, but the finer and purer layers lie more than 1100 feet below the surface. Besides the rock-salt, which is excavated by blasting, the saline deposits of Stassfurt yield a considerable quantity of deliquescent salts and other saline products, which have encouraged the foundation of numerous chemical factories in the town and in the neighboring village of Leopoldshall, which stands upon Anhalt territory. The formation of the Stassfurt salt-beds and the composition of the rock-salt are described under SALT (vol. xxi. pp. 242, 243). The rock-salt works are mainly Government property, while the chemical factories are in private hands. About 2000 workmen are employed in the Stassfurt salt industry, and about 490,000 tons of raw salt are annually excavated. The population of the town, which contains one or two miscellaneous factories, was 16,457 in 1885.

STATE, GREAT OFFICERS OF. All the principal ministers of the British crown are popularly called the great officers of state. Under this designation are more or less accurately included the premier for the time being, the other members of the cabinet, and the leading functionaries of the court. But properly speaking the great offices of state are only nine in number, and it is to the holders of them alone that the description of "the great officers of state" strictly and distinctively applies. They are the lord high steward, the lord high chancellor, the lord high treasurer, the lord-president of the privy council, the lord-keeper of the privy seal, the lord great chamberlain, the lord high constable, the earl marshal, and the lord high admiral. Of these, three—the lord chancellor, the lord-president of the council, and the lord privy seal—are the first and second always and the third almost always cabinet ministers. The offices of two more, those of the lord treasurer and the high constable—are now executed by commission, the chief of the lords commissioners, known severally as the first lord of the treasury and the first lord of the admiralty, being likewise members of the cabinet, while the first lord of the treasury is usually at the head of the Government. But, although it has become the rule for the treasury and the admiralty to be put in commission, there is nothing except usage of longer or shorter duration to prevent the crown from making a personal appointment to either of them, and the functions which formerly appertained to the lord treasurer and the high admiral are still regularly performed in the established course of the national administration. The four offices of the high steward, the great chamberlain, the high constable, and the earl marshal stand on a different footing, and can be regarded at the present day as little else than survivals from an earlier condition of society. They have practically ceased to have any relation to the ordinary routine of business in the country or of ceremonial in the palace, and the duties associated with them have either passed entirely into abeyance or are restricted within extremely narrow limits, save on certain occasions of exceptional pomp and solemnity. All of them were once hereditary, and, taking the three kingdoms together, they or their counterparts and equivalents continue to be held by right of inheritance in one or other of them even now. The prince of Wales is the hereditary great steward of Scotland, and the earl of Shrewsbury is the hereditary grand seneschal of Ireland. The great chamberlainship of England is held jointly by Lady Willoughby de Eresby and Lord Carrington on the one part and on the other part by the marquis of Cholmondeley. The hereditary high constable of Scotland is the earl of Erroll, and the hereditary earl marshal of England is the duke of Norfolk. It is of the great offices of the steward, the chamberlain, the constable, and the marshal that we shall at present speak, the rest of those we have mentioned being dealt with under their proper headings, or in the articles CABINET MINISTRY, PRIVY COUNCIL, and ROYAL HOUSEHOLD.

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[1] A most ridiculous and unfounded charge has been, however, more than once brought against it—that of destroying the eggs of Skylarks. There is little real evidence of its sucking eggs, and much of its not doing so; while, to render the allegation still more absurd, it has been brought by a class of farmers who generally complain that Skylarks themselves are highly injurious.

[2] A partial translation of this paper is given in the *Zoologist* for 1878, pp. 18-22.

[3] It is remarkable that on almost all of these occasions the locality pitched upon has been, either at the time or soon after, ravaged by locusts, which the birds greedily devour. Another fact worthy of attention is that they are often observed to affect trees or shrubs bearing rose-colored flowers, as *Nerium oleander* and *Robinia viscosa*, among the blossoms of which they themselves may easily escape notice, for their plumage is rose-pink and black shot with blue.

Lord high steward.

The lord high steward of England ranks as the first of the great officers of state. His office is called out of abeyance by commission under the great seal only for coronations and for trials by the House of Lords. At the former he bears the crown of St. Edward immediately before the sovereign in the procession to Westminster Abbey, and he presides at the latter on the arraignment of a peer or a peeress for treason or felony. From the reign of Richard II. to that of Henry VII. it was the duty of the lord high steward to sit judicially in the court of claims to hear and determine all claims to render services of grand serjeanty to the king or queen at his or her coronation. Since the accession of the house of Tudor, however, this function has generally been discharged by a specially appointed commission, or a committee of the privy council. According to the tradition once current among lawyers and antiquaries, the steward of England was, under the Norman and Angevin kings, the second personage in the realm, the viceroy in the absence and the chief minister in the presence of the sovereign. Coke says, on the more than doubtful authority of an ancient manuscript, that his office was to superintend under the king and next after the king the whole kingdom and all the ministers of the law within the kingdom in time of both peace and war. But of this there is no satisfactory evidence. It is not improbable that the steward of England may for a short period after the Conquest have occupied a position analogous to that of the Saxon heah-gerefa or that of the Norman seneschal, or of the two in combination. But, as Stubbs points out, the chief minister and occasional viceroy, either alone or with others, of the Conqueror and his early successors was the person to whom the historians and the later constitutional writers give the name of justiciarius with or without the prefix "summus" or "capitalis." He adds that most likely the Norman seneschalship was the origin of the English justiciarship, that under Henry II. the seneschal of Normandy receives the name of justiciar, and that it is only in the same reign that the office in England acquires the exclusive right to the definite name of "summus" or "capitalis justitiarius" or "justitiarius totius Angliæ." But whatever may have been his original condition the steward had been by that time at the latest eclipsed in his most important functions by the justiciar, and he makes, as Stubbs observes, in his official capacity no great figure in English history. By the reign of Henry II. at any rate all connection between the stewardship and the justiciarship had come to an end; and, while the second retained its authority unimpaired until its extinction, the first became a grand serjeanty, primarily annexed to the barony of Hinckley, it is said, and afterwards to the earldom of Leicester. On the attainder of Simon de Montfort the earldom and stewardship were forfeited, and both were granted by Edward I. to his brother Edmund Plantagenet, earl of Lancaster, from whom they descended to the daughter and eventual heiress of Henry Plantagenet, duke of Lancaster. She was the first wife of John of Gaunt and the mother of Henry IV. On the accession of her son to the throne they became merged in the crown, from which period the stewardship has been revived only *hac vice* from time to time as occasion required. It is indeed to John of Gaunt that the pre-eminent position accorded to the office since the end of the 14th century is really due. It emerged from the comparative obscurity in which it had rested for nearly three hundred years as soon as he became the tenant of it by courtesy in right of his deceased wife. As far as any records show to the contrary he was the first steward of England who took part in the coronation of a king or queen, and he was certainly the first steward of England who sat in the court of claims or who presided at a trial by the House of Lords. It seems to have been by him also that the precedence of the stewardship before all the other great offices of state was secured, a restoration or augmentation of rank which is the more remarkable in that the steward of Scotland gave place to the chamberlain and the seneschal of Ireland gave place to the constable of the two kingdoms respectively. John of Gaunt may be regarded, in fact, as the creator of the lord high stewardship and all its privileges and prerogatives as they have existed from his days to our own.

Lord great chamberlain.

The lord great chamberlain of England ranks as the sixth great officer of state. Whenever the sovereign attends the palace of Westminster the keys are delivered to him, and he is for the time in command of the building. At the opening or closing of the session of parliament by the sovereign in person he disposes of the sword of state to be carried by any peer he may select, and walks himself in the procession on the right of the sword of state, a little before it and next to the sovereign. He assists at the introduction of all peers into the House of Lords on their creation, and at the homage of all bishops after their consecration. At a coronation he receives the regalia from the dean and chapter of Westminster, and distributes them to the personages who are to bear them in the ceremony. On that day it is his duty to carry the sovereign his shirt and wearing apparel before he rises and to serve him with water to wash his hands before and after dinner. The chamberlain was originally a financial officer; his work, Stubbs says, was rather that of auditor or accountant than that of treasurer; he held a more definite position in the household than most of the other great officers, "and in the judicial work of the country he was only less important than the justiciar." The office was hereditary in the Veres, earls of Oxford, from the reign of Henry I. to the reign of Charles I., when it passed through an heiress to the Berties, Lord Willoughby de Eresby, and afterwards earls of Lindsey and dukes of Ancaster, and from the Berties it was transmitted through coheiresses to the present inheritors of the dignity. The Stuarts, dukes of Lennox, were hereditary great chamberlains of Scotland in the 16th and 17th centuries. The office on their extinction was granted by Charles II. to James, duke of Monmouth and Buccleuch, on whose attainder it passed to Charles, duke of Richmond and Lennox, by whom it was surrendered to the crown in 1703.

Lord high constable.

The lord high constable of England ranks as the seventh of the great officers of state. His office is called out of abeyance for coronations alone, when it is his duty to assist in the reception of the regalia from the dean and chapter of Westminster, and during the coronation banquet to ride into Westminster Hall on the right hand of the champion. The constable was originally the commander of the royal armies and the master of the horse. He was also one of the judges of the court of chivalry or court of honor. The constableship was granted as a grand serjeanty with the earldom of Hereford by the empress Maud to Milo of Gloucester, and was carried by his heiress to the Bohuns, earls of Hereford and Essex. Through a coheiress of the Bohuns it descended to the Staffords, dukes of Buckingham; and on the attainder of Edward Stafford, third duke of Buckingham, in the reign of Henry VIII. it became merged in the crown. The Lacys and Verduns were hereditary constables of Ireland from the 12th to the 14th century; and the Hays, earls of Erroll, have been hereditary constables of Scotland from early in the 14th century until the present time.

Earl marshal.

The earl marshal of England ranks as the eighth of the great officers of state. He is the head of the college of arms, and has the appointment of the kings-of-arms, heralds, and pursuivants at his discretion. He attends the sovereign in opening and closing the session of parliament, walking opposite to the lord great chamberlain on his or her right hand. It is his duty to make arrangements for the order of all state processions and ceremonials, especially for coronations and royal marriages and funerals. Like the lord high constable he rides into Westminster Hall with the champion after a coronation, taking his place on the left hand, and with the lord great chamberlain he assists at the introduction of all newly-created peers into the House of Lords. The marshal appears in the feudal armies to have been in command of the cavalry under the constable, and to have in some measure superseded him as master of the horse in the royal palace. He exercised joint and co-ordinate jurisdiction with the constable in the court of chivalry, and afterwards became the sole judge of that tribunal. The marshalship of England was made hereditary in the Clares and Marshals, earls of Pembroke, in the reign of Stephen or Henry II., and through a coheiress passed to the Bigots, earls of Norfolk, and by Roger Bigot, fifth earl of Norfolk, it was surrendered with his other dignities to Edward I. It was granted by Edward II. to his brother Thomas of Brotherton, earl of Norfolk, and, after it had been variously disposed of by Edward III., was by Richard II. erected into an earldom and conferred on Thomas Mowbray, duke of Norfolk, who was the great-grandson and heir of Thomas of Brotherton. One of the coheiresses of the Mowbrays was the mother of John Howard, duke of Norfolk, who was created earl marshal by Richard III. After several attainders and partial restorations in the reigns of the Tudors and the Stuarts, the earl marshalship was finally entailed by Charles II. on the male line of the Howards, with many specific remainders and limitations, under which settlement it has regularly descended to the present duke of Norfolk. The Clares and Marshals, earls of Pembroke, and the Lords Morley appear to have been hereditary marshals of Ireland from the invasion of the island until the end of the 15th century. The Keiths were Earls Marischal of Scotland from the institution of the office by James II. in 1458 until the attainder of George, the tenth earl, in 1716.

On the subject of the great offices of state generally, see Stubbs, *Constitutional History*, ch. xi.; Freeman, *Norman Conquest*, ch. xxiv.; Gneist, *Constitution of England*, ch. xvi., xxxv., and liv.; also Gibbon, *Decline and Fall*, ch. liii., and Bryce, *Holy Roman Empire*, ch. xiv. (F. DR.)

STATEN ISLAND, an island of New York State, forming with some adjacent islands, Richmond county, with a population of 38,991 in 1880, is situated about 5 miles south of New York city, from which it is separated by New York Bay, while the Narrows, commanded by Forts Wadsworth and Tompkins and a line of water-batteries, separate it from Long Island on the northeast, Staten Island Sound from New Jersey on the west, and Newark Bay and the Kill van Kull from the same State on the north. It is of an irregular triangular shape, its greatest length being about 13 miles, its greatest breadth about 8, and the total area 58½ square miles. The surface is gently undulating, but a range of hills attaining 310 feet in height extends across the northern portion. Iron ore is found. The island contains many detached villa residences of persons in business in New York. On an artificial island off the east shore is the New York quarantine establishment, and Staten Island is the seat of the "Sailors' Snug Harbor," a retreat for superannuated seamen. Steam ferries ply half-hourly to New York, and on the island there is a railway line from Tompkinsville to Tottenville.

STATE PAPERS. See RECORDS, PUBLIC.

STATES OF THE CHURCH, or PAPAL STATES (Ital. *Stato della Chiesa*, *Stato Pontificio*, *Stato Romano*, *Stato Ecclesiastico*; Fr. *États de l'Église*, *Pontificat Souverain de Rome*, etc.; Germ. *Kirchenstaat*; in ecclesiastical Latin often *Patrimonium Sancti Petri*), that portion of central Italy which, previous to the unification of the kingdom, was under the direct government of the see of Rome. The territory stood at the close as in the annexed table.

With the exception of Benevento, surrounded by the Neapolitan province of Principato Ulteriore, and the small state of Pontecorvo, inclosed within the Terra di Lavoro, the States of the Church formed a compact territory, bounded on the N.W. by the Lombardo-Venetian kingdom, on the N.E. by the Adriatic, on the S.E. by the kingdom of Naples, on the S.W. by the Mediterranean, and on the W. by the grand-duchy of Tuscany and the duchy of Modena. On the Adriatic the coast extended 140 miles, from the mouth of the Tronto (Truentus) to the southern mouth of the Po, and on the Tyrrhenian Sea 130 miles, from 41° 20′ to 42° 22′ N. lat. See vol. xiii. Plate VI.

		Area in English Sq. Miles.	Population in 1853.
Comarca of Rome		1752.8	326,509
Legations.	Bologna	1359.2	375,631
	Ferrara	1094	244,524
	Forlì	718.8	218,433
	Ravenna	701.5	175,994
	Urbino, with Pesaro	1414.6	257,751
	Velletri	571.3	62,013
Delegations.	Ancona	441.8	176,519
	Macerata	895	243,104
	Camerino	320	42,991
	Fermo	335.7	110,321
	Ascoli	476.3	91,916
	Perugia	1555.5	234,533
	Spoleto	1175.9	135,029
	Rieti	531.7	73,683
	Viterbo	1158.9	128,324
	Orvieto	316.6	29,047
	Cività Vecchia	380	20,701
	Frosinone, with Pontecorvo	739.9	154,559
	Benevento	61.3	23,176
		16,000.8	3,124,758

The divisions shown above were adopted on December 21, 1827, the legations being ruled by a cardinal and the delegations by a prelate. Previously the several districts formally recognized were Latium, the Marittima (or seaboard) and Campagna, the Patrimony of Saint Peter, the duchy of Castro, the Orvietano, the Sabina, Umbria, the Perugino, the March of Ancona, Romagna, the Bolognese, the Ferrarese, and the duchies of Benevento and of Pontecorvo.

The question of the origin of the territorial jurisdiction of the pope has been treated under POPEDOM (vol. xix. pp. 507-8). With the moral and ecclesiastical decay of the papacy in the 9th and 10th centuries much of its territorial authority slipped from its grasp; and by the middle of the 11th century its rule was not recognized beyond Rome and the immediate vicinity. By the treaty of Sutri (February, 1111) Paschal II. was compelled by the Emperor Henry V to surrender all the possessions and royalties of the church; but this treaty was soon afterwards repudiated, and by the will of Matilda, countess of Tuscany, the papal see was enabled to lay claim to new territories of great value. By the capitulation of Neuss (1201) Otto IV. recognized the papal authority over the whole tract from Radicofani in Tuscany to the pass of Ceperano on the Neapolitan frontier—the exarchate of Ravenna, the Pentapolis, the March of Ancona, the bishopric of Spoleto, Matilda's personal estates, and the countship of Brittenoro; but a good deal of the territory thus described remained for centuries an object of ambition only on the part of the popes. The actual annexation of Ravenna, Ancona, Bologna, Ferrara, etc., dates from the 16th century. The States of the Church were of course submerged for a time by the ground-swell of the French Revolution, but they appeared again in 1814. In 1849 they received a constitution. On the formation of the kingdom of Italy in 1860 they were reduced to the Comarca of Rome, the legation of Velletri, and the three delegations of Viterbo, Cività Vecchia, and Frosinone; and in 1870 they disappeared from the political map of Europe.

STATICS. See MECHANICS.

STATIONERY. Under the name of stationery are embraced all writing materials and implements, together with the numerous appliances of the desk and of mercantile and commercial offices. In addition to these, the term fancy stationery covers a miscellaneous assemblage of leather and other goods, such as pocket-books, purses, bags, card-cases, and many kindred objects which cannot be classified. The principal articles and operations of the stationery trade are dealt with in detail under separate headings—BOOKBINDING, EMBOSSING, INK, LITHOGRAPHY, PAPER, PEN, PENCIL, SEALING-WAX, etc.; but in connection with the separate industry of a commercial stationer there are a number of special operations and machines to which brief allusion may be made.

Paper-Ruling.—The ruling of blue and other colored lines is usually done on a self-feeding machine provided with as many ruling pens as there are lines to be made, and these fixed in parallel order at intervals the width of the ruled spaces. The pens consist of grooved slips of sheet brass coming to a fine point, which in their upper part are covered by a sheet of felt saturated with a flowing ink, whence each pen obtains the supply required for tracing its line. The paper is carried forward by endless tapes or threads which pass around cylinders. In a recent form of machine the rulers consist of metal disks with thin edges, which take up printing ink from an india-rubber cylinder, and print the lines on the paper as it passes around a revolving cylinder.

Paper-Folding machinery is used for numerous purposes in the stationery trade, apart from its application to the folding of sheets for the bookbinder. Devices for folding come most prominently forward in connection with the envelope manufacture, an industry which received an enormous development by the introduction of uniform postage rates. In envelope-making the folding is commonly associated with gumming, and sometimes with embossing, in the same system of machinery. The first efficient automatic machine for envelope manufacture was devised by Edwin Hill and Warren de la Rue, and by them patented in 1845. Many forms of envelope folding and gumming machines now exist. In making envelopes the blanks are first cut out by shaped cutters or punches acting at one stroke on a thickness of from 200 to 300 sheets of paper. These blanks in the latest form of machine are gummed by a pad which takes gum from a roller and presses it on the edges of the paper, just as printing ink is received from cylinders and pressed on paper in printing. The gummed surface of the pad lifts each blank separately, places it under a plunger, which, descending, passes it to folders, whence it is delivered into a clip in an endless band of considerable length. The envelopes are delivered into the clips in the band at the rate of about 100 to 150 per minute.

Perforating and *Punching* give rise to a range of machines of varied form and complexity. The idea of perforating paper so as to allow of the ready detaching of portions by tearing was conceived and patented in 1848 by Mr. Henry Archer. Of such utility was Mr. Archer's conception deemed by the post-office authorities as a convenience for detaching stamps from sheets that in 1853 he was awarded £4000 [$19,440] for his patent rights. The applications of perforation are now very numerous, but its value still remains most obvious in connection with the detachment of adhesive stamps from sheets.

Numbering and *Paging* constitute another series of stationery operations, for which ingenious machines have been devised. For consecutive numbering a series of printing disks are employed, on the periphery of which the series of digits 1 to 0 are raised. The outer disk moves a number after each impression, the second disk moves once in ten times, and so on, thus automatically imprinting consecutive numbers up to the limit of the disks on the machine. Such a machine prints only on one side of the paper, and where the numbering is required on both sides the disks must be geared to move two places, numbering only odd or even numbers, two printings being thus required. For printing right and left consecutively an endless band machine is used, which prints alternately below and above for the two sides of the sheet.

STATISTICS. The word "statistic" is derived from the Latin *status*, which, in the so-called Middle Ages, had come to mean a "state" in the political sense. "Statistic," therefore, originally denoted inquiries into the condition of a state. Since the beginning of the 18th century the denotation of the word has been extended so as to include subjects only indirectly connected with political organizations, while at the same time the scope of the investigations it implies has become more definite, and at the present day may be said, for practical purposes, to be fixed, though there are still controversies as to the position of statistical studies in relation to other departments of scientific procedure.

History.—The origin of what is now known as "statistic" (Ger. *Die Statistik;* Fr. *La Statistique;* Ital. *Statistica*) can only be referred to briefly here. As M. Maurice Block has observed in commencing his admirable treatise, "it is no exaggeration to say that statistic has existed ever since there were states." For the first administrative act of the first regular Government was probably to number its fighting men, and its next to ascertain with some degree of accuracy what amount of taxation could be levied on the remainder of the community. As human societies became more and more highly organized, there can be no doubt that a very considerable body of official statistics must have come into existence, and been constantly used by statesmen, solely with a view to administration. The Romans, who may be described as the most business-like people of antiquity, were careful to obtain accurate information regarding the resources of the state, and they appear to have carried on the practice of taking the census, a very comprehensive statistical operation, with a regularity which has hardly been surpassed in modern times. As to the efficiency of the work done we have unfortunately very little information, but those who are curious on the subject may be referred to an article by Dr. Hildebrand, entitled "Die amtliche Bevölkerungsstatistik im alten Rom," printed in the *Jahrbuch für Nationalökonomie und Statistik*, 1866, p. 82.

Statistics, or rather the material for statistics, therefore existed at a very early period, but it was not until within the last three centuries that systematic use of the information available began to be made for purposes of investigation and not of mere administration. According to M. Block, the earliest work in which facts previously known only to Government officials were published to the world was a volume compiled by Francesco Sansovino, entitled *Del Governo et Amministrazione di Diversi Regni et Republiche*, which was printed in Venice and bears the date 1583. Other works of a similar kind were published towards the end of the 16th century in Italy and France. Regarding these and other early books on the subject reference may be made to Fallati's *Einleitung in die Wissenschaft der Statistik*, Dr. G. B. Salvioni's preface and notes to his translation into Italian of Dr. Mayr's work on statistics, and other authors mentioned at the close of this article.

Works on state administration and finance continued to be published during the first half of the 17th century, and the tendency to employ figures, which were hardly used at all by Sansovino, became more marked, especially in England, where the facts connected with "bills of mortality" had begun to attract attention.

In the year 1660 Hermann Conring, "professor of medicine and politics," a rather odd combination, in the university of Helmstädt, was in the habit of giving lectures in which he analyzed and discussed the circumstances existing in various countries, in so far as they affected the happiness of the inhabitants. Conring's example was followed by other writers, in Germany and elsewhere, to whom reference is made by Block (*Traité*, pp. 5, 6) and Haushofer (*Lehr- und Handbuch*, p. 10, note).

The best-known member of the "descriptive" school was Achenwall (1719–1772), who is sometimes spoken of as "the father of modern statistics," but, as his procedure was essentially the same as that of Conring, though it was carried out more fully, the title has not been unanimously granted. It is generally admitted, however, that Achenwall's work gave a great impulse to the pursuit of the studies which are now included under the title of statistics. He called his book *Staatsverfassung der europäischen Reiche* in the first two editions (1749, 1752), meaning "Constitution of the States of Europe." Subsequently he added "vornehmsten" and then "heutigen" before "europäischen," evidently with the desire of bringing his work, which may be regarded as the germ of such volumes as the *Statesman's Year-Book*, "up to date." Achenwall is usually credited with being the first writer who made use of the word "statistics," which he applied to his collection of "noteworthy matters regarding the state" (*Staatsmerkwürdigkeiten*), but the claim has been disputed by M. Block, who points out that the term *collegium statisticum* had been previously employed by Schmeitzel, a follower of Conring, whose lectures at Jena were no doubt attended by Achenwall.

In any case statistics in the modern sense of the word, did not really come into existence until the publication by J. P. Süssmilch, a Prussian clergyman, of a work entitled *Die göttliche Ordnung in den Veränderungen des Menschlichen Geschlechts aus dem Geburt, dem Tode, und der Fortpflanzung desselben erwiesen.* In this book a systematic attempt was made to make use of a class of facts which up to that time had been regarded as belonging to "political arithmetic," under which description some of the most important problems of what modern writers term "vital statistics" had been studied, especially in England. Süssmilch had arrived at a perception of the advantage of studying what Quetelet subsequently termed the "laws of large numbers." He combined the method employed by the Conring-Achenwall school of "descriptive statistics," whose works were not unlike modern schoolbooks of geography, with that of the "political arithmeticians," who had confined themselves to investigations into the facts regarding mortality and a few other similar subjects, without much attempt at generalizing from them.

Political arithmetic had come into existence in England in the middle of the 17th century, or about the time when Conring was instructing the students of Helmstädt. The earliest example of this class of investigation is the work of Captain John Graunt of London, entitled *Natural and Political Annotations made upon the Bills of Mortality*, which was first published in 1666. This remarkable work, which dealt with mortality in London only, ran through many editions, and the line of inquiry it suggested was followed up by other writers, of whom the most distinguished was Sir William Petty, whose active mind was naturally attracted by the prospect of making use of a new scientific method in the class of speculations which occupied him. Sir William was the first writer to make use of the phrase which for nearly a century afterwards was employed to describe the use of figures in the investigation of the phenomena of human society. He called his book on the subject, which was published in 1683, *Five Essays in Political Arithmetick.* Other writers, of whom Halley, the celebrated mathematician and astronomer, was one, entered on similar investigations, and during the greater part of the 18th century the number of persons who devoted themselves to "arithmetical" inquiries into problems of the class now known as statistical was steadily increasing. Much attention was given to the construction of tables of mortality, a subject which had a great attraction for mathematicians, who were eager to employ the newly-discovered calculus of probabilities on concrete problems. Besides Halley, De Moivre, Laplace, and Euler busied themselves with this branch of study. Attempts were also made to deal with figures as the basis of political and fiscal discussion by Arthur Young, Hume, and other historical writers, as well as by the two Mirabeaus.

It is now necessary to return to Süssmilch, who, as already mentioned, endeavored to form a general theory of society, based on what were then termed "arithmetical" premises, treated nearly on the lines laid down by Achenwall. In modern language, he made use of quantitative aggregate-observation as an instrument of social inquiry. It is true he did not enter on his investigation with an "open mind." He desired to support a foregone conclusion, as the title of his work already mentioned shows. But nevertheless his work was a most valuable one, since it pointed out a road which others who had no desire to procure evidence in favor of a particular system of thought were not slow to follow. M. Block makes the following remarks on the influence exercised on his contemporaries by the work of Süssmilch: "If the author of the *Göttliche Ordnung* had been a professor his influence would have been much greater than it was. In maintaining that the movement of population is subject to law, that there is a regularity in the recurrence of such phenomena which allows of their being foreseen, he cast into the public mind a leaven which has evidently contributed to the progress of science." Although for many years after the appearance of Süssmilch's book there was a good deal of resistance to the introduction of "arithmetic" as the coadjutor of moral and political investigations, yet, practically there was a tacit admission of the usefulness of figures, even by the chiefs of the so-called "descriptive" school. On the other hand Süssmilch's success was the origin of a "mathematical" school of statisticians, some of whom carried their enthusiasm for figures so far that they refused to allow any place for mere "descriptions" at all. These two schools have now coalesced, each admitting the importance of the point of view urged by the other. They were, however, still perceptibly distinct even as late as 1850, and the ignorant hostility with which many people even among the cultivated classes still regard statistical inquiries into the nature of human society may be regarded as a survival of the much stronger feeling which showed itself among "orthodox" professors of law and economics on the publication of Süssmilch's treatise.

M. Block is of opinion that the descriptive school, by whom figures are regarded merely as accessories to and illustrations of the text, would have maintained its position even now but for the establishment of official statistical offices and the influence of the great Belgian Quetelet. Quetelet's work was certainly "epoch-making" in a far higher degree than that of any of his predecessors. To the impulse created by him must be attributed the foundation in 1835 of the Statistical Society of London, a body which, though it has contributed little to the discussion of the theory of statistics, has had a considerable and very useful influence on the practical work of carrying out statistical investigations in the United Kingdom and elsewhere. Quetelet's works were numerous and multifarious, but his most important contribution to the growth of statistical inquiry, was his investigation of the theory of probabilities as applied to the "physical and social" sciences, contained in a series of letters to the duke of Saxe-Coburg and Gotha, and published in 1846. Quetelet was above all things an exponent of the "laws of large numbers." He was especially fascinated with the tendency to relative constancy of magnitude displayed by the figures of moral statistics, especially those of crime, which inspired him with a certain degree of pessimism. His conception of an average man (*l'homme moyen*) and his disquisition on the "curve of possibility" were most important contributions to the technical development of the statistical method, though, as M. Block observes, their value may have been somewhat exaggerated by subsequent writers (Block, ch. i, p. 16, and ch. v. p. 112 *sq.*). It is not possible to enter at length into Quetelet's work in connection with statistical science. At the close of this article will be found a list including those of his works which are likely to be of use to students of statistics.

The influence exercised by Quetelet on the development of statistics is clearly seen from the fact that, though there is still considerable controversy among statisticians, the old controversy between the "descriptive" and arithmetical schools has disappeared, or perhaps we should say has been transformed into a discussion of another kind, the question now at issue being whether there is a science of statistics as well as a statistical method. It is true that a few books were published between 1830 and 1850 in which the politico-geographical description of a country is spoken of as "statistics," which is thus distinguished from "political arithmetic." The title of Knies's great work, *Die Statistik als selbständige Wissenschaft* (Cassel, 1850), is especially noteworthy as showing that the nature of the controversy was changing. The opponents of Süssmilch maintained that "political arithmetic" ought not to be spoken of as statistics at all. They clung to the conceptions of Conring and Achenwall, to whom "statistics" represented "Staatenkunde" or "Staatszustandskunde," or, as Herzberg, one of Achenwall's followers, called it, "die Kenntniss von der politischen Verfassung der Staaten." Knies claimed that the really "scientific" portion of statistics consisted of the figures employed. As Haushofer says, "his starting point is political arithmetic."

Some eminent statisticians of the latter half of the present century agree with Knies, but the majority of the modern writers on the theory of statistics have adopted a slightly different view, according to which statistics is at once a *science* relating to the social life of man and a *method of investigation* applicable to all sciences. This view is ably maintained by Mayr, Haushofer, Gabaglio, and Block, who may be taken to represent the opinions held by the majority of statisticians on the Continent.

Having dealt as far as was possible, within the limits of this article, with the history of statistics, we may here enter a little more minutely into the views of the existing Continental School. This is all the more necessary because, singular to say, there has been no systematic exposition of the subject in England. Isolated dicta have been furnished by high authorities, such as the late Dr. W. A. Guy, Prof. Ingram, Sir Rawsón W. Rawson, Mr. Robert Giffen, and to some extent also by John Stuart Mill, Buckle, Sir George Cornewall Lewis, and other historical and economic writers. There are also monographs on particular points connected with the *technique* of statistical investigation, such as the contribution made by Mr. F. Y. Edgeworth to the discussions at the jubilee of the Statistical Society in 1885, and some of the observations contained in a paper by Mr. Patrick Geddes, entitled *An Analysis of the Principles of Economics*, read before the Royal Society of Edinburgh in 1884. Prof. Foxwell has also lectured on the subject of statistics in his capacity of Newmarch lecturer at University College, London. But there has been no attempt to deal with the subject in a systematic way. The practice of statistical inquiry, on the other hand, has been carried on in England with a high decree of success.

With regard to the few invasions of the domain of theory attempted by English writers, it may be observed that the authorities above mentioned are not unanimous. Dr. Guy as well as Sir Rawson Rawson, who handled the subject with great ability at the jubilee meeting of the London Statistical Society in June, 1885, both claim that statistics is to be regarded as an independent science, apart from sociology, while Prof. Ingram, who presided over Section F at the Dublin meeting of the British Association in 1878, maintained that statistics cannot occupy a position co-ordinate with that of sociology, and went on to say that they "constitute only one of the aids or adminicula of science." Mr. Giffen has also expressed himself adversely to the Continental doctrine that there is an independent science of statistics, and this opinion appears to be the correct one, but, as Dr. Guy and Sir Rawson Rawson have the support of the great body of systematic teaching emanating from distinguished Continental statisticians in support of their view, while their opponents have so far only the *obiter dicta* of a few eminent men to rely upon, it appears needful to examine closely the views held by the Continental authorities, and the grounds on which they are based.

The clearest and shortest definition of the science of statistics as thus conceived is that of M. Block, who describes it as "la science de l'homme vivant en société en tant qu'elle peut être exprimée par les chiffres." He proposes to give a new name to the branch of study thus defined, namely, "Demography." Mayr's definition is longer. He defines the statistical science as "die systematische Darlegung und Erörterung der thatsächlichen Vorgänge und der aus diesen sich ergebenden Gesetze des gesellschaftlichen menschlichen Lebens auf Grundlage quantitativer Massenbeobachtungen" (the systematic statement and explanation of actual events, and of the laws of man's social life that may be deduced from these, on the basis of the quantitative observation of aggregates). Gabaglio's view is practically identical with those adopted by Mayr and Block, though it is differently expressed. He says "statistics may be interpreted in an extended and in a restricted sense. In the former sense it is a method, in the latter a science. As a science it studies the actual social-political order by means of mathematical induction."

This discussion regarding the nature of statistics is to a large extent a discussion about names. There is really no difference of opinion among statistical experts as to the subject-matter of statistics, the only question being—Shall statistics be termed a science as well as a method? That there are some investigations in which statistical procedure is employed which certainly do not belong to the domain of the supposed statistical science is generally admitted. But, as already shown, an attempt has been made to claim that the phenomena of human society, or some part of those phenomena, constitute the subject-matter of an independent statistical science. It is not easy to see why this claim should be admitted. There is no reason either of convenience or logic why the use of a certain scientific method should be held to have created a science in one department of inquiry, while in others the said method is regarded merely as an aid in investigation carried on under the superintendence of a science already in existence. It is impossible to get over the fact that in meteorology, medicine, and other physical sciences statistical inquiries are plainly and obviously examples of the employment of a method, like microscopy, spectrum analysis, or the use of the telescope. Why should the fact of their employment in sociology be considered as authorizing the classification of the phenomena thus dealt with to form a new science?

The most effective argument put forward by the advocates of this view is the assertion that statistics are merely a convenient aid to investigation in the majority of sciences, but are the sole method of inquiry in the case of sociology. Dr. Mayr especially (*Gesetzmässigkeit*, etc., p. 14 *sq.*) makes use of this argument, and illustrates it with his usual ability; but his reasoning is very far from being conclusive. When, indeed, it is tested by reference to the important class of social facts which are named economic, it becomes obvious that the argument breaks down. Economics is a branch—the only scientifically organized branch—of sociology, and statistics are largely used in it, but no one, so far as we are aware, has proposed to call economics a department of statistical science. Sir Rawson W. Rawson, it is true, has boldly proposed to throw over the term "sociology" altogether, and to describe the study of man in the social state as "statistics," but common usage is too firmly fixed to make this alteration of nomenclature practicable even if it were desirable. The existence of the works of Mr. Herbert Spencer and Dr. Schäffle alone would render the attempted alteration abortive.

Although, however, the above considerations forbid the acceptance of the Continental opinion that the study of man in the social state is identical with statistics, it must be admitted that without statistics the nature of human society could never become known. For society is an aggregate, or rather a congeries of aggregates. Not only that, but the individuals composing these aggregates are not in juxtaposition, and what is, from the sociological point of view, the same aggregate or organ of the "body politic" is not always composed of the same individuals. Constancy of social form is maintained concurrently with the most extensive changes in the collocation and identity of the particles composing the form. A "nation" is really changed, so far as the individuals composing it are concerned, every moment of time by the operation of the laws of population. But the nation, considered sociologically, remains the same in spite of this slow change in the particles composing it, just as a human being is considered to be the same person year by year, although year by year the particles forming his or her body are constantly being destroyed and fresh particles substituted. Of course the analogy between the life of a human being and the life of a human community must not be pressed too far. Indeed, in several respects human communities more nearly resemble some of the lower forms of animal life than the more highly organized forms of animal existence. There are organisms which are fissiparous, and when cut in two form two fresh independent organisms, so diffused is the vitality of the original organism; and the same phenomenon may be observed in regard to human communities.

Now the only means whereby the grouping of the individuals forming a social organism can be ascertained, and the changes in the groups year by year observed, is the statistical method. Accordingly the correct view seems to be that it is the function of this method to make perceptible facts regarding the constitution of society on which sociology is to base its conclusions. It is not claimed, or ought not to be claimed, that statistical investigation can supply *the whole* of the facts a knowledge of which will enable sociologists to form a correct theory of the social life of man. The statistical method is essentially a mathematical procedure, attempting to give a quantitative expression to certain facts; and the resolution of differences of quality into differences of quantity has not yet been effected even in chemical science. In sociological science the importance of differences of quality is enormous, and the effect of these differences on the conclusions to be drawn from figures is sometimes neglected, or insufficiently recognized, even by men of unquestionable ability and good faith. The majority of politicians, social "reformers," and amateur handlers of statistics generally are in the habit of drawing the conclusions that seem good to them from such figures as they may obtain, merely by treating as homogeneous quantities which are heterogeneous, and as comparable quantities which are not comparable. Even to the conscientious and intelligent inquirer the difficulty of avoiding mistakes in using statistics prepared by other persons is very great. There are usually "pitfalls" even in the simplest statistical statement, the position and nature of which are known only to the persons who have actually handled what may be called the "raw material" of the statistics in question; and in regard to complex statistical statements the "outsider" cannot be too careful to ascertain from those who compiled them as far as possible what are the points requiring elucidation.

The Statistical Method.—This method is a scientific procedure (1) whereby certain phenomena of aggregation not perceptible to the senses are rendered perceptible to the intellect, and (2) furnishing rules for the correct performance of the quantitative observation of these phenomena. The class of phenomena of aggregation referred to includes only such phenomena as are too large to be perceptible to the senses. It does not, *e.g.*, include such phenomena as are the subject-matter of microscopy. Things which are very large are often quite as difficult to perceive as those which are very small. A familiar example of this is the difficulty which is sometimes experienced in finding the large names, as of countries or provinces, on a map. Of course the terms "large," "too large," "small," and "too small" must be used with great caution, and with a clear comprehension on the part of the person using them of the standard of measurement implied by the terms in each particular case. A careful study of the first few pages of De Morgan's *Differential and Integral Calculus* will materially assist the student of statistics in attaining a grasp of the principles on which standards of measurement should be formed. It is not necessary that he should become acquainted with the calculus itself, or even possess anything more than an elementary knowledge of mathematical science, but it is essential that he should be fully conscious of the fact that "large" and "small" quantities can only be so designated with propriety by reference to a common standard.

Sources whence Statistics are Derived.—The term "statistics" in the concrete sense means systematic arrangements of figures representing "primary statistical quantities." A primary statistical quantity is a number obtained from numbers representing phenomena, with a view to enable an observer to perceive a certain other phenomenon related to the former as whole to parts. They represent either a phenomenon of existence at a given point of time or a phenomenon of accretion during a given period. As examples may be mentioned the number of deaths in a given district during *a given time*, the number of pounds sterling received by the London and North Western Railway during a given time, and the number of "inches of rain" that fell at Greenwich during a given time. Other examples are the number of tons of pig-iron lying in a particular store at *a given date*, the number of persons residing (the term "residing" to be specially defined) in a given territory at a given date, and the number of pounds sterling representing the "private deposits" of the Bank of England at a given date.

Primary Statistical Quantities are the result of labors carried on either (A) by Governments or (B) by individuals or public or private corporations.

A. *Government Statistics.*—(1) A vast mass of statistical material of more or less value comes into existence automatically in modern states in consequence of the ordinary administrative routine of departments. To this class belong the highly important statistical information published in England by the registrar-general, the returns of pauperism issued by the Local Government Board, the reports of inspectors of prisons, factories, schools, and those of sanitary inspectors, as well as the reports of the commissioners of the customs, and the annual statements of trade and navigation prepared by the same officials. There are also the various returns compiled and issued by the Board of Trade, which is the body most nearly resembling the statistical bureaus with which most foreign Governments are furnished. Most of the Government departments publish some statistics for which they are solely responsible as regards both matter and form, and they are very jealous of their right to do so, a fact which is to some extent detrimental to that uniformity as to dates and periods which should be the ideal of a well-organized system of statistics. Finally may be mentioned the very important set of statistical quantities known as the budget, and the statistics prepared and published by the commissioners of inland revenue, by the post-office, and by the national debt commissioners. All these sets of primary statistical quantities arise out of the ordinary work of departments of the public service. Many of them have been in existence, in some form or other, ever since a settled Government existed in the country. There are records of customs receipts at London and other ports of the time of Edward III., covering a period of many years, which leave nothing to be desired in point of precision and uniformity. It may be added that many of these sets of figures are obtained in much the same form by all civilized Governments, and that it is often possible to compare the figures relating to different countries, and thus obtain evidence as to the sociological phenomena of each, but in regard to others there are differences which make comparison difficult.

(2) Besides being responsible for the issue of what may be called administration statistics, all Governments are in the habit of ordering from time to time special inquiries into special subjects of interest, either to obtain additional information needful for administrative purposes, or, in countries possessed of representative institutions, to supply statistics asked for by parliaments or congresses. It is not necessary to refer particularly to this class of statistical information, except in the case of the census. This is an inquiry of such great importance that it may be regarded as one of the regular administrative duties of Governments, though as the census is only taken once in a series of years it must be mentioned under the head of occasional or special inquiries undertaken by Governments. In the United Kingdom the work is done by the registrars-general who are in office when the period for taking the census comes round. On the Continent the work is carried out by the statistical bureaus of each country,—except France, where it is under the supervision of the minister of the interior. For further information on this subject reference may be made to the excellent chapter in M. Maurice Block's *Traité* entitled "Recensement." See also "Instructions to the Superintendent Registrar of Births and Deaths as to his duties in taking the Census," 1871; also CENSUS, vol. v. p. 290 *sq.*

B. The primary statistical quantities for which individuals or corporations are responsible may be divided into three categories:

(1) Among those which are compiled in obedience to the law of the land are the accounts furnished by municipal corporations, by railway, gas, water, banking, insurance, and other public companies making returns to the Board of Trade, by trades unions, and by other bodies which are obliged to make returns to the registrar of friendly societies. The information thus obtained is published in full by the departments receiving it, and is also furnished by the companies themselves to their proprietors or members.

(2) An enormous mass of statistical information is furnished voluntarily by public companies in the reports and accounts which, in accordance with their articles of association, are presented to their proprietors at stated intervals. With these statistics may be classed the figures furnished by the various trade associations, some of them of great importance, such as Lloyd's, the London Stock Exchange, the British Iron Trade Association, the London Corn Exchange, the Institute of Bankers, the Institute of Actuaries, and other such bodies too numerous to mention.

(3) There are cases in which individuals have devoted themselves with more or less success to obtaining original statistics on special points. The great work done by Messrs. Behm and Wagner in arriving at an approximate estimate of the population of the earth does not belong to this category, though its results are really primary statistical quantities. Many of these results have not been arrived at by a direct process of enumeration at all, but by ingenious processes of inference. It need hardly be said that it is not easy for individuals to obtain the materials for any primary statistical quantity of importance, but it has been done in some cases with success.

Operations Performed on Primary Statistical Quantities.—Only a brief description of matters connected with the *technique* of the statistical method can be given in this article. In order to form statistics properly so called the primary statistical quantities must be formed into tables, and in the formation of these tables lies the art of the statistician. It is not a very difficult art when the principles relating to it have been properly grasped, but those who are unfamiliar with the subject are apt to underrate the difficulty of correctly practicing it.

Simple Tables.—The first thing to be done in the construction of a table is to form a clear idea of what the table is to show, and to express that idea in accurate language. This is a matter which is often neglected, and it is a source of much waste of time and occasionally of misapprehension to those who have to study the figures thus presented. No table ought to be considered complete without a "heading" accurately describing its contents, and it is frequently necessary that such headings should be rather long. It has been said that "you can prove anything by statistics." This statement is of course absurd, taken absolutely, but, like most assertions which are widely believed, it has a grain of truth in it. If this popular saying ran "you can prove anything by tables with slovenly and ambiguous headings," it might be assented to without hesitation. The false "statistical" facts which obtain a hold of the public mind may often be traced to some widely circulated table, to which either from stupidity or carelessness an erroneous or inaccurate "heading" has been affixed.

A statistical table in its simplest form consists of "primaries" representing phenomena of the same class, but existing at different points of time, or coming into existence during different portions of time. This is all that is essential to a table, though other things are usually added to it as an aid to its comprehension. A table stating the number of persons residing in each county of England on a given day of a given year, and also, in another column, the corresponding numbers for the same counties on the corresponding day of the tenth year subsequently, would be a simple tabular statement of the general facts regarding the total population of those counties supplied by two successive censuses. Various figures might, however, be added to it which would greatly add to its clearness. There might be columns showing the increase or decrease for each county and for the whole kingdom during the ten years, and another column showing what *proportion*, expressed in percentages, these increases or decreases bore to the figures for the earlier of the two years. Then there might be two columns showing what proportions, also expressed as percentages, the figures for each county bore in each year to the figures for the whole kingdom. The nine-column table thus resulting would still be simple, all the figures being merely explicit assertions of facts which are contained implicitly in the original "primaries."

Complex Tables.—Suppose now we have another table precisely similar in form to the first, and also relating to the counties of England, but giving the number of houses existing in each of them at the same two dates. A combination of the two would form a complex table, and an application of the processes of arithmetic would make evident a number of fresh facts, all of which would be implied in the table, but would not be obvious to most people until explicitly stated.

The technical work of the statistician consists largely in operations of which the processes just referred to are types.

Proportions.—The most usual and the best mode of expressing the proportion borne by one statistical quantity to another is to state it as a percentage. In some cases another method is adopted—namely, that of stating the proportion in the form "one in so many." This method is generally a bad one, and its use should be discouraged as much as possible, the chief reason being that the changing portion of this kind of proportional figure becomes greater or less inversely, and not directly, as the phenomenon it represents increases or diminishes.

Averages.—Averages or means are for statistical purposes divided into two classes, the *geometrical* and *arithmetical*. An arithmetical mean is the sum of all the members forming the series of figures under consideration divided by their number, without reference to their *weight* or relative importance among themselves. A geometrical mean is the sum of such figures divided by their number, with due allowance made for their weight. An example will make this clear, and the simplest example is taken from a class of statistical quantities of a peculiar kind—namely, *prices*. The price of a given article is the approximate mathematical expression of the rates, in terms of money, at which exchanges of the article for money were actually made at or about a given hour on a given day. A *quotation of price* such as appears in a daily price list is, if there has been much fluctuation, only a very rough guide to the actual rates of exchange that have been the basis of the successive bargains making up the day's business. But let us suppose that the closing price each day may be accepted as a fair representative of the day's transactions, and let us further suppose that we desire to obtain the *average* price for thirty days. Now the sum of the prices in question divided by thirty would be the arithmetical mean, and its weak point would be that it made no allowance for the fact that the business done on some days is much larger than that done on others; in other words, it treats them as being all of equal weight. Now if, as is actually the case in some markets, we have a daily account of the *total quantities sold* we can weight the members accurately, and can then obtain their geometrical mean. There are cases in which the careless use of arithmetical means misleads the student of the social organism seriously. It is often comparatively easy to obtain arithmetical means, but difficult to obtain geometrical means. Inferences based on the former class of average should be subjected to the most rigid investigation.

Before closing this short survey of the very important subject of averages or means, it is needful to discuss briefly the nature of the phenomena which they may safely be regarded as indicating, when they have been properly obtained. Given a geometric mean of a series of numbers referring to no matter what phenomenon, it is obvious that the value of the mean as a *type* of the whole series will depend entirely on the extent of divergence from it of the members of the series as a body. If we are told that there are in a certain district 1000 men, and that their average height is 5 feet 8 inches, and are told nothing further about them, we can make various hypotheses as to the structure of this body from the point of view of height. It is possible that they may consist of a rather large number of men about 6 feet high, and a great many about 5 feet 5 inches. Or the proportions of relatively tall and short men may be reversed, that is, there may be a rather large number of men about 5 feet 4 inches, and a moderate number of men about 5 feet 11 inches. It is also possible that there may be very few men whose height is exactly 5 feet 8 inches, and that the bulk of the whole body consists of two large groups—one of giants and the other of dwarfs. Lastly, it is possible that 5 feet 8 inches may really give a fair idea of the height of the majority of the men, which it would do if (say) 660 of them were within an inch of that height, either by excess or deficiency, while of the remainder one-half were all above 5 feet 9 inches and the other half all below 5 feet 7 inches. This latter supposition would most likely be found to be approximately correct if the men belonged to a race whose average height was 5 feet 8 inches, and if they had been collected by chance. The extent of the divergence of the items composing an average from the average itself may be accurately measured and expressed in percentages of the average, the algebraic signs + and − being employed to indicate the direction of the variation from the mean. An average may, therefore, advantageously be supplemented—(1) by a figure showing what proportion of the members from which it is derived differ from the average by a relatively small quantity, and (2) by figures showing the maximum and minimum deviations from the average. The meaning of the term "relatively small" must be considered independently in each investigation. Further remarks on averages will be found in the works mentioned at the conclusion of this article.

Prices.—Reference has already been made to the peculiar class of statistical quantities known as *prices.* Prices in their widest sense include all figures expressing *ratios of exchange.* In modern society the terms of exchange are always expressed in money, and the things for which money is exchanged are: (1) concrete entities with physical attributes, such as iron or wheat; (2) immediate rights, such as those given by interest-bearing securities of all kinds, by bills of exchange, by railway or steamship contracts to carry either passengers or goods, and by bargains relative to the foreign exchanges; (3) contingent rights, such as those implied in policies of insurance. All these rates of exchange belong to the same category, whether they are fixed within certain limits by law, as in the case of railway charges, or are left to be determined by the "higgling of the market." All these cases of price may conceivably come within the operation of the statistical method, but the only matter connected with price which it is necessary to refer to here is the theory of the *index number.*

Index Numbers.—The need for these became conspicuous during the investigations of Tooke, Newmarch, and others into the general cyclical movements of the prices of commodities; and to construct a good system of these may be said to be one of the highest technical aims of the statistical method. In comparing the prices of different years it was soon observed that, though whole groups of articles moved upwards or downwards simultaneously, they did not all move in the same proportion, and that there were nearly always cases in which isolated articles or groups of articles moved in the opposite direction to the majority of articles. The problem presented to statisticians, therefore, was and is to devise a statistical expression of the general movement of prices, in which all prices should be adequately represented. The first rough approximation to the desired result was attained by setting down the percentages representing the movements, with their proper algebraic signs before them, and adding them together algebraically. The total with its proper sign was then divided by the number of articles, and the quotient represented the movement in the prices of the whole body of articles during the period under consideration. It was soon seen, however, that this procedure was fatally defective, inasmuch as it treated all prices as of equal weight. Cotton weighed no more than pimento, and iron no more than umbrellas. Accordingly an improvement was made in the procedure, first by giving the prices of several different articles into which cotton, iron, and other important commodities entered, and only one price each in the case of the minor articles, and secondly by fixing on the price of some one article representing iron or cotton, and multiplying it by some number selected with the view of assigning to these articles their proper weights relatively to each other and to the rest. The objection to both these plans is the same,—that the numbers attached to the various articles or groups of articles are purely arbitrary; and of late years attempts have been made to obtain what may be called *natural* index numbers, the most successful so far being that of Mr. Robert Giffen, whose index numbers are obtained from the declared values of the imports or exports into or from the United Kingdom of the articles whose prices are dealt with. In the case of both imports and exports Mr. Giffen worked out the proportion borne by the value of each article to the total value for a series of years. Deducting the "unenumerated" articles, a series of numbers was thus obtained which could be used as the means of weighting the prices of the articles in an investigation of a movement of prices. This procedure is no doubt susceptible of further improvement, like its predecessors, but it is a great advance on the arbitrary systems of index numbers employed in them.

The Desirability of Increased Uniformity in Statistics.—One of the most serious difficulties in connection with statistical investigations is the variety of the modes in which primaries of the same order are obtained, as regards dates and periods. This is a matter of which all persons who have occasion to use statistics are made painfully aware from time to time. Some attempts have lately been made to introduce more harmony into the official statistics of the United Kingdom, and some years ago a committee of the Treasury sat to inquire into the matter. The committee received a good deal of evidence, and presented a report, from which, however, certain members of the committee dissented, preferring to express their views separately. The evidence will be found very interesting by all who wish to obtain an insight into the genesis of the official statistics of the country. The report and evidence were published in the June number of the *Journal of the Statistical Society* for 1881, as well as in the usual official form.

The International Institute of Statistics.—The absence of uniformity in statistics which is felt in England is not so marked in foreign countries, where the principle of centralization in arrangements of a political character is more powerful than it is here. In several Continental countries and in the United States there are statistical bureaus with definite duties to perform. In the United Kingdom, as already remarked, the nearest approach to a central statistical office is the Commercial and Statistical Department of the Board of Trade, on which the work of furnishing such statistics as are not definitely recognized as within the province of some other state department usually falls. Various attempts have been made to introduce more uniformity into the statistics of all countries. It was with this object that statistical congresses have met from time to time since 1853. An endeavor was made at the congress held in 1876 at Budapest to arrange for the publication of a system of international statistics, each statistical bureau undertaking a special branch of the subject. The experiment was, however, foredoomed to be only a very partial success, first because all countries were not then and are not yet furnished with central statistical offices, and secondly because the work which fell on the offices in existence could only be performed slowly, as the ordinary business of the offices necessarily left them little leisure for extra work. In 1885, at the jubilee of the London Statistical Society, a number of eminent statistical officials from all parts of the world except Germany were present, and the opportunity was taken to organize an International Institute of Statistics with a view to remedying the defects already ascertained to exist in the arrangements made by the congresses. The only obstacle to securing a proper representation of all countries was the absence of any German delegates, none of the official heads of the German statistical office being allowed to attend,—apparently on political grounds. Since then assurances of a satisfactory kind have been given to the German Government that their servants would be in no way committed to any course disapproved by that Government if they gave their assistance to the institute, from the formation of which it is hoped that much advantage may result. For information as to the constitution and objects of the institute reference may be made to a paper by Dr. F. X. von Neumann-Spallart in vol. i. (1886) of the *Bulletin de l'Institut International de Statistique* (Rome, 1886).

Literature.—Maurice Block, *Traité Théorique et Pratique de Statistique*, Paris, 1878; Luigi Bodio, *Della Statistica nei suoi Rapporti coll' Economia Politica*, etc., Milan, 1869; Antonio Gabaglio, *Storia e Teoria Generale della Statistica*, Milan, 1880; Max Haushofer, *Lehr- u. Handbuch der Statistik*, 2d ed., Vienna, 1882; K. Knies, *Die Statistik als selbständige Wissenschaft*, Cassel, 1850; Georg Mayr, *Die Gesetzmässigkeit im Gesellschaftsleben*, Munich, 1877 (abridged translation in *Journ. Stat. Soc.*, Sept., 1883; the work has also been translated into Italian with valuable notes by G. B. Salvioni, Turin, 1886); Adolphe Quetelet, various works, but especially that entitled *Sur l'Homme et le Développement de ses Facultés, ou Essai de Physique Sociale*, 2 vols., Paris, 1835, and *Letters on the Theory of Probabilities*, already referred to; Albert C. F. Schäffle, *Bau und Leben des socialen Körpers*, Tübingen, 1881; Herbert Spencer, *Principles of Sociology*, especially part ii. pp. 465 *sq.*; Adolf Wagner, article "Statistik" in Buntschli-Brater's *Staatswörterbuch*, vol. x.

(W. HO.)

STATIUS, Publius Papinius, Roman poet, lived from about 45 to 96 A.D., so far as can be judged from indications afforded by his poems. He was, to a great extent, born and trained to the profession of a poet. The Statii were of Græco-Campanian origin, and were gentle, though impoverished, and the family records were not without political distinctions. The elder Statius, our poet's father, was the Orbilius of his time, and taught with distinguished success at Naples and Rome. From boyhood to age he proved himself a champion in the poetic tournaments which formed an important part of the amusements of the early empire. The younger Statius declares that his father was in his time equal to any literary task, whether in prose or verse. Probably our poet inherited a modest competence and was not under the necessity of begging his bread from wealthy patrons. So far as appears he never pursued any occupation but that of poet, as poor an occupation in those days as in ours, if we may believe Juvenal and Martial. Statius certainly wrote poems to order (as *Silvae*, i. 1, 2, ii. 7, and iii. 4), but there is no indication that the material return for them was important to him. In his seventh satire Juvenal speaks of the immense public enthusiasm which attended the recitation of the *Thebais*, when the benches "were breaking," with applause; but the poet, he says, might have starved had not Paris, the favorite comedian of the day, bought from him the libretto of a comic opera. This reference of Juvenal deserves, however, as little to be accepted literally as his misleading allusions to Quintilian in the same satire. Of events in the life of Statius we know little. He married early a young widow, for whom he expresses tender affection in some of the few obviously sincere verses he ever wrote. From his boyhood he was victorious in poetic contests,—many times at his native city Naples, thrice at Alba, where he received the golden crown from the hand of the emperor. But at the great Capitoline competition (probably on its third celebration in 94 A.D.) Statius failed to win the coveted chaplet of oak leaves. No doubt the extraordinary popularity of his *Thebais* had led him to regard himself as the supreme poet of the age, and when he could not sustain this reputation in the face of rivals from all parts of the empire he accepted the judges' verdict as a sign that his day was past, and retired to Naples, the home of his ancestors and of his own young days. We still possess the poem he addressed to his wife on this occasion (*Silv.*, iii. 5). It was a hard task to overcome her objections to turning her back upon the great capital. Chief among them was that which arose from a fear lest it should prove difficult to find in Naples a husband for her daughter (by her first marriage; she had no children by Statius). There are hints in this poem which naturally lead to the surmise that Statius was suffering from a loss of the emperor's favor; he may have felt that a word from Domitian would have won for him the envied garland, and that the word ought to have been given. In the preface to book iv. of the *Silvae* there is mention of detractors who hated our poet's style, and these may have succeeded in inducing a new fashion in poetry at court. Such an eclipse, if it happened, must have cut Statius to the heart. He appears to have relished thoroughly the rôle of court-poet. The statement sometimes made that the elder Statius had been the emperor's teacher, and had bestowed many favors on him, so that the son inherited a debt of gratitude, seems to have no solid foundation. Statius lauds the emperor, not to discharge a debt, but rather to create an obligation. His flattery is as far removed from the gentle propitiatory tone of Quintilian as it is from the coarse and crawling humiliation of Martial. It is in the large extravagant style of a nature in itself healthy and generous, which has accepted the theme and left scruples behind. In one of his prefatory epistles Statius declares that he never allowed any work of his to go forth without invoking the godhead of the divine emperor. The poem on the equestrian statue of Domitian set up on to the Capitol (*Silv.*, i. 1) is such colossal rodomontade that if the emperor had had a grain of humor in his composition he must have died of merriment on receiving it. Statius had taken the full measure of Domitian's gross taste, and carefully puts conscience and sincerity out of view, lest some uneasy twinge should mar his master's enjoyment. But in one poem, that in which the poet pays his due for an invitation to the imperial table, we have sincerity enough. Statius clearly feels all the raptures he expresses. He longs for the power of him who told the tale of Dido's banquet, and for the voice of him who sang the feast of Alcinous, that he may give forth utterance worthy of the lofty theme. The poet seemed, he says, to dine with great Jove himself and to receive nectar from Ganymede the cup-bearer (an odious reference to the imperial favorite Earinus). All his life hitherto has been barren and profitless. Now only has he begun to live in truth. "O, ruler over all the lands, and mighty father of the world which thou hast conquered, do I, *recumbent*, see thee, thou hope of all mankind, and nursling of all the gods? Is it mine to gaze from near at hand on thy features, with the wine-cup and the feast beside me, *while I am forbidden to rise?*" The palace struck on the poet's fancy like the very hall of heaven; nay, Jove himself marvels at its beauty, but is glad that the emperor should possess such an earthly habitation; he will thus feel less desire to seek his destined abode among the immortals in the skies. Yet even so gorgeous a palace is all too mean for his greatness and too small for his vast presence. "But it is himself, himself, that my eager eye has alone time to scan. He is like a resting Mars or Bacchus or Alcides." Martial too swore that, were Jove and Domitian both to invite him to dinner for the same day, he would prefer to dine with the greater potentate on the earth. Pliny, however, has sketched for us the state dinners of Domitian, where the coarse contempt of the tyrant overclouded the guests, and where a man who still respected himself had torments to endure. Martial and Statius were no doubt supreme among the imperial flatterers. Each was the other's only serious rival. It is therefore not surprising that neither should breathe the other's name. Even if we could by any stretch excuse the bearing of Statius towards Domitian, he could never be forgiven the poem entitled "The Hair of Flavius Earinus," Domitian's Ganymede (*Silv.*, iii. 4), a poem than which it would be hard to find a more repulsive example of real poetical talent defiled for personal ends. Well for Statius that he did not, like Martial, live on into the days of Nerva to write sorry palinodes! Everything points to the conclusion that he did not survive his emperor—that he died, in fact, a short time after leaving Rome to settle in Naples. Apart from the emperor and his minions, the friendships of Statius with men of high station seem to have been maintained on fairly equal terms. He was clearly the poet of society in his day as well as the poet of the court.

As poet, Statius unquestionably shines in many respects when compared with the other post-Augustans. He was born with exceptional talent, and his poetic expression is, with all its faults, richer on the whole and less forced, more buoyant and more felicitous, than is to be found elsewhere in the Silver Age of Latin poetry. Statius is at his best in his occasional verses, the "*Silvae*," which have a character of their own, and in their best parts a charm of their own. The title was proper to verses of rapid workmanship, on everyday themes. Statius prided himself on his powers of improvisation, and he seems to have been quite equal to the Horatian feat of dictating two hundred lines in an hour, while standing on one leg. The improvisatore was in high honor among the later Greeks, as Cicero's speech for the poet Archias indicates; and the poetic contests common in the early empire did much to stimulate ability of the kind. Statius speaks of his "*Silvae*" (preface to book i.) as having "streamed from him under the influence of sudden inspiration, and with a certain pleasure due to their rapidity." No one poem occupied more than two days; some came to birth at the dinner table; many while the poet's friend Pollius sat by his side, and shuddered at the audacity of his pen (preface to book iii.). It is to this velocity that the poems owe their comparative freshness and freedom, along with their loose texture and their inequality. There are thirty-two poems, divided into five books, each with a dedicatory epistle. Of nearly four thousand lines which the books contain, more than five-sixths are hexameters. Four of the pieces (containing about 450 lines) are written in the hendecasyllabic metre, the "tiny metre of Catullus," and there is one Alcaic and one Sapphic ode. But the poems in these metres are merely the experiments of a poet who knows well that his strength lies in the hexameter, which in his hands shows greater freedom, variety, and music than it exhibits when handled by other poets of the Silver Latin Age. The subjects of the "*Silvae*" are very various. Five poems are devoted to flattery of the emperor and his favorites; but of these enough has already been said. Six are lamentations for deaths, or consolations to survivors. Statius seems to have felt a special pride in this class of his productions; and certainly, notwithstanding the excessive and conventional employment of pretty mythological pictures, with other affectations, he sounds notes of pathos such as only come from the true poet. There are oftentimes traits of an almost modern domesticity in these verses, and Statius, the childless, has here and there touched on the charm of childhood in lines for a parallel to which, among the ancients, we must go, strange to say, to his rival Martial. One of the *epicedia*, that on Priscilla the wife of Abascantus, Domitian's freeman (*Silv.*, v. 1), is full of interest for the picture it presents of the official activity of a high officer of state. Another group of the "*Silvae*" give picturesque descriptions of the villas and gardens of the poet's friends. In these we have a more vivid representation than elsewhere of the surroundings amid which the grandees of the early empire lived when they took up their abode in the country. It was of these pieces that Niebuhr thought when he said that the poems of Statius are charming to read in Italy. They exhibit, better even than Pliny's well-known letters, the passion of the rich Roman for so constructing his country house that light, air, sun, and leafage should subserve his luxury to the utmost, while scope was left for displaying all the resources of art which his wealth enabled him to command. As to the rest of the "*Silvae*," the congratulatory addresses to friends are graceful but commonplace, nor do the jocose pieces call for special mention here. In the "Kalendae Decembres" we have a striking description of the gifts and amusements provided by the emperor for the Roman population on the occasion of the Saturnalia. In his attempt at an epithalamium (*Silv.*, i. 2) Statius is forced and unhappy. But the birthday ode in Lucan's honor (*Silv.*, ii. 7) has, along with the accustomed exaggeration, many powerful lines, and shows high appreciation of preceding Latin poets. Some phrases, such as "the untaught muse of high-souled Ennius" and "the lofty passion of sage Lucretius," are familiar words with all scholars. The ode ends with a great picture of Lucan's spirit rising after death on wings of fame to regions whither only powerful souls can ascend, scornfully surveying earth and smiling at the tomb, or reclining in Elysium and singing a noble strain to the Pompeys and the Catos and all the "Pharsalian host," or with proud tread exploring Tartarus and listening to the wailings of the guilty, and gazing at Nero, pale with agony as his mother's avenging torch glitters before his eyes. It is singular to observe how thoroughly Nero had been struck out of the imperial succession as recognized at court, so that the "bald Nero" took no umbrage when his flatterer-in-chief profanely dealt with his predecessor's name.

The epic poems of Statius are less interesting because cast in a commoner mould, but they deserve study in many respects. They are the product of long elaboration. The "*Thebais*," which the poet says took twelve years to compose, is in twelve books, and has for its theme the old "tale of Thebes"—the deadly strife of the Theban brothers. There is also preserved a fragment of an "*Achilleis*," consisting of one book and part of another. In the weary length of these epics there are many flowers of pathos and many little finished gem-pictures, but the trammels of tradition, the fashionable taste, and the narrow bars of education check continually the poet's flight. The public idea of what an epic poem should be was firmly fixed, and Statius would not have towered above the thousand poets of his day in the estimation of his countrymen had he not given full embodiment to the idea. Not merely were the materials for his epics prescribed to him by rigid custom, but also to a great extent the method by which they were to be treated. All he could do was to sound the old notes with a distinctive *timbre* of his own. The gods must needs wage their wonted epic strife, and the men, their puppets, must dance at their nod; there must needs be heavenly messengers, portents, dreams, miracles, single combats, similes, Homeric and Virgilian echoes, and all the other paraphernalia of the conventional epic. But Statius treats his subjects with a boldness and freedom which contrast pleasingly with the timid traditionalism of Silius Italicus and the stiff scholasticism of Valerius Flaccus. The vocabulary of Statius is conspicuously rich, and he shows audacity, often successful, in the use of words and metaphors. At the same time he carried certain literary tricks to an aggravating pitch, in particular the excessive use of alliteration, and the misuse of mythological allusion. The most well-known persons and places are described by epithets or periphrases derived from some very remote connection with mythology, so that many passages are as dark as Heraclitus. The *Thebais* is badly constructed. The action of the epic is hindered and stopped by enormous episodes, one of which fills one-sixth of the poem. Nor had Statius a firm grasp or clear imagination of character. So trying are the late ancient epics to a modern reader that he who has read any one of the three—Statius, Silius, and Valerius (Lucan stands apart)—will with difficulty be persuaded to enter on the other two. Yet, if he honestly reads them all, he can hardly fail to rank Statius the highest of the three by a whole sphere.

The *editio princeps* of the epics is dated 1470, of the *Silvae* 1472. Notable editions since have been those of Bernartius (Antwerp, 1595), Gronovius (1653), and Barth (1664). The best text is the Teubner (the *Achilleis* and *Thebais* by Kohlmann, the *Silvae* by Baehrens). Among editions of portions of Statius's works, that of the *Silvae* by Jeremiah Markland, fellow of Peterhouse in Cambridge (1728), deserves special attention. The brilliance and erudition of the work mark him out as one of the best Latin scholars who ever lived. A critical edition of the *Thebais* and *Achilleis* was begun by O. Müller (1870) but not completed. The condition of the text of the *Silvae* is one of the most curious facts in the history of ancient literature. Poggio discovered a MS. at St. Gall and brought it into Italy. This MS. has disappeared, but from it are derived all our existing MSS., except one of the birthday ode to Lucan, now at Florence, and of the 10th century. Politian collated Poggio's MS. with the *editio princeps*, and the collation has come down to us, and is the principal basis of the text. The MSS. of the epics are numerous, as was to be expected from their great popularity in the Middle Ages, to which Dante is witness (see *Purg.*, xxi., where an interview with the shade of Statius is described at some length). (J. S. R.)

STATUTE, or Act of Parliament, is a law made by the sovereign power in the state, that is, the king, by and with the advice and consent of the lords spiritual and temporal and commons in parliament assembled. It forms a part of the *lex scripta*, or written law, which by English legal authorities is used solely for statutory law, a sense much narrower than it bore in Roman law. To make a statute the concurrence of the crown and the three estates of the realm is necessary. Thus a so-called statute of 5 Ric. II. c. 5, directed against the Lollards, was afterwards repudiated by the Commons as passed without their assent. The validity of a statute was indeed at times claimed for ordinances such as that just mentioned, not framed in accordance with constitutional rule, and was actually given to royal proclamations by 31 Hen. VIII. c. 8. But this Act was repealed by 1 Edw. VI. c. 12, and since that time nothing but a statute has possessed the force of a statute, unless indeed certain rules or orders depending ultimately for their sanction upon a statute may be said to have such force. Examples of what may be called indirect legislation of this kind are orders in council (see Privy Council), by-laws made under the powers of the Public Health Act, and rules of court such as those made under the powers of the Judicature Acts and Acts of Sederunt of the Court of Session.

The history of statutory legislation and the modern procedure by which bills become statutes are sufficiently treated under Act of Parliament and Parliament. It is proposed in this place to deal with the legal rather than the political aspect of the subject, and to give a short list of some of the more important statutes which have been passed by the legislature.

The list of statutes as at present existing begins with the Statute of Merton, 1235.[1] Many of the earlier statutes are known by the names of the places at which they were passed, *e.g.*, the Statutes of Merton, Marlbridge, Gloucester, Westminster, or by their initial words, *e. g.*, *Quia Emptores*, *Circumspecte agatis.* The earliest existing statute roll is 6 Edw. I. (the Statute of Gloucester). After 4 Hen. VII. the statute roll ceased to be made up, and enrolments in Chancery (first made in 1485) take its place. Some of the Acts prior to the Statute of Gloucester are of questionable authority, but have gained recognition by a kind of prescription.

All statutes were originally public, irrespectively of their subject matter. The division into public and private dates from the reign of Richard III. At present statutes are of four kinds—public general Acts, public local and personal Acts, private Acts printed by the queen's printers, and private Acts not so printed. The division into public general and public local and personal rests upon a resolution of both Houses of Parliament in 1798. In 1815 a resolution was passed in accordance with which private Acts are printed, with the exception of name, estate, naturalization, and divorce Acts. The last two are now practically superseded by the provisions of the Divorce Act, 1857, and the Naturalization Act, 1870. Since 1815 it has been usual to refer to public general Acts by Arabic numerals, *e.g.*, 5 and 6 Vict. c. 21, public local and personal Acts by small Roman numerals, *e.g.*, 5 and 6 Vict. c. xxi. Each Act is strictly but a chapter of the legislation of the session, which is regarded as composing a single Act divided into chapters for convenience, the chapters themselves being also called Acts. The citation of previous Acts is provided for by 13 and 14 Vict. c. 21, § 3. It is now usual for each chapter or Act to contain a short title by which it may be cited, *e.g.*, the Elementary Education Act, 1870. Sometimes a series of Acts is grouped under a generic title, *e.g.*, the Merchant Shipping Acts, 1854 to 1883.[2] 8 and 9 Vict. c. 113, § 3, makes evidence the queen's printers' copies of private and local and personal Acts. A private Act not printed by the queen's printers is proved by an examined copy of the parliament roll. A public Act binds all subjects of the realm, and need not be pleaded (except where the law from motives of policy specially provides for pleading certain Acts, as in the defences of not guilty by statute, the Statute of Frauds, and the Statute of Limitations). A private Act must generally be pleaded, and does not as a rule bind strangers to its provisions. Formerly an Act took effect from the first day of the session in which it was passed. The hardship caused by this technical rule has been obviated by 33 Geo. III. c. 13, by which an Act takes effect from the day on which it receives the royal assent, where no other date is named. This has been held to mean the beginning of the day, so as to govern all matters occurring on that day. An Act cannot in the strict theory of English law become obsolete by disuse. Nothing short of repeal can limit its operation. The law has, however, been interpreted in some recent cases with somewhat less rigor. In the case of a prosecution for blasphemy in 1883 (Reg. *v.* Ramsay) Lord Coleridge said, "though the principles of law remain unchanged, yet (and it is one of the advantages of the common law) their application is to be changed with the changing circumstances of the times."[3] This would be applicable as much to the interpretation of statutes as to other parts of the common law. The title, preamble, and marginal notes are strictly no part of a statute, though they may at times aid in its interpretation.

Besides the fourfold division above mentioned, statutes are often classed according to their subject-matter, as perpetual and temporary, penal and beneficial, imperative and directory, enabling and disabling. Temporary Acts are those which expire at a date fixed in the Act itself. Thus the Army Act is passed annually and continues for a year; the Ballot Act 1872, expired at the end of 1880, and the Regulation of Railways Act, 1873, at the end of five years. By means of these temporary Acts experimental legislation is rendered possible in many cases where the success of a new departure in legislation is doubtful. In every session an Expiring Laws Continuance Act is passed for the purpose of continuing (generally for a year) a considerable number of these temporary Acts. By 48 Geo. III. c. 106 a continuing Act is to take effect from the date of the expiration of a temporary Act, where a bill for continuing the temporary Act is in parliament, even though it be not actually passed before the date of the expiration.

Penal Acts are those which impose a new disability, beneficial those which confer a new favor. An imperative statute (often negative or prohibitory in its terms) makes a certain act or omission absolutely necessary, and subjects a contravention of its provisions to a penalty. A directory statute (generally affirmative in its terms) recommends a certain act or omission, but imposes no penalty on non-observance of its provisions. To determine whether an Act is imperative or directory the Act itself must be looked at, and many nice questions have arisen on the application of the rule of law to a particular case.

Enabling statutes are those which enlarge the common law, while disabling statutes restrict it. This division is to some extent coincident with that into beneficial and penal. Declaratory statutes, or those simply in affirmance of the common law, were at one period not uncommon, but they are now practically unknown. The Statute of Treasons of Edward III. is an example of such a statute. Statutes are sometimes passed in order to overrule specific decisions of the courts. Examples are the Factors Act, 1877, the Territorial Waters Jurisdiction Act, 1878, the Sale of Food and Drugs Act, 1879.

The construction or interpretation of statutes depends partly on the common law, partly on statute. The main rules of the common law, as gathered from the best authorities, are these: (1) Statutes are to be construed, not according to their mere letter, but according to the intent and object with which they were made. (2) The relation of the statute to the common law is to be considered. In the words of the resolution of the Court of Exchequer in Heydon's Case, 3 *Coke's Rep.*, 7, the points for consideration are: "1. What was the common law before the making of the Act? 2. What was the mischief and defect against which the common law did not provide? 3. What remedy the parliament hath resolved and appointed to cure the disease of the Commonwealth? 4. The true reason of the remedy." (3) Beneficial or remedial statutes are to be liberally, penal more strictly, construed. (4) Other statutes *in pari materia* are to be taken into consideration. (5) A statute which treats of persons of inferior rank cannot by general words be extended to those of superior rank. (6) A statute does not bind the crown, unless it be named therein. (7) Where the provision of a statute is general, everything necessary to make such provision effectual is implied. (8) A later statute repeals an earlier, as far as the two are repugnant, but, if they may stand together, repeal will not be presumed. (9) There is a presumption against creation of new or ousting of existing jurisdictions, against impairing obligations, against retrospective effect, against violation of international law, against monopolies, and in general against what is inconvenient or unreasonable. (10) If a statute inflicts a penalty, the penalty implies a prohibition of the act or omission for which the penalty is imposed. Whether the remedy given by statute is the only one depends on the words of the particular Act. In some cases an action or an indictment will lie; in others the statutory remedy, generally summary, takes the place of the common law remedy. In some few instances the courts have construed the imposition of a penalty as operating not to invalidate a contract but to create a tax upon non-compliance with the terms of the statute. What may be called the statutory rules of construction provide, *inter alia*, that any Act referring to England includes Wales and Berwick-upon-Tweed (20 Geo. II. c. 42), and that all words importing the masculine gender shall be taken to include females, and the singular to include the plural and the plural the singular (13 & 14 Vict. c. 21, § 4). The same Act further provides that, where any Act repealing in whole or in part any former Act is itself repealed, such last repeal shall not revive the Act or provisions before repealed unless words be added to that effect (§5), and that, wherever any Act shall be made repealing in whole or in part any former Act and substituting some provision or provisions instead of the provision or provisions repealed, such provision or provisions so repealed shall remain in force until the substituted provision or provisions shall come into operation by force of the last Act (§ 6). Numerous interpretations of particular words are contained in Acts of Parliament, either general, as "month," "county," "land," and other words in 13 and 14 Vict. c. 21, § 4, or for the purposes of the Act, as "settlement" for the purposes of the Settled Land Act, 1882.

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[1] Ruffhead's edition of the statutes begins with the Magna Carta of 1225. But in the *Revised Statutes* that form of Magna Carta which is now law appears as a statute of the year 1297. It is often known as *Confirmatio Cartarum*, and is a recital and confirmation by Edward I. of the chief provisions of John's charter.

[2] A short title has been occasionally given by retrospection to an Act which did not originally possess it. For instance, the Conveyancing Act, 1881, enacts that the Act of 5 and 6 Will. IV. c. 62, the original title of which is of unwieldy length, may be cited for the future as the Statutory Declarations Act, 1835. In some cases the title has been changed. Thus the name of the Summary Procedure (Scotland) Act, 1864, was changed in 1881 to that of the Summary Jurisdiction Act, 1864.

[3] This opinion carries out to a certain extent the view of Locke, who in Article 79 of his Carolina Code recommended the determination of Acts of the legislature by effluxion of time after a hundred years from their enactment.

The earlier Acts are generally simple in character and language, and comparatively few in number. At present the number passed every session is enormous; in the session of 1885 it was 80 general and 190 local and personal Acts. Without going as far as to concede with an eminent legal authority that of such legislation three-fourths is unnecessary and the other fourth is mischievous, it may be admitted that the immense library of the statutes would be but a trackless desert without trustworthy guides. Revision of the statutes was evidently regarded by the legislature as desirable as early as 1563 (see the preamble to 5 Eliz. c. 4). It was demanded by a petition of the Commons in 1610. Both Coke and Bacon were employed for some time on a commission for revision. At times Consolidation Acts in the nature of digests of law (generally amending as well as consolidating) were passed, such as the Merchant Shipping Act, 1854, and the Criminal Law Consolidation Acts of 1861. The most important action, however, was the nomination of a revision committee by Lord Chancellor Cairns in 1868, the practical result of which has been the issue of an edition of the *Revised Statutes* in eighteen volumes, bringing the revision of statute law down to 1878. This edition is of course subject to the disadvantage that it becomes less accurate every year as new legislation appears. An index to the statutes which are still law is published about every three years by the Council of Law Reporting.

The principal statutes may be classified under various heads according to the matter with which they deal. It should be remembered at the same time that many of them—Magna Carta, for example,—might fall with equal correctness under more than one head. A division, convenient, if not exhaustive, would be into historical, constitutional, legal and social.

Historical.—Under this head would come those Acts which to a greater or less extent mark important epochs in the national history, such as the Statute of Rhuddlan, the Acts of Union defining the relations of Wales, Scotland and Ireland to England, the Act of Settlement, the Stamp Act of 1765—the proximate cause of the revolt of the American colonies,—the Acts abolishing the slave trade and the corn laws, and those defining the position of dependencies, such as the Act for the Better Government of India, 1858, and the British North America Act, 1867.

Constitutional.—The principal Acts of this class would be Magna Carta, the statutes *De Tallagio non Concedendo* and *De Prærogativa Regis* and those dealing with mortmain and treason, the Petition of Right, the Bill of Rights, the Septennial Act, the Royal Marriage Act, the Mutiny, Militia, Naval Discipline, and Foreign enlistment Acts, and the Acts affecting the parliamentary franchise from the time of Henry VI. to the Redistribution of Seats Act, 1888. Under this head too might be placed the numerous Acts dealing with the question of religion. Some of the more interesting of these are the *Articuli Cleri*, the Statutes of Provisors, the Acts of Henry VIII. abolishing monasteries, the Acts of Supremacy and Uniformity of Henry VIII., Elizabeth, and Charles II., the Toleration, Catholic Emancipation, Tithe Commutation, Church Discipline, Public Worship Regulation, Irish Church, and Scottish Patronage Abolition Acts.

Legal.—The most important of this class are perhaps the Statutes of *Quia Emptores* and *De Donis*, the Statutes of Uses and of Wills, the Statutes of Limitation, the Statute of Frauds and its amendments, the Fines and Recoveries Act, the Conveyancing, Settled Land and Settled Estates, and Married Women's Property Acts, and the Acts for the amendment of procedure, *e. g.*, the Chancery Amendment, Common Law Procedure, Judicature, and Apellate Jurisdiction Acts.

Social—Social legislation (other than mere sumptuary laws) is of comparatively modern introduction. Among earlier instances are the Statutes of Laborers of Edward III. and the Poor Law of Elizabeth. More modern examples are the Factory, Public Health and Artisans' Dwellings Act, and, perhaps greatest of all the Education Acts. Beside these there are the Acts dealing with patent, copyright, summary jurisdiction, friendly and building societies, trades unions, savings banks, theatres, commons preservation, and agricultural holdings. Acts which have trade for their special object are the Bank Charter, Merchant Shipping, Bills of Lading, Bills of Exchange, Crossed Cheques, Factors, Stamp, Licensing, Bankruptcy, and Trade Marks Acts.

The chief editions of the statutes are the *Statutes of the Realm* printed by the queen's printers, Ruff head's and the fine edition issued from 1810 to 1824 in pursuance of an address from the House of Commons to George III. The safest authority is of course the *Revised Statutes.* Chitty's collection of statutes of practical utility is a useful compilation. Among the earlier works on statute law may be mentioned the readings on statutes by great lawyers, such as the second volume of Coke's *Institutes*, Bacon's *Reading* *on the Statute of Uses*, Barrington's *Observations on the more Ancient Statutes from Magna Carta to the* 21 *Jac. I. c.* 27 (5th ed. 1796), and the Introduction to Blackstone's *Commentaries*. Among the later works are the treatises of Dwarris (2d ed. 1848) and Sir P. B. Maxwell (2d ed. 1883) on the interpretation of statutes, and Sir H. Thring's *Practical Legislation, or the Composition and Language of Acts of Parliament.*

Scotland.—The statutes of the Scottish parliament before the Union differed from the English statutes in two important respects,—they were passed by the estates of the kingdom sitting together and not in separate Houses, and from 1367 to 1690 they were discussed only after preliminary consideration by the Lords of Articles. An Act of the Scottish parliament may in certain cases cease to be binding by desuetude. "To bring an Act of Parliament like those we are dealing with" (*i.e.*, the Sabbath Profanation Acts) "into what is called in Scotch law the condition of desuetude, it must be shown that the offence prohibited is not only practiced without being checked, but is no longer considered or dealt with in this country as an offence against law" (Lord Justice General Inglis in Bute's Case, 1 *Couper's Rep.*, 495). Acts of the imperial parliament passed since the Union extend in general to Scotland, unless that country be excluded from their operation by express terms or necessary implication.

Ireland.—Originally the lord deputy appears to have held parliaments at his option, and their Acts were the only statutory law which applied to Ireland, except as far as judicial decisions had from motives of policy extended to that country the obligation of English statutes. In 1495 the Act of the Irish parliament known as Poyning's Law or the Statute of Drogheda enacted that all statutes lately made in England be deemed good and effectual in Ireland. This was construed to mean that all statutes made in England prior to the 18 Hen. VII. were valid in Ireland, but none of later date were to have any operation unless Ireland were specially named therein or unless adopted by the Irish parliament (as was done, for instance, by Yelverton's Act, 21 and 22 Geo. III. c. 48, i.). Another article of Poyning's Law secured an initiative of legislation to the English privy council, the Irish parliament having simply a power of acceptance or rejection of proposed legislation. The power of the parliament of Great Britain to make laws to bind the people of Ireland was declared by 6 Geo. I. c. 5. This Act and the article of Poyning's Law were repealed in 1782, and the short-lived independence of the parliament of Ireland was recognized by 23 Geo. III. c. 28. The application of Acts passed since the Union is the same as in the case of Scotland.

Colonies and Dependencies.—Acts of the imperial parliament do not extend to the Isle of Man, the Channel Islands, or the colonies, unless they are specially named therein. By 28 and 29 Vict. c. 63 any colonial law repugnant to the provisions of any Act of Parliament extending to the colony is void to the extent of such repugnancy, and no colonial law is to be void by repugnancy to the law of England unless it be repugnant to such an Act of Parliament. For colonies without representative legislatures the crown usually legislates, subject to the consent of parliament in particular cases. For instance, it was the opinion of the judicial committee of the privy council in 1876 that a cession of British territory in India to a native state would probably need the concurrence of the imperial parliament (Damodhar Gordhan *v.* Deoram Kanji, *Law Rep.*, 1 *Appeal Cases*, 332).

United States.—By the constitutions of many States English statute law, as it existed at the time of the separation from England, and as far as it is applicable, has been adopted as part of the law of the States. The United States and the State are not bound by an Act of Congress, or a State law, unless specially named. The States legislate for themselves within the limits of their own constitution and that of the United States.[1] Here appears the striking difference between the binding force of a statute of the United Kingdom and an Act passed by congress or a State legislature. In the United Kingdom parliament is supreme; in the United States an Act is only of authority if it is in accordance with the constitution. The courts may declare an Act void if it contravene the constitution of the United States or of a State, so that practically the Supreme Court of the United States is the ultimate legislative authority. Examples of recent cases where the constitutionality of an Act has been contested will be found under PAYMENT and PRIVILEGE. The restrictions upon legislation contained in the constitution of the United States provide against the suspension of the writ of habeas corpus except in case of rebellion or invasion, the passing of a bill of attainder or *ex post facto* law, the imposition of capitation or other direct tax, unless in accordance with a previous article of the constitution, or of a tax or duty on exports, the preference of the ports of one State over those of another, the drawing of money from the treasury except by appropriations made by law, and the grant of a title of nobility. The amended constitution contains further limitations, *e.g.*, the taking of private property for public use without just compensation, and the abridging of the right of citizens on account of race, color, or previous condition of servitude. State legislation is limited by § 10: "No State shall . . . . . make anything but gold and silver coin a tender in payment of debts, pass any bill of attainder, *ex post facto* law, or law impairing the obligation of contracts, or grant any title of nobility." The section further forbids imposition of duties on imports or exports, or any duty of tonnage, without consent of congress. State constitutions often contain further restrictions; among the more usual are provisions against laws with a retrospective operation, or impairing the obligation of contracts, or dealing with more than one subject to be expressed in the title. The time when a statute is to take effect after its passage is often fixed by State constitutions. The statutes of the United States were revised under the powers of an Act of Congress passed in 1874 (sess. i. c. 333), and the volume of *Revised Statutes* (frequently amended since) was issued on February 22, 1875. Many of the States have also issued revised editions of their statutes. The rules of construction are in general agreement with those adopted in England. See Sedgwick, *Statutory Law.*

International Law.—The term statute is used by international jurists and civilians to denote the whole body of the municipal law of the state. In this sense, statutes are either real, personal, or mixed. A real statute is that part of the law which deals directly with property, whether movable or immovable. A personal statute has for its object a person, and deals with questions of status, such as marriage, legitimacy, or infancy. A mixed statute affects both property and person, or, according to some authorities, it deals with acts and obligations. Personal statutes are of universal validity; real statutes have no extra-territoral authority. The determination of the class under which a particular law ought to fall is one of great difficulty, and one in which there is often a conflict of legal opinion. On the whole, the division appears to have created more difficulties than it has solved, and it is rejected by Savigny as unsatisfactory. See Story, *Conflict of Laws*, §§ 12-16; Phillimore, *International Law*, vol. iv. ch. xvi. (J. W†.)

STATUTE MERCHANT and **STATUTE STAPLE** were two old forms of security, long obsolete in practice, though references to them still occur in some modern statutes. They were originally permitted only among traders for the benefit of commerce, but afterwards extended by 23 Henry VIII. c. 6 to all subjects, whether traders or not. The creditor under either form of security was allowed to seize the goods and hold the lands of a defaulting debtor until satisfaction of his debt. While he held the lands he was termed tenant by statute merchant or by statute staple. In addition to the loss of his goods and lands the debtor was liable to be imprisoned.

STAUNTON, a city of the United States, the county-seat of Augusta county, Virginia, lies at the foot of the Blue Ridge Mountains, on the Lewis Creek (a tributary of the Shenandoah), 136 miles west-northwest of Richmond. It is the seat of the State lunatic asylum and of the State institution for the deaf and dumb and blind, and has besides an unusual number of important educational establishments. Iron-works, planing-mills, and flour-mills represent the manufacturing interest. The population was 5120 in 1870 and 6664 in 1880.

STAUNTON, HOWARD (1810–1874), Shakespearean scholar and writer on chess, was born about 1810. He was educated at Eton and Oxford, but left the university without taking a degree, and settled in

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[1] ["This Constitution, and the laws of the United States which shall be made in pursuance thereof, and all treaties made, or which shall be made, under the authority of the United States, shall be the supreme law of the land; and the judges in every State shall be bound thereby, anything in the constitution or laws of any State to the contrary notwithstanding."—*U. S. Constitution, Article VI.* The several States have supreme jurisdiction, each within its own boundaries, over all matters not expressly delegated to the United States by the Constitution thereof.—AM. ED.]

London, devoting much of his attention to the study of the English dramatists of the Elizabethan age. In conjunction with this he also took a great interest in the stage, and as an amateur once played Lorenzo to the Shylock of Edmund Kean. Between 1857 and 1860 he edited in monthly parts an edition of Shakespeare published by Routledge, which has been several times reissued, and must be ranked as superior, as regards both text and notes, to any previously published. His skill as a Shakespearean commentator, combining in a remarkable degree the acuteness and caution which qualified him to excel in chess, and disciplined to rare perfection by a thorough mastery of the literature of the period, is still more strikingly shown in his papers in the *Athenæum* on "Unsuspected Corruptions of Shakespeare's Text," commenced in October, 1872. These formed part of the materials intended to be made use of in an improved edition of Shakespeare's works which he proposed to prepare, but which for a variety of reasons was never published. In 1864 he published a facsimile of the Shakespeare folio of 1623, and a finely illustrated work entitled *Memorials of Shakespeare.* He was also the author of the *Great Schools of England,—an Account of the Foundation, Endowments, and Discipline of the Chief Seminaries of Learning in England*, 1865. An account of his career as a chess-player, and a notice of his chief publications on the game, will be found under the heading CHESS (vol. v. pp. 522, 524). He died in London, 22d June, 1874.

STAVANGER, a seaport town of Norway, the administrative centre of an "amt" of the same name (population 114,164 in 1876) is situated on the west coast, on the south side of a beautiful fjord, about 127 miles northwest of Christiansand. A railway to connect Stavanger with Christiania has been planned, but as yet only the terminal portions have been constructed, the Stavanger portion, which runs south to Ekersund for 47 miles, being opened in 1878. The town is for the most part a collection of narrow and irregular streets, but signs of the wealth acquired by its shipping trade and herring fishery appear in the well-built stone houses erected since the great fire of 1860. In 1884, 314 vessels (70,006 tons) entered the harbor, and 267 (57,479 tons) cleared. Though the bishop's see was removed from Stavanger to Christiansand in 1685, the old cathedral of St. Swithun's, founded by the English bishop Reinald in the end of the 11th century, and rebuilt after being burned down in 1272, still remains, and next to the cathedral of Trondhjem, is the most interesting piece of Gothic architecture in Norway. The old episcopal palace of Kongsgaard is now a Latin school. The communal hospital is an important institution. The town dates from the 8th or 9th century and became the seat of a bishopric in the 13th. In 1801 the population of Stavanger was only 2500; by 1855 it was 12,000, and by 1875, 20,350.[1]

STAVROPOL, a government of Northern Caucasia, Russia, having an area of 26,530 square miles, and a population (rapidly increasing by Russian immigration) last returned at 637,893. It is bounded by Astrakhan and the province of the Don Cossacks on the N., Kubañ on the W., Terek on the S., and the Caspian Sea on the E., occupying the eastern part of the broad plains and steppes which fringe the main chain of CAUCASUS (*q.v.*) on the north. In the western part of the government a broad undulating swelling, ranging from 1500 to 2000 feet above sea-level, extends northwards from the central mountain chain; in the southern part of this swelling, in the vicinity of Pyatigorsk, there is a group of sixteen mountains, 2800 to 4600 feet in height—the Beshtau,—which, as shown by Abich, ought to be considered as a porphyritic upheaval which took place at a point where the two predominant directions in Caucasus (southwest to northeast and southeast to northwest) meet. Northward and eastward of the above plateau are extensive steppes, from 400 to 200 feet above the sea, having gentle slopes both to the north (to the depression of the Manytch) and to the east (towards the low and dry steppes of the Caspian littoral). The geological structure of Stavropol is most interesting. The mountains in the southern parts of Pyatigorsk consist of trachytic porphyries and volcanic rocks. Numberless hot mineral springs (see PYATIGORSK) occur in this group, and earthquakes are most common in the region. A broad belt of Miocene deposits, represented by the "steppe limestone" with *Mactra podolica*, girdles the hilly tracts, attaining a breadth of 40 miles or rather more; while the remainder of the steppes, which gently slope towards the Manytch and the Caspian, are occupied by the Post-Tertiary Caspian formation (loess).

Stavropol is chiefly watered by the Kuma and its tributaries (Podkumok, Karamyk, Buivola, etc.), its basin being the most fertile part of the province, but the evaporation is so great that the Kuma never reaches the Caspian except in spring. The Manytch is less a river than a series of lakes occupying a depression which formerly was a connecting channel between the Black Sea and the Caspian. This channel has two slopes, the eastern sometimes discharging its scanty water-supply into the Kuma, while on the western slope the elongated lakes which fill up the depression drain into the Don, reaching it, however, only during spring. Two Yegorlyks (Great and Middle), the Kalaus, and the Tchogra (temporary tributaries of the Manytch) water the west part of Stavropol; while the Yeya and the Barsukly—a tributary of the Kubañ—rise in the district of Pyatigorsk. On the whole, irrigation is scanty, and in the eastern steppes water is supplied only by cisterns. Besides the few lakes of the Manytch depression, there are many smaller salt lakes around the Caspian. Timber is scarce, even in the hilly tracts.

The climate is severe. Although Stavropol and Pyatigorsk both have an average yearly temperature of 48° Fahr., frosts of —22° Fahr. are not uncommon, and the average winter temperature is only 28.7° at Stavropol (January, 25°; July, 71°). Yellow and other endemic fevers, sometimes very severe, are common on the low banks of the Kuma and Manytch.

The region is traversed by both the great highways along the western shore of the Caspian (the Vladikavkaz and the Derbent routes), and accordingly several nations in their migrations have left stragglers on the steppes of Stavropol. Thus we now find in these steppes Lamaite Kalmucks (about 10,000), Mohammedan Turcomans and Nogais (together about 60,000), as well as less considerable remains of several other tribes. On the other hand, immigrants from Great and Little Russia, Poles, Germans, Esthonians, Greeks, and even a few Scots (in a colony close to Pyatigorsk) have settled in the most fertile and best watered parts of Stavropol in the course of the present century. The Russian population is growing very rapidly, and already numbers upwards of 500,000.

There are three administrative districts, the chief towns of which are Stavropol (35,470 inhabitants in 1884), Pyatigorsk (11,115), and Alexandrovskaya (8710), and a territory of nomad natives which occupies more than two-fifths of the entire area of the government.

The educational returns for 1883 show 7 gymnasiums and "real schools," with 1081 boys and 491 girls, and 139 elementary schools, with only 5310 boys and 1034 girls.

Agriculture is the chief occupation of the settled population, and so large is the harvest that no less than 16,000 laborers, attracted by high wages, come annually from European Russia to assist in gathering in the crops. Large amounts of corn are exported both to the mountainous districts of Caucasus and to Russia (Rostoff-on-the-Don). Cattle-breeding is engaged in very largely, not only by the Kalmucks, Turcomans, and Nogais, but also by the Russians. In 1884 Stavropol had 154,000 horses, 808,500 cattle, 2,540,000 sheep, 45,000 goats, 75,000 pigs, and 7500 camels. Cattle and horses, as also wool, hair, hides, and sheepskins, are exported in considerable quantities. A remarkable feature of Stavropol is the rapid growth among the Russian peasant population of a great variety of domestic trades both for local supply and for exportation. Silk wares are now woven in the villages to such an extent as to become an important article of export to Russia. Many other petty trades have also grown up of late, such as various kinds of cotton-weaving, the manufacture of leather wares, small metallic wares, and so on. Manufactures proper (chiefly distillation) employed some 1000 persons in 1870, and their produce was estimated at about £140,000 [$680,400] per annum. Since that time they have slowly expanded. A brisk trade is carried on in the above-mentioned articles of export, and twenty-nine village fairs show an aggregate annual return of nearly £300,000 [$1,458,000].

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[1] [In 1885 the population was 22,684. *Almanach de Gotha* for 1887.—AM. ED.]

History.—The northern slopes of Caucasus began to be colonized by Russians at a very early period, and as early as the 11th century part of the territory now occupied by Stavropol was known to Russian annalists as the Tmutarakañ principality, which had Russian princes. A new attempt to colonize North Caucasus was made in the 16th century, under Ivan the Terrible, who married a Kabardian princess. This was again unsuccessful, and it was not till 1711 that Russia began regularly to colonize the territory by Cossack settlements. The military colonization was continued during the whole of last century; Kizlar was founded in 1736, Stavropol in 1776 or 1777. Immense tracts were given by Catherine II. to her courtiers, who began to people them with serfs brought from Russia. The flow of immigrants rapidly increased as soon as peace was firmly established, and it is still on the increase, especially since the emancipation of the serfs, so that Stavropol is rapidly becoming a Russian province, with a comparatively limited number of natives in the steppes of its eastern part.

STAVROPOL, capital of the above province, is situated on a plateau 2000 feet above the sea, on the northern slope of the Caucasus, 360 miles to the northwest of Tiflis and 914 miles from Moscow. It is connected by rail with Rostoff-on-the-Don. Although founded only in 1776 for military purposes, it has rapidly grown, and has now a population of 35,500, while it is one of the best built provincial towns of the Russian empire. It has wide streets, and its houses are mostly of stone; large gardens surround the houses; and numerous farms and gardens occupy the territory (nearly 50,000 acres) belonging to the town. It is well provided with educational institutions, there being four gymnasia for boys and girls and several primary schools. Nearly all the manufactures of the province are concentrated in Stavropol. The trade is considerable, large numbers of cattle (more than 35,000 head annually) being sent to Moscow and St. Petersburg, while tallow and more than 15,000 sheepskins are exported *via* Rostoff to Russia. Corn is also exported to the value of nearly £300,000 [$1,458,000], while manufactured wares are imported to the value of nearly £150,000 [$729,000]. Armenian, Georgian, and Persian merchants carry on a lively trade in local wares.

STEAM-ENGINES AND OTHER HEAT-ENGINES.

Definition of heat-engines.

1. A **Heat-Engine** is a machine in which heat is employed to do mechanical work. In all practical heat-engines, work is done through the expansion by heat of a fluid which overcomes resistance as it expands—in steam-engines by the expansion of water and water-vapor, in air-engines by the expansion of hot air, in gas-engines by the expansion of a burnt mixture of air and gas. One of the most simple and historically one of the oldest types of heat-engines are guns, in which heat, generated by the combustion of an explosive, does work in giving energy of motion to a projectile. But guns differ so widely from all other types, both in their purpose and in their development, that it is convenient to leave them out of account in treating of engines which may serve as prime movers to other mechanism.

I. Early History of the Steam-Engine.

Hero, 130 B.C.

2. The earliest notices of heat-engines are found in the *Pneumatica* of Hero of Alexandria (c. 130 B.C.). Two contrivances described there deserve mention. One is the æolipile, a steam reaction-turbine consisting of a spherical vessel pivoted on a central axis and supplied with steam through one of the pivots. The steam escapes by bent pipes facing tangentially in opposite directions, at opposite ends of a diameter perpendicular to the axis. The globe revolves by reaction from the escaping steam, just as a Barker's mill is driven by escaping water. Another apparatus described by Hero (Fig. 1)[1] is interesting as the prototype of a class of engines which long afterwards became practically important. A hollow altar containing air is heated by a fire kindled on it; the air in expanding drives some of the water contained in a spherical vessel beneath the altar into a bucket, which descends and opens the temple doors above by pulling round a pair of vertical posts to which the doors are fixed. When the fire is extinguished the air cools, the water leaves the bucket, and the doors close. In another device a jet of water driven out by expanding air is turned to account as a fountain.

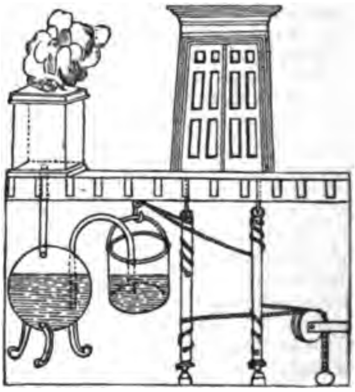

FIG. 1.—Hero's Apparatus, 130 B.C.

Della Porta, 1601.

3. From the time of Hero to the 17th century there is no progress to record, though here and there we find evidence that appliances like those described by Hero were used for trivial purposes, such as organ-blowing and the turning of spits. The next distinct step was the publication in 1601 of a treatise on pneumatics by Giovanni Battista della Porta, in which he shows an apparatus similar to Hero's fountain, but with steam instead of air as the displacing fluid. Steam generated in a separate vessel passes into a closed chamber containing water, from which a pipe (open under the water) leads out. He also points out that the condensation of steam in the closed chamber may be used to produce a vacuum and suck up water from a lower level. In fact, his suggestions anticipate very fully the engine

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[1] From Greenwood's translation of Hero's *Pneumatica*.

which a century later became in the hands of Savery the earliest commercially successful steam-engine. In 1615 Solomon de Caus gives a plan of forcing up water by a steam fountain which differs from Della Porta's only in having one vessel serve both as boiler and as displacement-chamber, the hot water being itself raised.

De Caus.

4. Another line of invention was taken by Giovanni Branca (1629), who designed an engine shaped like a water-wheel, to be driven by the impact of a jet of steam on its vanes, and, in its turn, to drive other mechanism for various useful purposes. But Branca's suggestion was unproductive, and we find the course of invention revert to the line followed by Della Porta and De Caus.

Branca, 1629.

5. The next contributor is one whose place is not easily assigned. To Edward Somerset, second marquis of Worcester, appears to be due the credit of making the first useful steam-engine. Its object was to raise water, and it worked probably like Della Porta's model, but with a pair of displacement-chambers, from each of which alternately water was forced by steam from an independent boiler, or perhaps by applying heat to the chamber itself, while the other vessel was allowed to refill. Lord Worcester's description of the engine in his *Century of Inventions* (1663) is obscure, and no drawings are extant. It is therefore difficult to say whether there were any distinctly novel features except the double action; in particular it is not clear whether the suction of a vacuum was used to raise water as well as the direct pressure of steam. An engine of about two horse-power was in use at Vauxhall in 1656, and the walls of Raglan Castle contain traces of another, but neither Worcester's efforts nor those of his widow were successful in securing the commercial success of his engine.

Marquis of Worcester, 1663.

6. This success was reserved for Thomas Savery, who in 1698 obtained a patent for a water-raising engine, shown in Fig. 2. Steam is admitted to one of the oval vessels A, displacing water, which it drives up through the check-valve B. When the vessel A is emptied of water, the supply of steam is stopped, and the steam already there is condensed by allowing a jet of cold water from a cistern above to stream over the outer surface of the vessel. This produces a vacuum and causes water to be sucked up through the pipe C and the valve D. Meanwhile, steam has been displacing water from the other vessel, and is ready to be condensed there. The valves B and D open only upwards. The supplementary boiler and furnace E are for feeding water to the main boiler; E is filled while cold and a fire is lighted under it; it then acts like the vessel of De Caus in forcing a supply of feed-water into the main boiler F. The gauge-cocks G, G are an interesting feature of detail. Another form of Savery's engine had only one displacement-chamber and worked intermittently. In the use of artificial means to condense the steam, and in the application of the vacuum so formed to raise water by suction from a level lower than that of the engine, Savery's engine was probably an improvement on Worcester's; in any case it found what Worcester's engine had failed to find,—considerable employment in pumping mines and in raising water to supply houses and towns, and even to drive water-wheels. A serious difficulty which prevented its general use in mines was the fact that the height through which it would lift water was limited by the pressure the boiler and vessels could bear. Pressures as high as 8 or 10 atmospheres were employed—and that, too, without a safety-valve—but Savery found it no easy matter to deal with high-pressure steam; he complains that it melted his common solder, and forced him, as Desaguliers tells us, "to be at the pains and charge to have all his joints soldered with spelter." Apart from this drawback the waste of fuel was enormous, from the condensation of steam which took place on the surface of the water and on the sides of the displacement-chamber at each stroke; the consumption of coal, was, in proportion to the work done, some twenty times greater than in a good modern steam-engine. In a tract called *The Miner's Friend*, Savery alludes thus to the alternate heating and cooling of the water-vessel: "On the outside of the vessel you may see how the water goes out as well as if the vessel were transparent, for so far as the steam continues within the vessel so far is the vessel dry without, and so very hot as scarce to endure the least touch of the hand. But as far as the water is, the said vessel will be cold and wet where any water has fallen on it; which cold and moisture vanishes as fast as the steam in its descent takes place of the water." Before Savery's engine was entirely displaced by its successor, Newcomen's, it was improved by Desaguliers, who applied to it the safety-valve (invented by Papin), and substituted condensation by a jet of cold water within the vessel for the surface condensation used by Savery.

Savery, 1698.

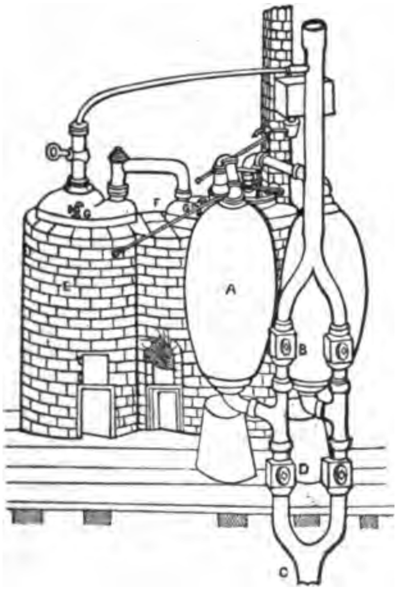

FIG. 2.—Savery's Pumping Engine, 1698.[1]

7. So early as 1678 the use of a piston and cylinder (long before known as applied to pumps) in a heat-engine had been suggested by Jean Heautefeuille, who proposed to use the explosion of gunpowder either to raise a piston or to force up water, or to produce, by the subsequent cooling of the gases, a partial vacuum into which water might be sucked up. Two years later Huygens described an engine in which the explosion of gunpowder in a cylinder expelled part of the gaseous contents, after which the cooling of the remainder caused a piston to descend under atmospheric pressure, and the piston in descending did work by raising a weight.

Cylinder and piston engine.

8. In 1690 Denis Papin, who ten years before had invented the safety-valve as an adjunct to his "digester," suggested that the condensation of steam should be employed to make a vacuum under a piston previously raised by the expansion of the steam. Papin's was the earliest cylinder and piston steam-engine, and his plan of using steam was that which afterwards took practical shape in the atmospheric engine of Newcomen. But his scheme was made unworkable by the fact that he proposed to use but one vessel as both boiler and cylinder. A small quantity of water was placed at

Papin.

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[1] [This cut represents the improved engine of 1702. That of 1698 is ruder. See R. H. Thurston's *Growth of the Steam-Engine*, New York, 1878.—AM. ED.]

the bottom of a cylinder and heat was applied. When the piston had risen the fire was removed, the steam was allowed to cool, and the piston did work in its down-stroke under the pressure of the atmosphere. After hearing of Savery's engine in 1705 Papin turned his attention to improving it, and devised a modified form, shown in Fig. 3, in which the displacement-chamber A was a cylinder, with a floating diaphragm or piston on the top of the water to keep the water and steam from direct contact with one another. The water was delivered into a closed air-vessel B, from which it issued in a continuous stream against the vanes of a water-wheel. After the steam had done its work in the displacement-chamber it was allowed to escape by the stop-cock C instead of being condensed. Papin's engine was in fact a non-condensing single-acting steam-pump, with steam-cylinder and pump-cylinder in one. A curious feature of it was the heater D, a hot mass of metal placed in the diaphragm for the purpose of keeping the steam dry. Among the many inventions of Papin was a boiler with an internal fire-box,—the earliest example of a construction that is now almost universal.[1]

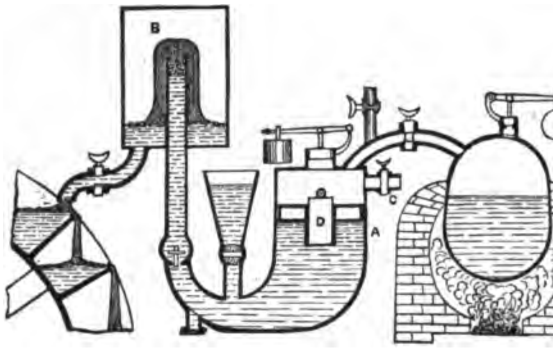

FIG. 3.—Papin, 1705.

Newcomen's atmospheric engine, 1705.

9. While Papin was thus going back from his first notion of a piston-engine to Savery's cruder type, a new inventor had appeared who made the piston-engine a practical success by separating the boiler from the cylinder and by using (as Savery had done) artificial means to condense the steam. This was Newcomen, who in 1705, with his assistant Cawley, gave the steam-engine the form shown in Fig. 4. Steam admitted from the boiler to the cylinder allowed the piston to be raised by a heavy counterpoise on the other side of the beam. Then the steam-valve was shut and a jet of cold water entered the cylinder and condensed the steam. The piston was consequently forced down by the pressure of the atmosphere and did work on the pump. The next entry of steam expelled the condensed water from the cylinder through an escape valve. The piston was kept tight by a layer of water on its upper surface. Condensation was at first effected by cooling the outside of the cylinder, but the accidental leakage of the packing water past the piston showed the advantage of condensing by a jet of injection water, and this plan took the place of surface condensation. The engine used steam whose pressure was little if at all greater than that of the atmosphere; sometimes indeed it was worked with the manhole lid off the boiler.

Self-acting valve-gear: Potter, Beighton, 1713-18.

10. About 1711 Newcomen's engine began to be introduced for pumping mines; and in 1713 a boy named Humphrey Potter, whose duty it was to open and shut the valves of an engine he attended, made the engine self-acting by causing the beam itself to open and close the valves by suitable cords and catches. Potter's rude device was simplified in 1718 by Henry Beighton, who suspended from the beam a rod called the plug-tree, which worked the valves by means of tappets. By 1725 the engine was in common use in collieries, and it held its place without material change for about three-quarters of a century in all. Near the close of its career the atmospheric engine was much improved in its mechanical details by Smeaton, who built many large engines of this type about the year 1770, just after the great step which was to make Newcomen's engine obsolete had been taken by James Watt.

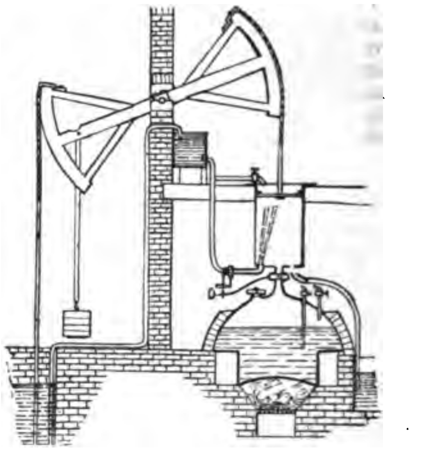

FIG. 4.—Newcomen's Atmospheric Engine, 1705.

Compared with Savery's engine, Newcomen's had (as a pumping-engine) the great advantage that the intensity of pressure in the pumps was not in any way limited by the pressure of the steam. It shared with Savery's, in a scarcely less degree, the defect already pointed out, that steam was wasted by the alternate heating and cooling of the vessel into which it was led. Though obviously capable of more extended uses, it was in fact almost exclusively employed to raise water,—in some instances for the purpose of turning water-wheels to drive other machinery. Even contemporary writers complain of its "vast consumption of fuel," which appears to have been scarcely smaller than that of the engine of Savery.

Watt, 1763.

11. In 1763 James Watt, an instrument maker in Glasgow, while engaged by the university in repairing a model of Newcomen's engine, was struck with the waste of steam to which the alternate chilling and heating of the cylinder gave rise. He saw that the remedy, in his own words, would lie in keeping the cylinder as hot as the steam that entered it. With this view he added to the engine a new organ—an empty vessel separate from the cylinder, into which the steam should be allowed to escape from the cylinder, to be condensed there by the application of cold water either outside or as a jet. To preserve the vacuum in his condenser he added a pump called the air-pump, whose function was to pump from it the condensed steam and water of condensation, as well as the air which would otherwise accumulate by leakage or by being brought in with the steam or with the injection water. Then as the cylinder was no longer used as a condenser he was able to keep it hot by clothing it with non-conducting bodies, and in particular by the use of a *steam jacket*, or layer of hot

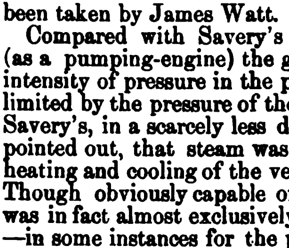

FIG. 5.—Watt's Experimental Apparatus.

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[1] For an account of Papin's inventions, see his *Life and Letters*, by Dr. E. Gerland, Berlin, 1881.

steam between the cylinder and an external casing. Further, and still with the same object, he covered in the top of the cylinder, taking the piston-rod out through a steam-tight stuffing-box, and allowed steam instead of air to press upon the piston's upper surface. The idea of using a separate condenser had no sooner occurred to Watt than he put it to the test by constructing the apparatus shown in Fig. 5. There A is the cylinder, B a surface condenser, and C the air-pump. The cylinder was filled with steam above the piston, and a vacuum was formed in the surface condenser B. On opening the stop-cock D the steam rushed over from the cylinder and was condensed, while the piston rose and lifted a weight. After several trials Watt patented his improvements in 1769; they are described in his specification in the following words, which, apart from their immense historical interest, deserve careful study as a statement of principles which to this day guide the scientific development of the steam-engine:

Watt's specification, 1769.

> "My method of lessening the consumption of steam, and consequently fuel, in fire-engines, consists of the following principles:
>
> "*First*, That vessel in which the powers of steam are to be employed to work the engine, which is called the cylinder in common fire-engines, and which I call the steam-vessel, must, during the whole time the engine is at work, be kept as hot as the steam that enters it; first by enclosing it in a case of wood, or any other materials that transmit heat slowly; secondly, by surrounding it with steam or other heated bodies; and, thirdly, by suffering neither water nor any other substance colder than the steam to enter or touch it during that time.
>
> "*Secondly*, In engines that are to be worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from the steam-vessels or cylinders, although occasionally communicating with them; these vessels I call condensers; and, whilst the engines are working, these condensers ought at least to be kept as cold as the air in the neighborhood of the engines, by application of water or other cold bodies.
>
> "*Thirdly*, Whatever air or other elastic vapor is not condensed by the cold of the condenser, and may impede the working of the engine, is to be drawn out of the steam-vessels or condensers by means of pumps, wrought by the engines themselves, or otherwise.
>
> "*Fourthly*, I intend in many cases to employ the expansive force of steam to press on the pistons, or whatever may be used instead of them, in the same manner in which the pressure of the atmosphere is now employed in common fire-engines. In cases where cold water cannot be had in plenty, the engines may be wrought by this force of steam only, by discharging the steam into the air after it has done its office. . . .
>
> "*Sixthly*, I intend in some cases to apply a degree of cold not capable of reducing the steam to water, but of contracting it considerably, so that the engines shall be worked by the alternate expansion and contraction of the steam.
>
> "*Lastly*, Instead of using water to render the pistons and other parts of the engine air and steam tight, I employ oils, wax, resinous bodies, fat of animals, quicksilver and other metals in their fluid state."

The fifth claim was for a rotary engine, and need not be quoted here.

The "common fire-engine" alluded to was the steam-engine, or, as it was more generally called, the "atmospheric" engine of Newcomen. Enormously important as Watt's first patent was, it resulted for a time in the production of nothing more than a greatly improved engine of the Newcomen type, much less wasteful of fuel, able to make faster strokes, but still only suitable for pumping, still single-acting, with steam admitted during the whole stroke, the piston, as before, pulling the beam by a chain working on a circular arc. The condenser was generally worked by injection, but Watt has left a model of a surface condenser made up of small tubes, in every essential respect like the condensers now used in marine engines.

Watt's pumping engine, 1769.

12. Fig. 6 is an example of the Watt pumping-engine of this period. It should be noticed that, although the top of the cylinder is closed and steam has access to the upper side of the piston, this is done only to keep the cylinder and piston warm. The engine is still single-acting; the steam in the upper side merely plays the part which was played in Newcomen's engine by the atmosphere; and it is the lower end of the cylinder alone that is ever put in communication with the condenser. There are three valves,—the "steam" valve *a*, the "equilibrium" valve *b*, and the "exhaust" valve *c*. At the beginning of the down-stroke *c* is opened to produce a vacuum below the piston and *a* is opened to admit steam above it. At the end of the down-stroke *a* and *c* are shut and *b* is opened. This puts the two sides in equilibrium, and allows the piston to be pulled up by the pump-rod P, which is heavy enough to serve as a counterpoise. C is the condenser, and A the air-pump, which discharges into the hot well H, whence the supply of the feed-pump F is drawn.

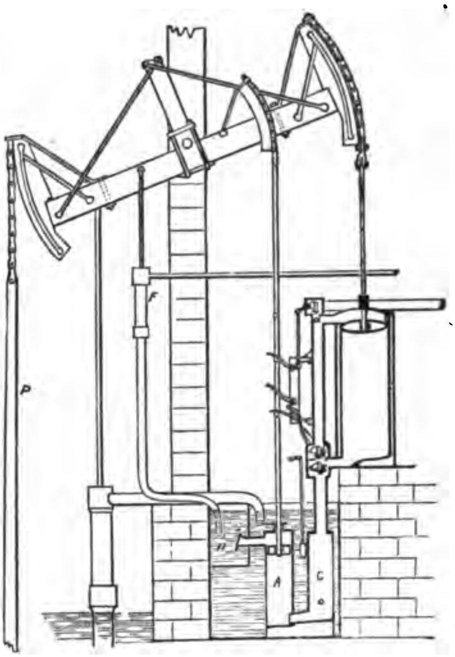

FIG. 6.—Watt's Single-Acting Engine, 1769.

Rotative engine.

13. In a second patent (1781) Watt describes the "sun-and-planet" wheels and other methods of making the engine give continuous revolving motion to a shaft provided with a fly-wheel. He had invented the crank and connecting-rod for this purpose, but it had meanwhile been patented by one Pickard, and Watt, rather than make terms with Pickard, whom he regarded a plagiarist of his own ideas, made use of his sun-and-planet motion until the patent on the crank expired. The reciprocating motion of earlier forms had served only for pumping; by this invention Watt opened up for the steam-engine a thousand other channels of usefulness. The engine was still single-acting; the connecting-rod was attached to the far end of the beam, and that carried a counterpoise which served to raise the piston when steam was admitted below it.

Double action.

14. In 1782 Watt patented two further improvements of the first importance, both of which he had invented some years before. One was the use of double action, that is to say, the application of steam and vacuum to each side of the piston alternately. The other (invented as early as 1769) was the use of steam expansively, in other words the plan (now used in all engines that aim at economy of fuel) of stopping the admission of steam when the piston had made only a part of its stroke, and allowing the rest of the stroke to be performed by the expansion of the

Expansion of steam.

Parallel motion.

Governor.

steam already in the cylinder. To let the piston push as well as pull the end of the beam Watt devised his so-called parallel motion, an arrangement of links, connecting the piston-rod head with the beam in such a way as to guide the rod to move in a very nearly straight line. He further added the throttle-valve for regulating the rate of admission of steam, and the centrifugal governor, a double conical pendulum, which controlled the speed by acting on the throttle-valve. The stage of development reached at this time is illustrated by the engine of Fig. 7 (from Stuart's *History of the Steam Engine*), which shows the parallel motion *pp*, the governor *g*, the throttle-valve *t*, and a pair of steam and exhaust valves at each end of the cylinder. Among other inventions of Watt were the "indicator," by which diagrams showing the relation of the steam-pressure in the cylinder to the movement of the piston are automatically drawn; a steam tilt-hammer; and also a steam locomotive for ordinary roads,—but this invention was not prosecuted.

Indicator.

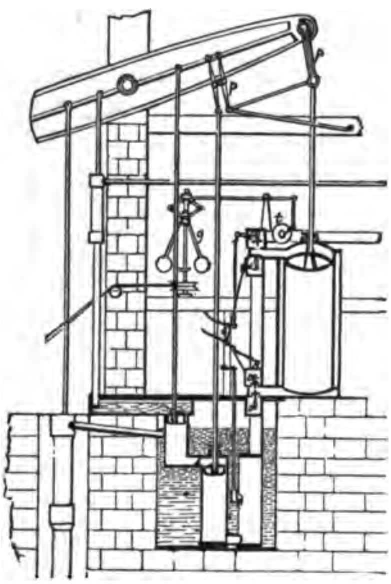

FIG. 7.—Watt's Double-Acting Engine, 1782.

Rating of engines by "horse-power."

In partnership with Matthew Boulton, Watt carried on in Birmingham the manufacture and sale of his engines with the utmost success, and held the field against all rivals in spite of severe assaults on the validity of his patents. Notwithstanding his accurate knowledge of the advantage to be gained by using steam expansively he continued to employ only low pressures—seldom more than 7 lbs. per square inch over that of the atmosphere. His boilers were fed, as Newcomen's had been, through an open pipe which rose high enough to let the column of water in it balance the pressure of the steam. He introduced the term "horse-power" as a mode of rating engines, defining one horse-power as the rate at which work is done when 33,000 lbs. are raised one foot in one minute. This estimate was based on trials of the work done by horses; it is excessive as a statement of what an average horse can do, but Watt purposely made it so in order that his customers might have no reason to complain on this score.

Non-condensing engine.

Leupold, 1725.

15. In the fourth claim in Watt's first patent, the second sentence describes a non-condensing engine, which would have required steam of a higher pressure. This, however, was a line of invention which Watt did not follow up, perhaps because so early as 1725 a non-condensing engine had been described by Leupold in his *Theatrum Machinarum*. Leupold's proposed engine is shown in Fig. 8, which makes its action sufficiently clear. Watt's aversion to high-pressure steam was strong, and its influence on steam-engine practice long survived the expiry of his patents. So much indeed, was this the case that the terms "high-pressure" and "non-condensing" were for many years synonymous, in contradistinction to the "low-pressure" or condensing engines of Watt. This nomenclature no longer holds; in modern practice many condensing engines use as high pressures as non-condensing engines, and by doing so are able to take advantage of Watt's great invention of expansive working to a degree which was impossible in his own practice.

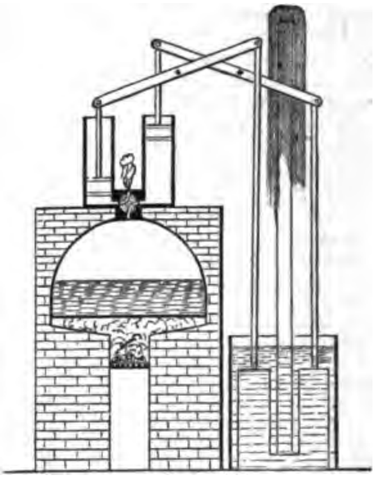

FIG. 8.—Leupold's Non-condensing Engine, 1725.

High-pressure steam; Trevithick and Evans.

Cugnot, 1769.

16. The introduction of the non-condensing and, at that time, relatively high-pressure engine, was effected in England by Richard Trevithick and in America by Oliver Evans about 1800. Both Evans and Trevithick applied their engines to propel carriages on roads, and both used for boiler a cylindrical vessel with a cylindrical flue inside—the construction now known as the Cornish boiler. In partnership with Edward Bull, Trevithick had previously made direct-acting pumping-engines, with an inverted cylinder set over and in line with the pump-rod, thus dispensing with the beam that had been a feature in all earlier forms. But in these "Bull" engines, as they were called, a condenser was used, or, rather, the steam was condensed by a jet of cold water in the exhaust-pipe, and Boulton and Watt successfully opposed them as infringing Watt's patents. To Trevithick belongs the distinguished honor of being the first to use a steam-carriage on a railway; in 1804 he built a locomotive in the modern sense, to run on what had formerly been a horse-tramway in Wales, and it is noteworthy that the exhaust steam was discharged into the funnel to force the furnace draught, a device which twenty-five years later, in the hands of George Stephenson, went far to make the locomotive what it is to-day. In this connection it may be added that as early as 1769 a steam-carriage for roads had been built by Nicholas Joseph Cugnot in France, who used a pair of single-acting high-pressure cylinders to turn a driving axle step by step by means of pawls and ratchet-wheels. To the initiative of Evans may be ascribed the early general use of high-pressure steam in the United States, a feature which for many years distinguished American from English practice.

Compound engine: Hornblower, 1781.

17. Amongst the contemporaries of Watt one name deserves special mention. In 1781 Jonathan Hornblower constructed and patented what would now be called a compound engine, with two cylinders of different sizes. Steam was first admitted into the smaller cylinder, and then passed over into the larger, doing work against a piston in each. In Hornblower's engine the two cylinders were placed side by side, and both pistons worked on the same end of a beam overhead. This was an instance of the use of steam expansively, and as such was earlier than the patent, though not earlier than the invention, of expansive working by Watt. Hornblower was crushed by the Birmingham firm for infringing their patent in the use of a separate condenser and air-pump. The compound engine was revived in 1804 by Woolf, with whose name it is often associated. Using steam of fairly high pressure, and cutting off the supply before the end of the stroke in the small cylinder, Woolf expanded the steam to several times its original volume. Mechanically the double-cylinder compound engine has this advantage over an engine in which the same amount of expansion is performed in a single cylinder, that the sum of the forces exerted by the two pistons in the compound engine varies less throughout the action than the force exerted by the piston of the single-cylinder engine. This advantage may have been clear to Hornblower and Woolf, and to other early users of compound expansion. But another and probably a more important merit of the system lies in a fact of which neither they nor for many years their followers in the use of compound engines were aware—the fact that by dividing the whole range of expansion into two parts the cylinders in which these are separately performed are subject to a reduced range of fluctuation in their temperature. This, as will be afterwards pointed out, limits to a great extent a source of waste which is present in all steam-engines, the waste which results from the heating and cooling of the metal by its alternate contact with hot and cooler steam. The system of compound expansion is now used in nearly all large engines that pretend to economy. Its introduction forms the only great improvement which the steam-engine has undergone since the time of Watt; and we are able to recognize it as a very important step in the direction set forth in his "first principle," that the cylinder should be kept as hot as the steam that enters it.

Woolf, 1804.

Cornish engine.

18. Woolf introduced the compound engine somewhat widely about 1814, as a pumping engine in the mines of Cornwall. But here it met a strong competitor in the high-pressure single-cylinder engine of Trevithick, which had the advantage of greater simplicity in construction. Woolf's engine fell into comparative disuse, and the single-cylinder type took a form which, under the name of the Cornish pumping engine, was for many years famous for its great economy of fuel. In this engine the cylinder was set under one end of a beam, from the other end of which hung a heavy rod which operated a pump at the foot of the shaft. Steam was admitted above the piston for a short portion of the stroke, thereby raising the pump-rod, and was allowed to expand for the remainder. Then an equilibrium valve, connecting the space above and below the piston, as in Fig. 6, was opened, and the pump-rod descended, doing work in the pump and raising the engine piston. The large mass which had to be started and stopped at each stroke served by its inertia to counterbalance the unequal pressure of the steam, for the ascending rods stored up energy of motion in the early part of the stroke, when the steam pressure was greatest, and gave out energy in the later part, when expansion had greatly lowered the pressure. The frequency of the stroke was controlled by a device called a cataract, consisting of a small plunger pump, in which the plunger, raised at each stroke by the engine, was allowed to descend more or less slowly by the escape of fluid below it through an adjustable orifice, and in its descent liberated catches which held the steam and exhaust valves from opening. A similar device controlled the equilibrium valve, and could be set to give a pause at the end of the piston's downstroke, so that the pump cylinder might have time to become completely filled. The Cornish engine is interesting as the earliest form which achieved an efficiency comparable with that of good modern engines. For many years monthly reports were published of the "duty" of these engines, the "duty" being the number of foot-pounds of work done per bushel or (in some cases) per cwt. of coal. The average duty of engines in the Cornwall district rose from about 18 millions of foot-pounds per cwt. of coal in 1813 to 68 millions in 1844, after which less effort seems to have been made to maintain a high efficiency.[1] In individual cases much higher results were reported, as in the Fowey Consols engine, which in 1835 was stated to have a duty of 125 millions. This (to use a more modern mode of reckoning) is equivalent to the consumption of only a little more than 1⅔ ℔ of coal per horse-power per hour—a result surpassed by very few engines in even the best recent practice. It is difficult to credit figures which, even in exceptional instances, place the Cornish engine of that period on a level with the most efficient modern engines—in which compound expansion and higher pressure combine to make a much more perfect thermodynamic machine; and apart from this there is room to question the accuracy of the Cornish reports. They played, however, a useful part in the process of steam-engine development by directing attention to the question of efficiency, and by demonstrating the advantage to be gained by high pressure and expansive working, at a time when the theory of the steam-engine had not yet taken shape.

Compound engine.

19. The final revival of the compound engine did not occur until about the middle of the century, and then several agencies combined to effect it. In 1845 M'Naught introduced a plan of improving beam engines of the original Watt type, by adding a high-pressure cylinder whose piston acted on the beam between the centre and the fly-wheel end. Steam of higher pressure than had formerly been used, after doing work in the new cylinder, passed into the old or low-pressure cylinder, where it was further expanded. Many engines whose power was proving insufficient for the extended machinery they had to drive were "M'Naughted" in this way, and after conversion were found not only to yield more power but to show a marked economy of fuel. The compound form was selected by Mr. Pole for the pumping engines of Lambeth and other water-works about 1850; in 1854 John Elder[2] began to use it in marine engines; in 1857 Mr. Cowper added a steam-jacketed intermediate reservoir for steam between the high and low pressure cylinders, which made it unnecessary for the low-pressure piston to be just beginning when the other piston was just ending its stroke. As facilities increased for the use of high-pressure steam, compound expansion became more and more general, its advantage becoming more conspicuous with every increase in boiler pressure—until now there are few large land engines and scarcely any marine engines that do not employ it. In marine practice where economy of fuel is a much more important factor in determining the design than it is on land, the principle of compound expansion has lately been greatly extended by the introduction of triple and even quadruple expansion engines in which the steam is made to expand successively in three or in four cylinders. Even in the building of locomotive engines, where other considerations are of more moment than the saving of coal, the system of compound expansion is beginning to find a place.

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[1] *Min. Proc. Inst. C. E.*, vol. xxiii., 1863.

[2] [Son (1824-69) of David, manager of the Napier shipyards at Glasgow. With Charles Randolph he patented in 1853 compound marine engines turning opposed screws, died in London, commemorated by a $250,000 monument at Govan and the esteem of workmen, to whom he was beneficent.—AM. ED.]

The growth of compound expansion has been referred to at some length, because it forms the most distinctive improvement which the steam-engine has undergone since the time of Watt. For the rest, the progress of the steam-engine has consisted in its adaptation to particular uses, in the invention of features of mechanical detail, in the recognition and application of thermodynamical principles, and in improved methods of engineering construction by which it has profited in common with all other machines. These have in particular made possible the use of steam of eight or ten times the pressure of that employed by Watt.

Application to locomotives.

20. The adaptation of the steam-engine to railways, begun by Trevithick, became a success in the hands of George Stephenson, whose engine the "Rocket," when tried along with others on the Stockton and Darlington road in 1829, not only distanced its competitors but settled once and for all the question whether horse traction or steam traction was to be used on railways. The principal features of the "Rocket" were an improved steam-blast for urging the combustion of coal, and a boiler (suggested by Booth, the secretary of the railway) in which a large heating surface was given by the use of many small tubes through which the hot gases passed. Further, the cylinders, instead of being vertical as in earlier locomotives, were set in at a slope, which was afterwards altered to a position more nearly horizontal. To these features there was added later the "link motion," a contrivance which enabled the engine to be easily reversed and the amount of expansion to be readily varied. In the hands of George Stephenson and his son Robert the locomotive took a form which has been in all essentials maintained by the far heavier locomotives of to-day.

Application to steamboats.

21. The first practical steamboat was the tug "Charlotte Dundas," built by William Symmington, and tried in the Forth and Clyde Canal in 1802.[1] A Watt double-acting condensing engine, placed horizontally, acted directly by a connecting-rod on the crank of a shaft at the stern, which carried a revolving paddle-wheel. The trial was successful, but steam towing was abandoned for fear of injuring the banks of the canal. Ten years later Henry Bell built the "Comet," with side paddle-wheels, which ran as a passenger steamer on the Clyde; but an earlier inventor to follow up Symmington's success was the American Robert Fulton, who, after unsuccessful experiments on the Seine, fitted a steamer on the Hudson in 1807 with engines made to his designs by Boulton and Watt, and brought steam navigation for the first time to commercial success.

Theory of steam-engine.

22. The early inventors had little in the way of theory to guide them. Watt had the advantage, which he acknowledges, of a knowledge of Black's doctrine of latent heat; but there was no philosophy of the relation of work to heat until long after the inventions of Watt were complete. The theory of the steam-engine as a heat-engine dates from 1824, when Carnot published his *Reflexions sur la Puissance Motrice du Feu*, and showed that heat does work only by being let down from a higher to a lower temperature. But Carnot had no idea that any of the heat disappears in the process, and it was not until the doctrine of the conservation of energy was established in 1843 by the experiments of Joule that the theory of heat-engines began a vigorous growth. From 1849 onwards the science of thermodynamics was developed with extraordinary rapidity by Clausius, Rankine, and Thomson, and was applied, especially by Rankine, to practical problems in the use of steam. The publication in 1859 of Rankine's *Manual of the Steam-Engine* formed an epoch in the history of the subject by giving inventors a new basis, outside of mere empiricism, from which they could push on the development of the steam-engine. Unfortunately, however, for its bearing on practice, the theory of the steam-engine was to a great extent founded on certain simplifying assumptions which experience has now shown to be far from correct. It was assumed that the cylinder and piston might be treated as behaving to the steam like non-conducting bodies, —that the transfer of heat between the steam and the metal was negligibly small. Rankine's calculations of steam-consumption, work, and thermodynamic efficiency involve this assumption, except in the case of steam-jacketed cylinders, where he estimates that the steam in its passage through the cylinder takes just enough heat from the jacket to prevent a small amount of condensation which would otherwise occur as the process of expansion goes on. If the transfer of heat from steam to metal could be overlooked, the steam which enters the cylinder would remain during admission as dry as it was before it entered, and the volume of steam consumed per stroke would correspond with the volume of the cylinder up to the point of cut-off. It is here that the actual behavior of steam in the cylinder diverges most widely from the behavior which the theory assumes. When steam enters the cylinder it finds the metal chilled by the previous exhaust, and a portion of it is at once condensed. This has the effect of increasing, often very largely, the volume of boiler steam required per stroke. As expansion goes on the water that was condensed during admission begins to be re-evaporated from the sides of the cylinder, and this action is often prolonged into the exhaust. In a later chapter the effect which this exchange of heat between the metal of the cylinder and the working fluid produces on the economy of the engine will be discussed, and an account will be given of experimental means by which we may examine the amount of steam that is initially condensed and trace its subsequent re-evaporation. It is now recognized that any theory which fails to take account of these exchanges of heat fails also to yield even comparatively correct results in calculating the relative efficiency of various steam pressures or various ranges of expansion. But the exchanges of heat are so complex that there seems little prospect of submitting them to any comprehensive theoretical treatment, and we must rather look for help in the future development of engines to the scientific analysis of experiments with actual machines. Much careful work of this kind has already been done by Hirn and others, and there is room for much more. Questions relating to the influence (on heat-engine economy) of speed, of pressure, of ratio of expansion, of jacketing, of compound expansion, or of superheating must in the main be settled by an appeal to experiment,—experiment guided and interpreted at every step by reference to the principles of thermodynamics and the theory of steam.

Carnot.

Joule.

Clausius, Rankine, Thomson.

References.—Stuart, *Descriptive History of the Steam-Engine*, 1825; Farey, *Treatise on the Steam-Engine*, 1827; Tredgold, *The Steam-Engine*, 1838; Muirhead's *Mechanical Inventions of James Watt*, and *Life of Watt*; Galloway, *The Steam-Engine and its Inventors*; Thurston, *History of the Growth of the Steam-Engine*; Cowper on the Steam-Engine (*Heat Lectures Inst. C. E.*, 1884). Tait, *Sketch of Thermodynamics*.

II. THEORY OF HEAT-ENGINES.

Laws of thermodynamics.

23. A heat-engine acts by taking in heat, converting a part of the heat received into mechanical energy, which appears as the work done by the engine, and rejecting the remainder, still in the form of heat. The theory of heat-engines comprises the study of the amount of work done, in its relation to the heat supplied and to the heat rejected. The theory is based on the two laws of thermodynamics, which may be stated here as follows:

LAW 1. *When mechanical energy is produced from heat,* 1

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[1] [Symmington had built a small steamboat which ran five miles an hour in 1788. For John Fitch's inventions of a still earlier date, see vol. ix. p. 286, and fuller details in Thurston's *Growth of the Steam-Engine*, already quoted,—a book which also discusses Fulton's originality of invention authoritatively.—AM. ED.]

thermal unit of heat goes out of existence for every 772 foot-pounds of work done; and, conversely, when heat is produced by the expenditure of mechanical energy, 1 thermal unit of heat comes into existence for every 772 foot-pounds of work spent.

The "thermal unit" is the heat required to raise the temperature of 1 ℔ of water 1 degree Fahr. when at its temperature of maximum density. The equivalent quantity of work, 772 foot-pounds, was determined by the experiments of Joule, and is called Joule's equivalent. Later researches by Joule and others have indicated that this number is probably too small; it should perhaps be as much as 774 foot-pounds. Joule's original value is still generally used by engineers; and as it enters into many published tables it may conveniently be adhered to until its accuracy is more definitely disproved. Since a definite number of foot-pounds are equivalent to 1 thermal unit, we may, if we please, express quantities of work in thermal units, or quantities of heat in foot-pounds; the latter practice will frequently be found useful.

LAW 2. *It is impossible for a self-acting machine, unaided by any external agency, to convey heat from one body to another at a higher temperature.*

This is the form in which the second law has been stated by Clausius. Another statement of it, different in form but similar in effect, has been given by Thomson. Its force may not be immediately obvious, but it will be shown below that it introduces a most important limitation of the power which any engine has of converting heat into work. So far as the first law shows, there is nothing to prevent the whole heat taken in by the engine from changing into mechanical energy. In consequence of the second law, however, no heat-engine converts or can convert, more than a small fraction of the heat supplied to it into work; a large part is necessarily rejected as heat. The ratio

$$\frac{\text{Heat converted into work}}{\text{Heat taken in by the engine}}$$

is a fraction always much less than unity. This ratio is called the *efficiency* of the engine considered as a heat-engine.

Working substance.

24. In every heat-engine there is a *working substance* which takes in and rejects heat, thereby suffering changes of form, or more commonly of volume, and does work by overcoming resistance to these changes of form or volume. The working substance may be gaseous, liquid, or solid. We can, for example, imagine a heat-engine in which the working substance is a long metallic rod, arranged to act as the pawl of a ratchet-wheel with fine teeth. Let the rod be heated so that it elongates sufficiently to drive the wheel forward through the space of one tooth. Then let the rod be cooled (say by applying cold water), the wheel being meanwhile held from returning by a separate click or detent. The rod, on cooling, will retract so as to engage itself with the next succeeding tooth, which may then be driven forward by heating the rod again, and so on. To make it evident that such an engine would do work, we have only to suppose that the ratchet-wheel carries round with it a drum by which a weight is wound up. We have, then, a complete heat-engine, in which the working substance is a solid rod, which receives heat by being brought into contact with some source of heat at a comparatively high temperature, transforms a small part of this heat into work, and rejects the remainder to what we may call a receiver of heat, at a comparatively low temperature. The greater part of the heat may be said simply to pass through the engine, from the source to the receiver, *becoming degraded as regards temperature* as it goes. We shall see presently that this is typical of the action of all heat-engines; when they are doing work, the heat which they reject is rejected at a temperature lower than that at which it is taken in. They convert some heat into work only by letting down a much larger quantity of heat from a high to a relatively low temperature. The action is analogous to that of a water-wheel, which does work by letting down water from a high to a lower level, but with this important difference that in the transfer which occurs in heat-engines an amount of heat disappears which is equivalent to the work done.

Degradation of temperature.

Fluid working substance. Work by changes of volume.

25. In almost all actual heat-engines the working substance is a fluid. In some it is air, in some a mixture of several gases. In the steam-engine the working fluid is a mixture (in varying proportions) of water and steam. With a fluid for working substance, work is done by changes of volume only; its amount depends solely on the relation of pressure to volume during the change, and not at all on the form of the vessels in which the change takes place. Let a diagram be drawn (Fig. 9) in which the relation of the intensity of pressure to the volume of any supposed working substance is graphically exhibited by the line ABC, where AM, CN are pressures and AP, CQ are volumes, then the work done by the substance in expanding from A to C is the area of the figure MABCN. And similarly, if the substance be compressed from C back to its original volume in such a manner that the line CDA represents the relation of pressure and volume during compression, the work done *upon* the substance is the figure NCDAM. Taking the two operations together we find that the substance has done a net amount of work equal to the area of the shaded figure ABCDA, or $\int PdV$. This is an example and a generalization of the method of representing work which Watt introduced by his invention of the indicator; the figure ABCDA may be called the indicator diagram of the supposed action.

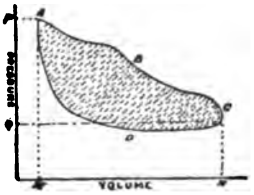

FIG. 9.

Cycle of operation of working substance.

26. Generally in heat-engines the working substance returns periodically to the same state of temperature, pressure, volume, and physical condition. When this has occurred the substance is said to have passed through a complete cycle of operations. For example, in a condensing steam-engine, water taken from the hot-well is pumped into the boiler; it then passes into the cylinder as steam, passes thence into the condenser, and thence again into the hot-well; it completes the cycle by returning to the same condition as at first. In other less obvious cases, as in that of the non-condensing steam-engine, a little consideration will show that the cycle is completed, not indeed by the same portion of working substance being returned to the boiler, but by an equal quantity of water being fed to it, while the steam which has been discharged into the atmosphere cools to the temperature of the feed. In the theory of heat-engines it is of the first importance to consider (as was first done by Carnot in 1824) the cycle of operations performed by the working substance as a complete whole. If we stop short of the completion of a cycle matters are complicated by the fact that the substance is in a state different from its initial state, and may therefore have changed its stock of internal energy. After a complete cycle, on the other hand, we know at once that, since the condition is the same, the internal energy of the substance is the same as at first, and therefore—

Heat taken in = work done + heat rejected.

Engine working with a perfect gas.

27. It will serve our purpose best to approach the theory of heat-engines by considering, in the first instance, the action of an engine in which the working substance is any one of the so-called permanent gases, or a mixture of them, such as air. The word permanent, as applied to a gas, can now[1] be understood only as meaning that the gas is liquefied with difficulty—either by the use of extremely low temperature or extremely high pressure or both. So long as gases are under conditions of pressure and temperature widely different from those which produce liquefaction, they conform very approximately to certain simple laws—laws which may be regarded as *rigorously* applicable to ideal substances called *perfect* gases. After stating these laws briefly we shall examine the efficiency of a heat-engine using a gas in a certain manner as working substance, and then show that the conclusion so derived has a general application to all heat-engines whatsoever. In this procedure there is no sacrifice of generality, and a part of the process is of independent service in the discussion of actual air-engines.

Laws of the permanent gases.

28. The laws of the permanent gases are the following:

LAW 1. (Boyle). *The volume of a given mass of gas varies inversely as the pressure, the temperature being kept constant.*

Boyle's law.

Thus, if V be the volume of 1 ℔ of a gas in cubic feet, and P the pressure in pounds per square foot, so long as the temperature is unchanged—

$$P \propto V^{-1}, \text{ or } PV = \text{constant}.$$

For air the value of the constant is 26220 when the temperature is 32° F.

Charles's law.

29. LAW 2. (Charles). *Under constant pressure equal volumes of different gases increase equally for the same increment of temperature. Also, if a gas be heated under constant pressure, equal increments of its volume correspond very nearly to equal intervals of temperature as determined by the scale of a mercury thermometer.*

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[1] Since the liquefaction of hydrogen and other gases by MM. Cailletet and Pictet.

Thus, let us take, say, 493 cubic inches of hydrogen, also of oxygen, of air, etc., all at 32° F., and, keeping each at a constant pressure (not necessarily the same for all), heat all so that their temperature rises 1° F. We shall find that each has expanded by sensibly the same amount and now occupies 494 cubic inches. And further, if we heat any one through another 1° F. to 34° F., we shall find that its volume is now 495 cubic inches, and so on. Thus for any gas, kept at constant pressure, if the volume was

493 at 32° F.,
it would be 492 at 31° F.,
⋮
461 at 0° F.,
⋮
and finally 0 at — 461° F.,

provided the same law were to hold at indefinitely low temperatures. This we may assume to be the case with a perfect gas, although any actual gas would change its physical state long before so low a temperature were reached.

Absolute temperature.

This result may be concisely expressed by saying that if we reckon temperature, not from the ordinary zero but from a point 461° below the zero of Fahrenheit's scale, the volume of a given quantity of a gas, kept at constant pressure, is proportional to the temperature reckoned from that zero. Temperatures so reckoned are called absolute temperatures, and the point — 461° F. is called the absolute zero of temperature. Denoting any temperature according to the ordinary scale by t, and the corresponding absolute temperature by τ, we have

$\tau = t + 461$ on the Fahrenheit scale,
and $\tau = t + 274$ on the Centigrade scale.

Charles's law shows that if temperatures be measured by thermometers in which the expanding substance is air, hydrogen, oxygen, or any other permanent gas, and, if those intervals of temperature be called equal which correspond to equal amounts of expansion, then the indications of these thermometers always agree very closely with each other, and also agree, though less closely, with the indications of a mercury thermometer. We shall see later that the theory of heat-engines affords a means of forming a thermometric scale which is independent of the properties, as to expansion, of any substance, and that this scale coincides with the scale of a perfect gas thermometer, a fact which justifies the use of the term absolute, as applied to temperatures measured by the expansion of a gas.

30. Combining laws 1 and 2, we have, for a given mass of any gas,

$$PV = c\tau,$$

where c is a constant depending on the specific density of the gas and on the units in which P and V are measured. In what follows we shall assume that P is measured in pounds per square foot, that V is the volume of 1 ℔ in cubic feet, and that τ is the absolute temperature in Fahrenheit degrees. In air, with these units,

$$PV = 53.18\tau.$$

31. LAW 3 (Regnault). *The specific heat at constant pressure is constant for any gas.*

Regnault's law.

Specific heat at constant pressure.

By specific heat at constant pressure is meant the heat taken in by 1 ℔ of a substance when its temperature rises 1° F., while the pressure remains unchanged—the volume of course increasing. The law states that this quantity is the same for any one gas, no matter what be the temperature, or what the constant pressure, at which the process of heating takes place.

Specific heat at constant volume.

32. Another important quantity in the theory of heat-engines is the specific heat at constant volume, that is, the heat taken in by 1 ℔ of the substance when its temperature rises 1° F. while the volume remains unchanged—the pressure of course increasing. We shall denote specific heat at constant pressure by K_p and specific heat at constant volume by K_v. Let 1 ℔ of a gas be heated at constant pressure P from temperature τ_1 to temperature τ_2 (absolute). Let V_1 be the volume at τ_1 and V_2 the volume at τ_2. Heat is taken in, and external work is done by the expansion of the gas, namely:

Heat taken in $= K_p(\tau_2 - \tau_1)$.
Work done $= P(V_2 - V_1) = c(\tau_2 - \tau_1)$.

The difference between these quantities, or $(K_p - c)(\tau_2 - \tau_1)$, is the amount by which the stock of internal energy possessed by the gas has increased during the process. We shall see presently that this gain of internal energy would have been the same had the gas passed in any other manner from τ_1 to τ_2.

33. LAW 4 (Joule). ***When a gas expands without doing external work, and without taking in or giving out heat, its temperature does not change.***

Joule's law.

To prove this, Joule connected a vessel containing compressed gas with another vessel that was empty, by means of a pipe with a closed stop-cock. Both vessels were immersed in a tub of water and were allowed to assume a uniform temperature. Then the stop-cock was opened, the gas expanded without doing external work, and finally the temperature of the water in the tub was found to have undergone no change. The temperature of the gas was unaltered, and no heat had been taken in or given out by it.

Internal energy of a gas depends only on temperature.

34. Since the gas had neither gained nor lost heat, and had done no work, its internal energy was the same at the end as at the beginning of the experiment. The pressure and volume had changed, but the temperature had not. We must therefore conclude that the internal energy of a given mass of a gas depends only on its temperature, and not upon its pressure or volume; in other words, a change of pressure and volume not associated with a change of temperature does not alter the internal energy. Hence in any change of temperature the change of internal energy is independent of the relation of pressure to volume throughout the operation. Now we have seen above that the quantity

$$(K_p - c)(\tau_2 - \tau_1)$$

measures the gain of internal energy when 1 ℔ of a gas has its temperature changed from τ_1 to τ_2 in one particular way, namely, at constant pressure. Hence this same quantity also measures the gain of internal energy when 1 ℔ of a gas has its temperature changed from τ_1 to τ_2 in any manner whatsoever.

Relation of the two specific heats.

35. Next consider the case of 1 ℔ of a gas heated from τ_1 to τ_2 at constant volume. The heat taken in is

$$K_v(\tau_2 - \tau_1).$$

Since no work is done, this is all gain of internal energy, and is therefore (§ 34) equal to

$$(K_p - c)(\tau_2 - \tau_1).$$

Hence in any gas

$$K_p - c = K_v.$$

The ratio K_p/K_v will be denoted by γ; obviously

$$K_v = c/(\gamma - 1).$$

The following table of values of K_p, K_v, c, and γ will be found useful in dealing with air and gas engines.

TABLE I.—*Properties of Gases.*

	K_p.	K_v.	c.	γ.
	Foot-lbs.	Foot-lbs.	Foot-lbs.	
Dry air	183.4	130.2	53.2	1.409
Oxygen	167.9	119.8	48.1	1.402
Nitrogen	188.2	133.4	54.8	1.411
Hydrogen	2632	1864	768	1.412
Carbonic oxide	189.1	133.4	55.7	1.418
Carbonic acid	167.4	132.6	34.8	1.263
Marsh gas	457.7	263.1	94.6	1.261
Olefiant gas	311.9	257.7	54.2	1.213
Steam gas, or highly superheated steam	371	285.5	85.5	1.30

Work done in expansion.

36. We shall now return to the consideration of diagrams like that of § 25, which exhibit the action of a working substance by curves showing the relation of P to V during expansion or compression. In most of the instances which occur in the theory of heat-engines such curves may be exactly or approximately represented by equations of the form

$$PV^n = \text{constant},$$

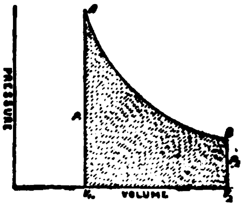

FIG. 10.

where the index n has various numerical values. Let AB, Fig. 10, be a curve of expansion (of any substance) in which PV^n is constant, from pressure P_1 and volume V_1 at A to pressure P_2 and volume V_2 at B. We have, by assumption,

$$P_1V_1^n = P_2V_2^n.$$

The work done is.

$$\int_{V_1}^{V_2} P dV = P_1V_1^n \int_{V_1}^{V_2} \frac{dV}{V^n} = \frac{P_1V_1^n (V_2^{1-n} - V_1^{1-n})}{1-n}.$$

This may also be written

$$\frac{P_1V_1(1-r^{1-n})}{n-1},$$

where r is the ratio V_2/V_1, which may be called the ratio of expansion.

Still another form of the above expression for the work done is

$$\frac{P_1V_1 - P_2V_2}{n-1}.$$

37. Applying this result to the case of an expanding gas, we have

$$\text{Work done} = c(\tau_1 - \tau_2)/(n-1).$$

The loss of internal energy during expansion is, by § 34,

$$K_v(\tau_1 - \tau_2), \text{ or } c(\tau_1 - \tau_2)/(\gamma - 1), \text{ by § 35.}$$

Suppose now that the mode of expansion is such that the loss of internal energy is equal to the external work done, then

$$\frac{c(\tau_1 - \tau_2)}{n-1} = \frac{c(\tau_1 - \tau_2)}{\gamma - 1}, \text{ or } n = \gamma,$$

and the law of expansion is

$$PV^\gamma = \text{constant.}$$

The same formula applies when a gas is being compressed in such a manner that the work spent upon the gas is equal to the gain of internal energy by the gas.

Adiabatic expansion.

38. This mode of expansion (or compression) is termed *adiabatic*. It occurs when the working substance is neither gaining nor losing heat by conduction or radiation or internal chemical action. It would be realized if we had a substance expanding or being compressed, without chemical change, in a cylinder which (with the piston) was a perfect non-conductor of heat. In adiabatic expansion the external work is done entirely at the expense of the substance's stock of internal energy. Hence in the adiabatic expansion of a gas the temperature falls, and in adiabatic compression it rises. To find the change of temperature in a gas when expanded or compressed adiabatically we have only to combine the equations

$$P_1V_1^\gamma = P_2V_2^\gamma \text{ and } \frac{P_2V_2}{P_1V_1} = \frac{\tau_2}{\tau_1},$$

and we find

$$\tau_2 = \tau_1 (V_1/V_2)^{\gamma - 1}.$$

It is clear from the above that if, during expansion, n is less than γ the fluid is taking in heat, and if n is greater than γ the fluid is rejecting heat.

Isothermal expansion.

39. Another very important mode of expansion or compression is that called *isothermal*, in which the temperature of the working substance is kept constant during the process.

In the case of a gas the curve of isothermal expansion is a rectangular hyperbola, having the equation

$$PV = \text{constant} = c\tau.$$

When a gas expands (or is compressed) isothermally at temperature τ from V_1 to V_2 the work done by (or upon) it (per lb) is

$$\int_{V_1}^{V_2} P dV = P_1 \int_{V_1}^{V_2} \frac{dV}{V} = PV \log_e r = c\tau \log_e r,$$

where r is the ratio V_2/V_1 as before.[1]

During isothermal expansion or compression a gas suffers no change of internal energy (by § 34, since τ is constant). Hence during isothermal expansion a gas must take in an amount of heat just equal to the work it does, and during isothermal compression it must reject an amount of heat just equal to the work spent upon it. The expression $c\tau \log_e r$ consequently measures, not only the work done by or upon the gas, but also the heat taken in during isothermal expansion or given out during isothermal compression. In the diagram, Fig. 11, the line AB is an example of a curve of isothermal expansion for a perfect gas, called for brevity an isothermal line, while AC is an adiabatic line starting from the same point A.

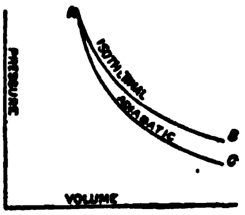

FIG. 11.

Carnot's cycle of operations.

40. We shall now consider the action of an ideal engine in which the working substance is a perfect gas, and is caused to pass through a cycle of changes each of which is either isothermal or adiabatic. The cycle to be described was first examined by Carnot, and is spoken of as Carnot's cycle of operations. Imagine a cylinder and piston composed of a perfectly non-conducting material, except as regards the bottom of the cylinder, which is a conductor. Imagine also a hot body or indefinitely capacious source of heat A, kept always at a temperature τ_1, a perfectly non-conducting cover B, and a cold body or indefinitely capacious receiver of heat C, kept always at a temperature τ_2, which is lower than τ_1. It is supposed that A, B, or C can be applied to the bottom of the cylinder. Let the cylinder contain 1 lb of a perfect gas, at temperature τ_1, volume V_a, and pressure P_a to begin with. The suffixes refer to the points on the indicator diagram, Fig. 12.

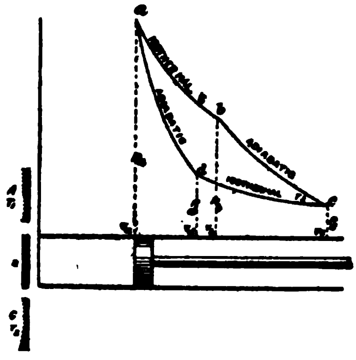

FIG. 12.—Carnot's Cycle, with a gas for working substance.

(1) Apply A, and allow the piston to rise. The gas expands isothermally at τ_1, taking heat from A and doing work. The pressure changes to P_b and the volume to V_b.

(2) Remove A and apply B. Allow the piston to go on rising. The gas expands adiabatically, doing work at the expense of its internal energy, and the temperature falls. Let this go on until the temperature is τ_2. The pressure is then P_c, and the volume V_c.

(3) Remove B and apply C. Force the piston down. The gas is compressed isothermally at τ_2, since the smallest increase of temperature above τ_2 causes heat to pass into C. Work is spent upon the gas, and heat is rejected to C. Let this be continued until a certain point d (Fig. 12) is reached, such that the fourth operation will complete the cycle.

(4) Remove C and apply B. Continue the compression, which is now adiabatic. The pressure and temperature rise, and if the point d has been properly chosen, when the pressure is restored to its original value P_a, the temperature will also have risen to its original value τ_1. [In other words, the third operation must be stopped when a point d is reached such that an adiabatic line drawn through d will pass through a.] This completes the cycle.

To find the proper place at which to stop the third operation, we have, by § 38, $\tau_1/\tau_2 = (V_c/V_b)^{\gamma-1}$ in the second operation, and again $\tau_1/\tau_2 = (V_d/V_a)^{\gamma-1}$ in the fourth operation. Hence $V_c/V_b = V_d/V_a$, and V_b/V_a, the ratio of isothermal expansion, is equal to V_c/V_d, the ratio of isothermal compression. For brevity we shall denote either of these last ratios by r.

41. The following are the transfers of heat to and from the working fluid, in successive stages of the cycle:

(1) Heat taken in from A $= c\tau_1 \log_e r$ (by § 39).
(2) No heat taken in or rejected.
(3) Heat rejected to C $= c\tau_2 \log_e r$ (by § 39).
(4) No heat taken in or rejected.

Hence, by the first law of thermodynamics, the net external work done by the gas is

$$c(\tau_1 - \tau_2)\log_e r;$$

and the efficiency of the engine (§ 23) is

$$\frac{c(\tau_1 - \tau_2)\log_e r}{c\tau_1 \log_e r} = \frac{\tau_1 - \tau_2}{\tau_1}.$$

This is the fraction of the whole heat given to it which an engine following Carnot's cycle converts into work. The engine takes in an amount of heat, at the temperature of the source, proportional to τ_1; it rejects an amount of heat, at the temperature of the receiver, proportional to τ_2. It works within a range of temperature extending from τ_1 to τ_2, by letting down heat from τ_1 to τ_2 (§ 24), and in the process it converts into work a fraction of that heat, which fraction will be greater the lower the temperature τ_2 at which heat is rejected is below the temperature τ_1 at which heat is received.

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[1] In calculations where this expression is involved it is convenient to remember that $\log_e$, the hyperbolic logarithm, of any number is 2.3026 times the common logarithm of the number.

Carnot's cycle reversed.

42. Next let us consider what will happen if we reverse Carnot's cycle, that is to say, if we force this engine to act so that the same indicator diagram as before is traced out, but in the direction opposite to that followed in § 40. Starting as before from the point *a* and with the gas at τ_1, we shall require the following four operations:

(1) Apply B and allow the piston to rise. The gas expands adiabatically, the curve traced is *ad*, and when *d* is reached the temperature has fallen to τ_2.

(2) Remove B and apply C. Allow the piston to go on rising. The gas expands isothermally at τ_2, taking heat from C, and the curve *dc* is traced.

(3) Remove C and apply B. Compress the gas. The process is adiabatic. The curve traced is *cb*, and when *b* is reached the temperature has risen to τ_1.

(4) Remove B and apply A. Continue the compression, which is now isothermal, at τ_1. Heat is now rejected to A, and the cycle is completed by the curve *ba*.

In this process the engine is not doing work; on the contrary, work is spent upon it equal to the area of the diagram, or $c(\tau_1 - \tau_2) \log_e r$. Heat is taken in from C in the first operation, to the amount $c\tau_2 \log_e r$. Heat is rejected to A in the fourth operation, to the amount $c\tau_1 \log_e r$. In the first and third operations there is no transfer of heat.

The action is now in every respect the reverse of what it was before. . The same work is now spent upon the engine as was formerly done by it. The same amount of heat is now given to the hot body A as was formerly taken from it. The same amount of heat is now taken from the cold body C as was formerly given to it, as will be seen by the following scheme:

Carnot's Cycle, Direct.

Work done by the engine $= c(\tau_1 - \tau_2) \log_e r$;
Heat taken from A $= c\tau_1 \log_e r$;
Heat rejected to C $= c\tau_2 \log_e r$.

Carnot's Cycle, Reversed.

Work spent upon the engine $= c(\tau_1 - \tau_2) \log_e r$;
Heat rejected to A $= c\tau_1 \log_e r$;
Heat taken from C $= c\tau_2 \log_e r$.

The reversal of the work has been accompanied by an exact reversal of each of the transfers of heat.

Reversible engine.

43. An engine in which this is possible is called, from the thermodynamic point of view, a *reversible* engine. In other words, a reversible heat-engine is one which, if forced to trace out its indicator diagram reversed in direction, so that the work which would be done by the engine, when running direct, is actually spent upon it, will reject to the source of heat the same quantity of heat as, when running direct, it would take from the source, and will take from the receiver of heat the same quantity as, when running direct, it would reject to the receiver. By "the source of heat" is meant the hot body which acts as source, and by "the receiver" is meant the cold body which acts as receiver, when the engine is running direct. Carnot's engine is one example of a reversible engine. The idea of thermodynamic reversibility is highly important, for the reason that no heat-engine can be more efficient than a reversible engine, if both take in and reject heat at the same pair of temperatures.

Reversibility the test of perfection in a heat-engine.

44. To prove this let it be supposed that we have two engines M and N, of which N is reversible in the above sense, and that we have a hot body A capable of acting as a source of heat, and a cold body C capable of acting as a receiver of heat. The engine M is set to work as a heat-engine, taking heat from A and rejecting heat to C. To prove that M cannot be more efficient than the reversible engine N, we shall assume that it *is* more efficient, and trace the consequences of that assumption.

Let M, working direct, be coupled so as to work N reversed; if we suppose that the engines are without mechanical friction, and can be coupled up without loss of power, the work represented by the indicator diagram of M is spent on N, and N will therefore reject to A an amount of heat which we will call Q_A and take from B an amount of heat which we will call Q_B. Now, since N is reversible, if it worked direct, taking Q_A from A, it would do the same amount of work as, in the supposed circumstances, is spent upon it. Hence, if M is more efficient than N it is taking from A an amount of heat *less* than Q_A, and consequently also is giving to B an amount of heat correspondingly less than Q_B. The joint effect, therefore, of M working direct and N working reversed is that the heat taken from A by M is less than the heat given to A by N, while the heat given to B by M is less (to an equal extent) than the heat taken from B by N. The consequence is that the hot body A is gaining heat on the whole, and the cold body B is losing an equal amount of heat; in other words, with the continued action of the double system heat passes, in indefinitely large quantity, from a cold body to a hot body, by means of an agency which, it is to be observed, is purely self-acting, for if we suppose there is no mechanical friction the system requires no help from without. Now this result is, by the second law of thermodynamics (§ 23), contrary to all experience; and we are forced to conclude that the assumption that M is more efficient than the reversible engine N, when both take in and reject heat at the same two temperatures, is false. Hence, with given temperatures of source and receiver of heat no engine is more efficient than a reversible engine.

Next, let M and N both be reversible and both work between the same limits, but be different in any other respect. Then by the foregoing argument M cannot be more efficient than N, neither can N be more efficient than M. Hence all reversible heat-engines taking in and rejecting heat at the same temperatures are equally efficient.

45. These results imply that reversibility, in the thermodynamic sense, is the criterion of what may be called perfection in a heat-engine. A reversible engine is perfect in the sense that it cannot be improved on as regards efficiency: no other engine, taking in and rejecting heat at the same temperatures, will convert into work a greater fraction of the heat which it takes in. Moreover, if this criterion be satisfied, it is as regards efficiency a matter of complete indifference what is the nature of the working substance, or what, in other respects, is the mode of the engine's action.

Efficiency of a perfect heat-engine.

46. Further, since all engines that are reversible are equally efficient, provided they work between the same temperatures, an expression for the efficiency of one will apply equally to all. Now, the engine whose efficiency we have found in § 41 is one example of a reversible engine. Hence its efficiency

$$(\tau_1 - \tau_2)/\tau_1$$

is the efficiency of any reversible heat-engine whatsoever taking in heat at τ_1 and rejecting heat at τ_2. And as no engine can be more efficient than one that is reversible, this expression is the measure of *perfect efficiency*. We have thus arrived at the immensely important conclusion that no heat-engine can convert into work a greater fraction of the heat which it receives than is expressed by the excess of the temperature of reception above that of rejection divided by the absolute temperature of reception.

Summary of the argument.

47. Briefly recapitulated the steps of the argument by which this result has been reached are as follows. After stating the experimental laws to which gases conform, we examined the action of a heat-engine in which the working substance took in heat when at the temperature of the source and rejected heat when at the temperature of the receiver, the change of temperature from one to the other of these limits being accomplished by adiabatic expansion and adiabatic compression. Taking a special case in which this engine had for its working substance a perfect gas, we found that its efficiency was $(\tau_1 - \tau_2)/\tau_1$ (§ 41). We also observed that it was, in the thermodynamic sense, a reversible engine (§ 43). Then we found, by an application of the second law of thermodynamics, that no heat-engine can have a higher efficiency than a reversible engine, when taking in and giving out heat at the same two temperatures τ_1 and τ_2; this was shown by the fact that a contrary assumption leads to a violation of the second law (§ 44). Hence, we concluded that all reversible heat-engines receiving and rejecting heat at the same temperatures τ_1 and τ_2 respectively are equally efficient, and hence that the efficiency $(\tau_1 - \tau_2)/\tau_1$, already determined for one particular reversible engine, measures the efficiency of any reversible engine, and is a limit of efficiency which no engine whatever can exceed.

Second law of thermodynamics.

48. The second law of thermodynamics, on which (along with the first law) this conclusion rests, has been given in many different forms. The statement of it in § 23 is that of Clausius, and is very similar to that of Sir W. Thomson. Rankine, to whom with Thomson and Clausius is due the development of the theory of heat-engines from the point at which Carnot left it, has stated the second law in

a form which is neither easy to understand, nor obvious, as an experimental result, when understood. His statement runs:

"If the absolute temperature of any uniformly hot substance be divided into any number of equal parts, the effects of those parts in causing work to be performed are equal."[1]

To make this intelligible we may suppose that any quantity q of heat from a source at temperature τ_1 is taken by the first of a series of perfect heat-engines, and that this engine rejects heat at a temperature τ_2 less than τ_1, by a certain interval $\Delta\tau$. Let the heat so rejected by the first engine form the heat supply of a second perfect engine working from τ_2 to τ_3 through an equal interval $\Delta\tau$; let the heat which it in turn rejects form the heat-supply of a third perfect engine working again through an equal interval from τ_3 to τ_4; and so on. The efficiencies of the several engines are (by § 46) $\frac{\Delta\tau}{\tau_1}, \frac{\Delta\tau}{\tau_2}, \frac{\Delta\tau}{\tau_3}$, etc. The amounts of heat supplied to them are q, $q\frac{\tau_2}{\tau_1}$, $q\frac{\tau_3}{\tau_2}$, etc. Hence the amount of work done by each engine is the same, namely, $q\frac{\Delta\tau}{\tau_1}$. Thus Rankine's statement is to be understood as meaning that each of the equal intervals into which any range of temperature may be divided is equally effective in allowing work to be produced from heat when heat is made to pass, doing work in the most efficient possible way, through all the intervals from the top to the bottom of the range.

Thermodynamic absolute measurement of temperature.

49. A point of much theoretical interest may be noted in passing. In place of measuring temperature, as we have done, by the expansion of a perfect gas, a scale of temperature might be formed thus. Starting from any one temperature, let a series of intervals be taken such that a series of reversible engines, each working with one of the intervals for its range, in the manner described in § 48 (so that the heat rejected by the first forms the supply of the second, and so on), will each do the same amount of work; then *call these intervals equal*. This gives a scale of temperature (originally suggested by Sir W. Thomson) which is truly absolute in the sense of being independent of the properties of any substance; it coincides, as is evident from § 48, with the scale we have been using, in which equal intervals of temperature are defined as those corresponding to equal amounts of expansion of a perfect gas under constant pressure; and it coincides approximately with the scale of a mercury thermometer when that is graduated to read from the absolute zero by the addition of a suitable constant (§ 29).

Conditions of maximum efficiency.

50. The availability of heat for transformation into work depends essentially on the range of temperature through which the heat is let down from the hot source to the cold body into which heat is rejected; it is only in virtue of a difference of temperature between bodies that conversion of any part of their heat into work becomes possible. If τ_1 and τ_2 are the highest and lowest temperatures of the range through which a heat-engine works, it is clear that the maximum of efficiency can be reached only when the engine takes in all its heat at τ_1 and rejects at τ_2 all that is rejected. With respect to every portion of heat taken in and rejected the greatest ideal efficiency is

$$=\frac{\text{Temperature of reception}-\text{temperature of rejection}}{\text{Temperature of reception.}}.$$

Any heat taken in at a temperature below τ_1 or rejected at a temperature above τ_2 will have less availability for conversion into work than if taken in at τ_1 and rejected at τ_2, and hence, with a given pair of limiting temperatures, it is essential to maximum efficiency that no heat be taken in by the engine except at the top of the range, and no heat rejected except at the bottom of the range. Further, as we have seen in § 45, when the temperatures at which heat is received and rejected are assigned, an engine attains the maximum of efficiency if it be reversible.

Conditions of reversibility.

51. It is therefore important to inquire more particularly what kinds of action are reversible in the thermodynamic sense. A little consideration will show that a transfer of heat from the source or to the receiver is reversible only when the working substance is at sensibly the same temperature as the source or the receiver, as the case may be, and an expansion is reversible only when it occurs by the gradual displacement of some part of the containing envelope in such a manner that the expanding fluid does external work on the envelope, and does not waste energy to any sensible extent in setting itself in motion. This excludes what may be termed free expansion, such as that of the gas in Joule's experiment, § 33, and it excludes also what may be called imperfectly-resisted expansion, such as would occur if the fluid were allowed to expand into a closed chamber in which the pressure was less than that of the fluid, or if the piston in a cylinder rose so fast as to cause, through the inertia of the expanding fluid, local variations of pressure throughout the cylinder.

To make a heat-engine, working within given limits of temperature, as efficient as possible we must therefore strive —(1) to take in no heat except at the highest temperature, and to reject no heat except at the lowest temperature; (2) to secure that the working substance shall, when receiving heat, be at the temperature of the body from which the heat comes, and that it shall, when giving up heat, be at the temperature of the body to which heat is given up; (3) to avoid free or imperfectly-resisted expansion. If these conditions are fulfilled the engine is a perfect heat-engine.

Temperature of working substance changed by adiabatic expansion or compression.

The first and second of these conditions are satisfied if in the action of the engine the working substance changes its temperature from τ_1 to τ_2 by adiabatic expansion, and from τ_2 to τ_1 by adiabatic compression, thereby being enabled to take in and reject heat at the ends of the range without taking in or rejecting any by the way. This is the action in Carnot's engine (§ 40).

Regenerative principle.

52. But if we can cause the working substance to deposit heat in some body within the engine while passing from τ_1 to τ_2, in such a manner that the transfer of heat from the substance to this body is reversible (satisfying the second condition above), then when we wish the working substance to pass from τ_2 to τ_1 we may reverse this transfer and so recover the heat that was deposited in this body. This alternate storing and restoring of heat may then take the place of adiabatic expansion and compression, in causing the temperature of the working substance to pass from τ_1 to τ_2 and from τ_2 to τ_1 respectively. The alternate storing and restoring is an action occurring wholly within the engine, and is therefore distinct from the taking in and rejecting of heat by the engine.

Stirling's regenerator.

53. In 1827 Robert Stirling designed an apparatus, called a *regenerator*, by which this process of alternate storing and restoring of heat could be actually performed. For the present purpose it will suffice to describe the regenerator as a passage through which the working fluid can travel in either direction, whose walls have a very large capacity for heat, so that the amount alternately given to or taken from them by the working fluid causes no more than an insensible rise or fall in their temperature. The temperature of the walls at one end of the passage is τ_1, and this tapers continuously down to τ_2 at the other end. When the working fluid at temperature τ_1 enters the hot end and passes through, it comes out at the cold end at temperature τ_2, having stored in the walls of the regenerator an amount of heat which it will pick up again when passed through in the opposite direction. During the return journey its temperature rises from τ_2 to τ_1. The process is strictly reversible, or rather would be so if the regenerator had an unlimited capacity for heat, if no conduction of heat took place along its walls from the hot to the cold end, and if no loss took place by conduction or radiation from its external surface.

Cycle in Stirling's engine.

54. Using air as the working substance, and employing his regenerator, Stirling made an engine (to be described later) which, allowing for practical imperfections, is the earliest example of a truly reversible engine. The cycle of operations in Stirling's engine is substantially this:

(1) Air (which has been heated to τ_1 by passing through the regenerator) is allowed to expand isothermally through a ratio r, taking in heat from a furnace and raising a piston. Heat taken in (per lb of air) $= c\tau_1 \log_e r$.

(2) The air is caused to pass through the regenerator from the hot to the cold end, depositing heat and having its temperature lowered to τ_2, without change of volume. Heat stored in regenerator $= K_p(\tau_1 - \tau_2)$. The pressure of course falls.

(3) The air is then compressed isothermally to its original volume at τ_2 in contact with a refrigerator (or receiver of heat). Heat rejected $= c\tau_2 \log_e r$.

(4) The air is again passed through the regenerator from the cold to the hot end, taking up heat and having its temperature raised to τ_1. Heat restored by the regenerator $= K_v(\tau_1 - \tau_2)$.

$$\text{Efficiency} = \frac{c\tau_1 \log_e r - c\tau_2 \log_e r}{c\tau_1 \log_e r} = \frac{\tau_1 - \tau_2}{\tau_1}.$$

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[1] *Manual of the Steam-Engine and other Prime Movers*, § 243.

The indicator diagram of the action is shown in Fig. 13, and a diagram of the engine is given in chap. XIV. Stirling's engine is important, not as a present-day heat-engine (though it has recently been revived in small forms after a long interval of disuse), but because it is typical of the only mode, other than Carnot's plan of adiabatic expansion and compression, by which the action of a heat-engine can be made reversible. Valuable as the regenerator has proved in metallurgy and other industrial processes, its actual application to heat-engines has hitherto been very limited. Another way of using it in air-engines was designed by John Ericsson, and attempts have been made by C. W. Siemens and F. Jenkin to apply it to steam-engines and to gas-engines. But almost all actual engines, in so far as they can be said to approach the condition of reversibility, do so, not by the use of the regenerative principle, but by more or less nearly adiabatic expansion and compression after the manner of Carnot's ideal engine.

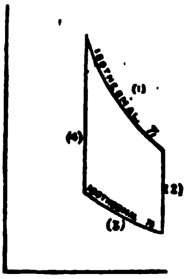

FIG. 13.—Air-engine with Regenerator (Stirling).

III. PROPERTIES OF STEAM AND THEORY OF THE STEAM-ENGINE.

Formation of steam under constant pressure.

55. We have now to consider the action of heat-engines in which the working substance is water and water-vapor or steam. The properties of steam are most conveniently stated by referring in the first instance to what happens when steam is formed *under constant pressure*. This is substantially the process which occurs in the boiler of a steam-engine when the engine is at work. To fix the ideas we may suppose that the vessel in which steam is to be formed is a long upright cylinder fitted with a piston which may be loaded so that it exerts a constant pressure on the fluid below. Let there be, to begin with, at the foot of the cylinder a quantity of water (which for convenience of numerical statement we shall take as 1 ℔), at any temperature t_0; and let the piston press on the surface of the water with a force of P ℔ per square foot. Let heat now be applied to the bottom of the cylinder. As it enters the water it will produce the following effects in three stages:

(1) The temperature of the water rises until a certain temperature t is reached, at which steam begins to be formed. The value of t depends on the particular pressure P which the piston exerts. Until the temperature t is reached there is nothing but water below the piston.

(2) Steam is formed, more heat being taken in. The piston (which is supposed to exert a constant pressure) rises. No further increase of temperature occurs during this stage, which continues until all the water is converted into steam. During this stage the steam which is formed is said to be *saturated*. The volume which the piston incloses at the end of this stage,—the volume, namely, of 1 ℔ of saturated steam at pressure P (and temperature t),—will be denoted by V in cubic feet.

(3) If after all the water is converted into steam more heat be allowed to enter, the volume will increase and the temperature will rise. The steam is then said to be *superheated*.

Saturated and superheated steam.

56. The difference between saturated and superheated steam may be expressed by saying that if water (at the temperature of the steam) be mixed with steam some of the water will be evaporated if the steam is superheated, but none if the steam is saturated. Any vapor in contact with its liquid and in thermal equilibrium is necessarily saturated. When saturated its properties differ considerably, as a rule, from those of a perfect gas, but when superheated they approach those of a perfect gas more and more closely the farther the process of superheating is carried, that is to say, the more the temperature is raised above t, the temperature of saturation corresponding to the given pressure P.

Relation of pressure and temperature in saturated steam.

57. The temperature t at which steam is formed depends on the value of P. Their relation was determined with great care by Regnault, in a series of classical experiments on which our knowledge of the properties of steam chiefly depends.[1] The pressure of saturated steam rises with the temperature at a rate which increases rapidly in the upper regions of the scale. This will be apparent from the first and second columns of Table II., given below, which is compiled from Rankine's reduction of Regnault's results. The first column gives the temperature on the Fahr. scale; the second gives the corresponding pressure in pounds per square inch. Rankine has also expressed the relation of temperature and pressure in saturated steam by the following formula (which is applicable with other constants to other vapors[2]):

$$\log p = 6.1007 - \frac{2732}{\tau} - \frac{396945}{\tau^2},$$

where p is the pressure in pounds per square inch, and τ is the absolute temperature in Fahr. degrees. For most purposes, however, it is more convenient to find the pressure corresponding to a given temperature, or the temperature corresponding to a given pressure, from the table by interpolation.

Relation of pressure and volume.

58. The same table shows the volume V, in cubic feet, occupied by 1 ℔ of saturated steam at each pressure. This is a quantity the direct experimental measurement of which is of very great difficulty. It may, however, be calculated, from a knowledge of other properties of steam, by a process which will be described later (§ 75). The values of V given in the table were determined by Rankine by means of this process; they agree fairly well with such direct observations of the density of steam as have been hitherto made.[3] The relation of P to V may be approximately expressed by the formula[4]

$$PV^{\frac{17}{16}} = \text{constant} = 68500 \text{ (nearly)},$$

when P is stated in ℔ per sq. ft. and V in cub. ft. per ℔.

TABLE II.—*Properties of Saturated Steam.*

Temperature.	Pressure.	Volume of 1 ℔.	Heat of Formation.	
			H.	λ.
Degrees F.	℔ per sq. in.	Cub. Ft.	Therm. Units	Therm. Units
32	0.065	3390	1091.8	0
41	0.122	2406	1094.5	9.0
50	0.173	1732	1097.3	18.0
59	0.241	1264	1100.0	27.0
68	0.333	935	1102.8	36.0
77	0.452	699	1105.5	45.0
86	0.607	529	1108.2	54.0
95	0.806	405	1111.0	63.0
104	1.06	313	1113.7	72.0
113	1.38	244	1116.5	81.0
122	1.78	192	1119.2	90.1
131	2.27	152.4	1121.9	99.1
140	2.88	122.0	1124.7	108.1
149	3.62	98.45	1127.4	117.1
158	4.51	80.02	1130.2	126.2
167	5 58	65.47	1132.9	135.2
176	6.87	53.92	1135.6	144.3
185	8.38	44.70	1138.4	153.3
194	10.16	37.26	1141.1	162.4
203	12.26	31.26	1143.9	171.4
212	14.70	26.36	1146.6	180.5
221	17.53	22.34	1149.3	189.6
230	20.80	19.03	1152.1	198.7
239	24.54	16.28	1154.8	207.8
248	28.83	14.00	1157.6	216.9
257	33.71	12.09	1160.3	226.0
266	39.25	10.48	1163.1	235.2
275	45.49	9.124	1165.8	244.3
284	52.52	7.973	1168.6	253.5
293	60.40	6.992	1171.3	262.7
302	69.21	6.153	1174.1	271.9
311	79.03	5.433	1176.8	281.1
320	89.86	4.816	1179.5	290.3
329	101.9	4.280	1182.2	299.5
338	115.1	3.814	1185.0	308.7
347	129.8	3.410	1187.7	318.0
356	145.8	3.057	1190.4	327.3
365	163.3	2.748	1193.2	336.6
374	182.4	2.476	1195.9	345.9
383	203.3	2.236	1198.6	352.2
392	225.9	2.025	1201.4	364.5
401	250.3	1.838	1204.1	373.9
410	276.9	1.672	1206.9	383.2
419	305.5	1.525	1209.6	392.6
428	336.3	1.393	1212.4	402.0

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[1] *Mem. Inst. France*, 1847, vol. xxi. An account of Regnault's methods of experiment and a statement of his results expressed in British measures will be found in Dixon's *Treatise on Heat*.

[2] *Phil. Mag.*, Dec., 1854, or *Manual of the Steam-Engine*, p. 237.

[3] See Fairbairn and Tate, "On the Density of Steam at Different Temperatures," *Phil. Trans.*, vol. cl., 1860.

[4] This is Rankine's formula. Zeuner gives $PV^{1.0646}$ = constant.

Supply of heat in formation of steam under constant pressure.

59. We have next to consider the supply of heat. During the first stage, until the temperature rises from its initial value t_0 to t, the temperature at which steam begins to form under the given pressure, heat is required only to warm the water. Since the specific heat of water is nearly constant, the amount of heat taken in during the first stage is approximately $t - t_0$ thermal units or $J(t - t_0)$ foot-pounds, J being Joule's equivalent (§ 23), and this expression for it will generally serve with sufficient accuracy in practical calculations. More exactly, however, the heat taken in is somewhat greater than this, for Regnault's experiments show that the specific heat of water increases slightly as the temperature rises. In stating the amount of heat required for this first stage, t_0 must be taken as a known temperature; for convenience in numerical statement the temperature 32° F. is usually chosen as an arbitrary starting-point from which the reception of heat is to be reckoned. We shall employ the symbol h to designate the heat required to raise 1 ℔ of water from 32° F. to the temperature t at which steam begins to form. The value of h in thermal units is given, approximately, by the equation

$$h = t - 32.$$

More exact values, which take account of the variation in the specific heat of water, will be found in the last column of Table II. During the first stage, sensibly all the heat supplied goes to increase the stock of internal energy which the fluid possesses, the amount of external work which is done by the expansion of the fluid being negligible.

Latent heat.

60. The heat taken in during the second stage is what is called the *latent heat* of steam, and is denoted by L. Of it a part is spent in doing external work,—namely, P multiplied by the excess of the volume of the steam over the volume of the water,—and the remainder is the difference of internal energy between 1 ℔ of steam at t and 1 ℔ of water at t. The volume of 1 ℔ of water, at such temperatures as are usual in steam-engines, is nearly 0.017 cubic feet. We may therefore write the external work (in foot-pounds) done during the production of 1 ℔ of steam under constant pressure P,—

$$\text{External work} = P(V - 0.017).$$

Total heat of steam.

61. Adding together the heat taken in during the first and second stages we have a quantity designated by H and called the *total heat* of 1 ℔ of saturated steam:

$$H = h + L.$$

Regnault's values of H are very accurately expressed (in thermal units) by the formula

$$H = 1082 + 0.305\,t.$$

They are given in the fourth column of Table II. A similar formula gives approximate values of L, exact enough for use in practical calculations,—

$$L = 1114 - 0.7\,t.$$

The total heat of formation of 1 ℔ of steam, when formed under constant pressure from water at any temperature t_0, is of course $H - h_0$, where h_0 corresponds to t_0.

Internal energy.

62. Of the whole latent heat of steam, L, the part $P(V - 0.017)$ is, as has been said above, spent in doing external work. The remainder (in foot-pounds)—

$$JL - P(V - 0.017)—$$

is the change of internal energy which the substance undergoes during evaporation. This quantity, for which it is convenient to have a separate symbol, will be denoted by ρ in thermal units, or $J\rho$ in foot-pounds. In dealing with the heat required to produce steam we adopted the state of water at 32° F. as an arbitrary starting-point from which to reckon the reception of heat. In the same way it is convenient to use this arbitrary starting-point in reckoning what may be called the *internal energy* of the substance, which is the excess of the heat taken in over the external work done by the substance during its reception of heat. Thus the internal energy I of 1 ℔ of saturated steam at pressure P is equal to the total heat H, less that part of the total heat which is spent in doing external work, or (in foot-pounds)

$$JI = JH - P(V - 0.017),$$

or

$$I = L + h - P(V - 0.017)/J = h + \rho.$$

The notion of internal energy is useful in calculating the heat taken in or rejected by steam during any stage of its expansion or compression in an engine. When a working substance passes from one condition to another, its gain or loss of heat is determined by the equation

$$\text{Heat taken in} = \text{increase of internal energy} + \text{external work}.$$

Any of the terms of this equation may be negative; the last term is negative when work is done, not by, but upon the substance.

Heat of formation under any conditions.

63. The same equation gives the means of finding the amount of heat required to form steam under any assigned conditions in place of the condition assumed at the beginning of this chapter, where the formation of steam under constant pressure was considered. Whatever be the condition as to pressure under which the process of formation is carried on, the total heat required is the sum of the internal energy of the steam when formed and the work done by the substance during the process. Thus in general

$$\text{Heat of formation} = I + J^{-1}\int P\,dV,$$

the limits of integration being the final volume of the steam and the original volume of the water. When steam is formed in a closed vessel of constant volume no external work is done; the heat of formation is then equal to the internal energy, and is less than the total heat of formation (H) of steam, when formed at a constant pressure equal to the pressure reached in the vessel, by the quantity $P(V - 0.017)$.

Wet steam.

64. In calculations which relate to the action of steam in engines we have generally to deal, not with *dry* saturated steam, but with *wet* steam, or steam which either carries in suspension, or is otherwise mixed with, a greater or less proportion of water. In every such mixture the steam and water have the same temperature, and the steam is saturated. The dryness of wet steam is measured by the proportion q of dry steam in each pound of the mixed substance. When that is known it is easy to determine the other physical constants: thus:

Latent heat of 1 ℔ of wet steam $= qL$;
Total heat of 1 ℔ of wet steam $= h + qL$;
Volume of 1 ℔ of wet steam $= qV + (1 - q)0.017$.
$= qV$ very nearly,
unless the steam is so wet as to consist mainly of water;
Internal energy of 1 ℔ of wet steam $= h + q\rho$.

Superheated steam.

65. Steam is superheated when its temperature is raised, in any manner, above the temperature corresponding to saturation at the actual pressure. When much superheated, steam behaves like a perfect gas, and may be called "steam gas." It then follows the equation

$$PV = 85.5\,\tau,$$

and the specific heat at constant pressure, K_p, is 371 foot-pounds or 0.48 thermal unit. At very low temperatures steam approximates closely to the condition of a perfect gas when very slightly superheated, and even when saturated; at high temperatures a much greater amount of superheating is necessary to bring about an approach to the perfectly gaseous state. The total heat required for the production of superheated steam under any constant pressure, when the superheating is sufficient to bring the steam to the state of steam gas, may therefore be reckoned by taking the total heat of saturated steam at a low temperature and adding to it the product of K_p into the excess of temperature above that. Thus Rankine, treating saturated steam at 32° F. as a gas, gives the formula

$$H' = 1092 + 0.48\,(t' - 32)$$

to express the heat of formation (under any constant pressure) of superheated steam, at any temperature t' which is so much above the temperature of saturation corresponding to the actual pressure that the steam may be treated as a perfect gas. Calculated from its chemical composition, the density of steam gas should be 0.622 times that of air at the same pressure and temperature. The value of γ or K_p/K_v for steam gas is 1.3. These formulas, dealing as they do with steam which is so highly superheated as to be perfectly gaseous, fail to apply to high-pressure steam that is heated but little above its temperature of saturation. The relation of pressure to volume and temperature in the region which lies between the saturated and the perfectly gaseous states has been experimented on by Hirn.[1] Formulas which are applicable with more or less accuracy to steam in either the saturated or superheated condition have been devised by Hirn, Zeuner,[2] Ritter,[3] and others.

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[1] *Théorie Mécanique de la Chaleur.*

[2] *Ztschr. d. Vereins deutscher Ingenieure*, vol. xi.

[3] *Wied. Ann.*, 1878. For a discussion of several of these formulas, see a paper by H. Dyer, *Trans. Inst. of Engineers and Shipbuilders in Scotland*, 1885.

Isothermal expansion of steam.

66. The expansion of volume which occurs during the conversion of water into steam under constant pressure—the second stage of the process described in § 55—is isothermal. From what has been already said it is obvious that steam, or any other saturated vapor, can be expanded or compressed isothermally only when wet, and that evaporation (in the one case) or condensation (in the other) must accompany the process. Isothermal lines for a working substance which consists of a liquid and its vapor are straight lines of uniform pressure.

Adiabatic expansion of steam.

67. The form of adiabatic lines for substances of the same class depends not only on the particular fluid, but also on the proportion of liquid to vapor in the mixture. In the case of steam, it has been shown by Rankine and Clausius that if steam initially dry be allowed to expand adiabatically it becomes wet, and if initially wet (unless very wet[1]) it becomes wetter. A part of the steam is condensed by the process of adiabatic expansion, at first in the form of minute particles suspended throughout the mass. The temperature and pressure fall; and, as that part of the substance which remains uncondensed is saturated, the relation of pressure to temperature throughout the expansion is that which holds for saturated steam. The following formula, proved by Rankine[2] and Clausius[3] (see § 75), serves to calculate the extent to which condensation takes place during adiabatic expansion, and so allows the relation of pressure to volume to be determined.

Before expansion, let the initial dryness of the steam be q_1 and its absolute temperature τ_1. Then, if it expand adiabatically until its temperature falls to τ, its dryness after expansion is

$$q = \frac{\tau}{L}\left(\frac{q_1 L_1}{\tau_1} + \log_e \frac{\tau_1}{\tau}\right).$$

L_1 and L are the latent heats (in thermal units) of 1 ℔ of steam before and after expansion respectively. When the steam is dry to begin with, $q_1 = 1$.

This formula is easily applied to the construction of the adiabatic curve when the initial pressure and the pressure after expansion are given, the corresponding values τ and L being found from the table. It is less convenient if the data are the initial pressure and the initial and final volumes, or the initial pressure and the ratio of expansion r. An approximate formula more appropriate in that case is

$$Pv^n = \text{constant, or } P/P_1 = (v/v_1)^n = r^n.$$

Here v and v_1 denote the volume of 1 ℔ of the mixture of steam and water before and after expansion respectively, and are to be distinguished from V and V_1, which we have already used to denote the volume of 1 ℔ of dry saturated steam at pressures P and P_1. The index n has a value which depends on the degree of initial dryness q_1.

According to Zeuner,[4] $n = 1.035 + 0.1q_1$, so that for

$q_1 =$ 1	0.95	0.9	0.85	0.8	0.75	0.7
$n =$ 1.135	1.130	1.125	1.120	1.115	1.110	1.105.

Rankine gave for this index the value $\frac{10}{9}$, which is too small if the steam be initially dry. He determined it by examining the expansion curves of indicator diagrams taken from working steam-engines; but, as we shall see later, the expansion of steam in an actual engine is by no means adiabatic, on account of the transfer of heat which goes on between the working fluid and the metal of the cylinder and piston. When it is desired to draw an adiabatic curve for steam, that value of n must be chosen which refers to the degree of dryness at the beginning of the expansion.

Carnot's cycle with steam for working substance.

68. We are now in a position to study the action of a heat-engine employing steam as the working substance. To simplify the first consideration as far as possible, let it be supposed that we have, as before, a long cylinder composed of non-conducting material except at the base, and fitted with a non-conducting piston; also a source of heat A at some temperature τ_1; a receiver of heat or, as we may now call it, a condenser C, at a lower temperature τ_2; and a non-conducting cover B (as in § 40). Then we can perform Carnot's cycle of operations as follows. To fix the ideas, suppose that there is 1 ℔ of water in the cylinder to begin with, at the temperature τ_1:

(1) Apply A, and allow the piston to rise. The water will take in heat and be converted into steam, expanding isothermally at constant pressure P_1. This part of the operation is shown by the line *ab* in Fig. 14.

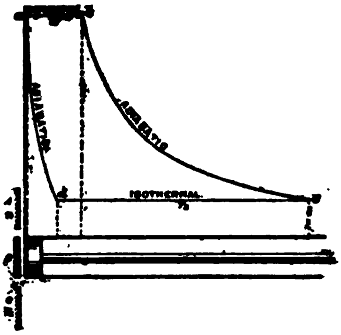

FIG. 14.—Carnot's Cycle with water and steam for working substance.

(2) Remove A and apply B. Allow the expansion to continue adiabatically (*bc*), with falling pressure, until the temperature falls to τ_2. The pressure will then be P_2, corresponding (in Table II.) to τ_2.

(3) Remove B, apply C, and compress. Steam is condensed by rejecting heat to C. The action is isothermal, and the pressure remains P_2. Let this be continued until a certain point *d* is reached, after which adiabatic compression will complete the cycle.

(4) Remove C and apply B. Continue the compression, which is now adiabatic. If the point *d* has been rightly chosen, this will complete the cycle by restoring the working fluid to the state of water at temperature τ_1.

The indicator diagram for the cycle is given in Fig. 14, as calculated by the help of the equations in § 67 and of Table II. for a particular example, in which $p_1 = 90$ ℔ per square inch ($\tau_1 = 781$), and the expansion is continued down to the pressure of the atmosphere, 14.7 ℔ per square inch ($\tau_2 = 673$). Since the process is reversible, and since heat is taken in only at τ_1 and rejected only at τ_2, the efficiency is $(\tau_1 - \tau_2)/\tau_2$. The heat taken in per ℔ of the fluid is L_1, and the work done is $L_1(\tau_1 - \tau_2)/\tau_1$, a result which may be used to check the calculation of the diagram.

Efficiency of a perfect steam-engine.

Limits of temperature.

69. If the action here described could be realised in practice, we should have a thermodynamically perfect steam-engine using saturated steam. The fraction of the heat supplied to it which such an engine would convert into work would depend simply on the temperature, and therefore on the pressure at which the steam was produced and condensed. The temperature of condensation is limited by the consideration that there must be an abundant supply of some substance to absorb the rejected heat; water is actually used for this purpose, so that τ_2 has for its lower limit the temperature of the available water-supply.

To the higher temperature τ_1 and pressure P_1 no limit can be set except such as is brought about in practice by the mechanical difficulties, with regard to strength and to lubrication, which attend the use of high-pressure steam. By a very special construction of engine and boiler Mr. Perkins has been able to use steam with a pressure as high as 500 ℔ per square inch; with engines of the usual construction the value ranges from 190 ℔ downwards.

If the temperature of condensation be taken as 60° F., as a lower limit, the efficiency of a perfect steam-engine, using saturated steam, would depend on the value of P_1, the absolute pressure of production of the steam, as follows:

For perfect steam-engine, with condensation at 60° F.,

P_1 in ℔ per square inch being	40	80	120	160	200
Highest ideal efficiency =	.284	.326	.350	.368	.381

But it must not be supposed that these values of the efficiency are actually attained, or are even attainable. Many causes conspire to prevent steam-engines from being thermodynamically perfect, and some of the causes of imperfection cannot be removed. These numbers will serve, however, as a standard of comparison in judging of the performance of actual engines, and as setting forth the advantage of high-pressure steam from the thermodynamic point of view.

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[1] Prof. Cotterill, in his *Treatise on the Steam-Engine*, § 79, has calculated (using the equation which follows in the text) that, when a mixture of steam and water expands adiabatically, steam condenses if the proportion of steam be, roughly, over 50 per cent., but water is evaporated if the proportion of steam be less than about 50 per cent. The exact proportion depends on the initial pressure.

[2] *Steam-Engine*, § 281.

[3] *Mechanical Theory of Heat* (tr. by W. R. Browne), chap. vi. § 12.

[4] *Grundzüge der Mech. Wärmetheorie*, p. 342. See also Grashof, *Resultate aus der Mech. Wärmetheorie*, § 87. In the adiabatic compression of wet steam $n = 1.034 + 0.11q_1$ where q_1 is the dryness at the beginning of compression.

Efficiency of an engine using steam non-expansively.

70. As a contrast to the ideally perfect steam-engine of § 68 we may next consider a cyclic action such as occurred in the early engines of Newcomen or Leupold, when steam was used non-expansively,—or rather, such an action as would have occurred in engines of this type had the cylinder been a perfect non-conductor of heat. Let the cycle of operations be this:

(1) Apply A and evaporate the water as before at P_1. Heat taken in $= L_1$.

(2) Remove A and apply C. This at once condenses a part of the steam, and reduces the pressure to P_2.

(3) Compress at P_2, in contact with C, till condensation is complete, and water at τ_2 is left.

(4) Remove B and apply A. This heats the water again to τ_1 and completes the cycle. Heat taken in $= h_1 - h_2$.

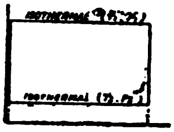

FIG. 15.

The indicator diagram for this series of operations is shown in Fig. 15.

Here the action is not reversible. To calculate the efficiency, we have

$$\frac{\text{Work done}}{\text{Heat taken in}} = \frac{(P_1 - P_2)(V_1 - 0.017)}{J(L_1 + h_1 - h_2)}.$$

The values of this will be found to range from 0.067 to 0.072 for the values of P_1 which are stated in § 69, when the temperature of condensation is 60° F.

Engine with separate organs.

71. In the ideal engine represented in Fig. 14 the functions of boiler, cylinder, and condenser are combined in a single vessel; but after what has been said in chap. II. it is scarcely necessary to remark that, provided the working substance passes through the same cycle of operations, it is indifferent whether these are performed in several vessels or in one. To approach a little more closely the conditions that hold in practice, we may think of the engine which performs the cycle of § 70 as consisting of a boiler A (Fig. 16) kept at τ_1, a non-conducting cylinder and piston B, a surface condenser C kept at τ_2, and a feed-pump D which restores the water of condensation to the boiler. Then for every pound of steam supplied and used non-expansively as in § 70, we have work done on the piston $= (P_1 - P_2) V_1$; but an amount of work has to be expended in driving the feed-pump $= (P_1 - P_2)$ 0.017. Deducting this, the net work done per lb. of steam is the same as before, and the heat taken in is also the same. An indicator diagram taken from the cylinder would give the area *efgh* (Fig. 17), where $oe = P_1$, $ef = V_1$, $oh = P_2$; an indicator diagram taken from the pump would give the negative area *hjie*, where *ei* is the volume of the feed-water, or 0.017 cub. ft. The difference, namely, the shaded area, is the diagram of the complete cycle gone through by each pound of the working substance. In experimental measurements of the work done in steam-engines, only the action which occurs within the cylinder is shown on the indicator diagram. From this the work spent on the feed-pump is to be subtracted in any accurate determination of the thermodynamic efficiency. If the feed-water is at any temperature τ_0 other than that of the condenser as assumed in § 70, it is clear that the heat taken in is $H_1 - h_0$ instead of $H_1 - h_2$.

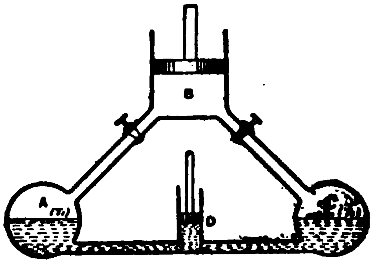

FIG. 16.—Organs of a Steam-Engine.

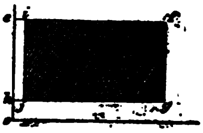

FIG. 17.

How nearly may the process be reversible?

72. We have now to enquire how nearly, with the engine of Fig. 16 (that is to say, with an engine in which the boiler and condenser are separate from the cylinder), we can approach the reversible cycle of § 68. The first stage of that cycle corresponds to the *admission* of steam from the boiler into the cylinder. Then the point known as the point of *cut-off* is reached, at which admission ceases, and the steam already in the cylinder is allowed to expand, exerting a diminishing pressure on the piston. This is the second stage, or the stage of *expansion*. The process of expansion may be carried on until the pressure falls to that of the condenser, in which case the expansion is said to be complete. At the end of the expansion *release* takes place, that is to say, communication is open with the condenser. Then the return stroke begins, and a period termed the *exhaust* occurs, that is to say, steam passes out of the cylinder, into the condenser, where it is condensed at pressure P_2, which is felt as a *back pressure* opposing the return of the piston. So far, all has been essentially reversible, and identical with the corresponding parts of Carnot's cycle.

But we cannot complete the cycle as Carnot's cycle was completed. The existence of a separate condenser makes the fourth stage, that of adiabatic compression, impracticable, and the best we can do is to continue the exhaust until condensation is complete, and then return the condensed water to the boiler by means of the feed-pump.

It is true that we may, and in actual practice do, stop the exhaust before the return stroke is complete, and compress that portion of the steam which remains below the piston, but this does not materially affect the thermodynamic efficiency; it is done partly for mechanical reasons, and partly to avoid loss of power through clearance (see chap. IV.). In the present instance it is supposed that there is no clearance, in which case this compression is out of the question. The indicator diagram given by a cylinder in which steam goes through the action described above is shown to scale in Fig. 18 for a particular example, in which it is supposed that 1 cubic foot of dry saturated steam is admitted at an absolute pressure of 90 lbs. per square inch, and is expanded twelve times, or down to a pressure of 5.4 lb. per square inch, at which pressure it is discharged to the condenser. As we have assumed the cylinder to be non-conducting, and the steam to be initially dry, the expansion follows the law $PV^{1 \cdot 135} =$ constant. The advantage of expansion is obvious, that part of the diagram which lies under the curve being so much clear gain.

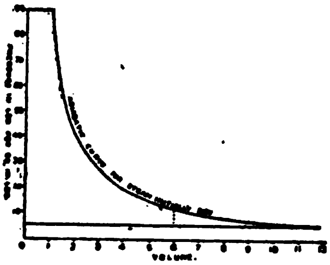

FIG. 18.—Ideal Indicator Diagram for Steam used expansively.

Efficiency of engine working expansively.

73. To calculate the efficiency, we have

Work done per lb. during admission $= P_1 V_1$;

Work done per lb. during expansion to volume

$$rV_1 = \frac{P_1 V_1 - P_2 r V_1}{n - 1}, \text{ (by § 36)}, = (P_1 V_1 - P_2 r V_1)/0.135;$$

Work spent during return stroke $= P_2 r V_1$;

Work spent on the feed-pump $= (P_1 - P_2) 0.017$;

Heat taken in $= H_1 - h_0$.

Incomplete expansion.

74. These expressions refer to complete expansion. When the expansion is incomplete, as it generally is, the expression given above for the work done during expansion still applies if we take P_2 to be the pressure at the end of expansion, while the work spent on the steam during the back-stroke is $P_3 r V_1$ and that spent on the feed-pump is $(P_1 - P_3)$0.017, P_3 being the back pressure. Incomplete expansion is illustrated by the dotted line in Fig. 18.

It is easy by the aid of §§ 64 and 67 to extend these calculations to cases where the steam, instead of being initially dry, is supposed to have any assigned degree of wetness. The efficiency which is calculated in this way, which for the present purpose may be called the theoretical efficiency corresponding to the assumed conditions of working, is always much less than the ideal efficiency of a perfect engine, since the cycle we are now dealing with is not reversible. But even this theoretical efficiency short as it falls of the ideal of a perfect engine, is far greater than can be realized in practice when the same boiler and condenser temperatures are used, and the same ratio of expansion. The reasons for this will be briefly considered in the next chapter; at present the fact is mentioned to guard the reader from supposing that the results which the above formulas give apply to actual engines.

Calculation of density of saturated steam.

75. The results of § 68 have been turned to account by Rankine and Clausius for the purpose of deducing the density of steam from other properties which admit of more exact direct measurement. Let the perfect steam-engine there described work through a very small interval of temperature $\Delta\tau$ between two temperatures τ and $\tau-\Delta\tau$. The efficiency is $\Delta\tau/\tau$, and the work done (in foot-lbs.) is $JL\Delta\tau/\tau$. The indicator diagram is now reduced to a long narrow strip, whose length is $V-0.017$ and its breadth ΔP, the difference in pressure between steam at temperatures τ and $\tau-\Delta\tau$. Hence the work done is also $\Delta P(V-0.017)$, and therefore

$$V-0.017=\frac{JL}{\tau}\cdot\frac{\Delta\tau}{\Delta P}.$$

Here $\frac{\Delta\tau}{\Delta P}$, or (in the limit) $\frac{d\tau}{dP}$, is the rate of increase of temperature with increase of pressure in saturated steam at the particular temperature τ. It may be found roughly from Table II., p. 484, or more exactly by differentiating the equation given in § 57. L is also known, and hence the value of V corresponding to any assigned temperature may be calculated with a degree of accuracy which it would be difficult to reach in direct experiment. The volumes given in the Table are determined in this way.[1]

IV. ACTUAL BEHAVIOR OF STEAM IN THE CYLINDER.

Actual indicator diagram.

76. In Fig. 18 we have what might be called a first approximation to the theoretical indicator diagram of a steam-engine. In the action then described it was assumed: (1) that the steam supplied was dry and saturated, and had during admission the full (uniform) pressure of the boiler P_1; (2) that there was no transfer of heat to or from the steam except in the boiler and in the condenser; (3) that after more or less complete expansion all the steam was discharged by the return stroke of the piston, during which the back pressure was the (uniform) pressure in the condenser P_2; (4) that the whole volume of the cylinder was swept through by the piston. It remains to be seen how far these assumptions are untrue in practice, and how far the efficiency is affected in consequence.

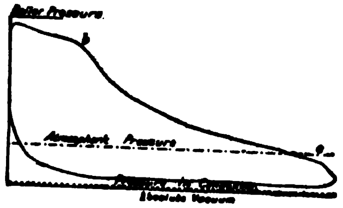

FIG. 19.—Actual Indicator Diagram from a Condensing Steam-Engine.

The actual conditions of working differ from these in the following main respects, some of which are illustrated by the practical indicator diagram of Fig. 19, which is taken from an actual engine.

Wire-drawing.

77. Owing to the resistance of the ports and passages, and to the inertia of the steam, the pressure within the cylinder is less than P_1 during admission, and greater than P_2 during exhaust. Moreover P_1 and P_2 are themselves not absolutely uniform, and P_2 is greater than the pressure of steam at the temperature of the condenser, on account of the presence of air in the condenser.

During admission the pressure of steam in the cylinder is less than the boiler pressure by an amount which increases as the piston advances, on account of the increased velocity of the piston's motion and the consequent increased demand for steam. When the ports and passages offer much resistance the steam is expressively said to be throttled or "wire-drawn." Wire-drawing of steam is in fact a case of imperfectly-resisted expansion (§ 51). The steam is dried by the process to a small extent, and if initially dry it becomes superheated. In an indicator diagram wire-drawing causes the line of admission to lie below a line drawn at the boiler pressure and to slope downwards. In fairly good practical instances the mean absolute pressure during admission is about nine-tenths of the pressure in the boiler.

In the same way, during the exhaust the actual back pressure exceeds the pressure in the condenser (shown by a dotted line in Fig. 19) by an amount depending on the freedom with which the steam makes its exit from the cylinder. In condensing engines with a good vacuum the actual back pressure is from 3 to 5 ℔ per square inch, and in non-condensing engines it is 16 to 18 ℔ in place of the mere 14.7 ℔ which is the pressure of the atmosphere. The excess of back pressure may be greatly increased by the presence of water in the cylinder. The effects of wire-drawing do not stop here. The valves open and close more or less slowly; the points of cut-off and release are therefore not absolutely sharp, and the diagram has rounded corners at *b* and *e* in place of the sharp angles which mark those events in Fig. 18. For this reason release is allowed in practice to occur a little before the end of the forward stroke, hence the toe of the diagram takes a form like that shown in Fig. 19. The sharpness of the cut-off, and to a less extent the sharpness of the release, depends greatly on the kind of valves and valve-gear used; valves of the Corliss type (to be described later), which are noted for the suddenness with which admission of steam is stopped, have the merit amongst others of producing a very sharply defined diagram.

Clearance.

78. When the piston is at either end of its stroke there is a small space left between it and the cylinder cover. This space, together with the volume of the passage or passages leading thence to the steam and exhaust valves, is called the *clearance*. It constitutes a volume through which the piston does not sweep, but which is nevertheless filled with steam when admission occurs, and the steam in the clearance forms a part of the whole steam which expands after the supply from the boiler is cut-off. If AC be the volume swept through by the piston up to release, OA the volume of the clearance, and AB the volume swept through during admission, the apparent ratio of expansion is AC/AB, but the real ratio is (OA + AC)/OA + AB).

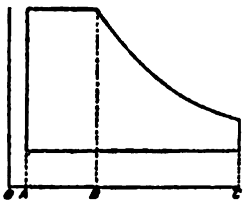

FIG. 20.—Effect of Clearance.

Clearance must obviously be taken account of in any calculation of curves of expansion. It is conveniently allowed for in indicator diagrams by shifting the line of no volume back through a distance corresponding to the clearance (Fig. 20). In actual engines OA is from $\frac{1}{10}$ to $\frac{1}{50}$ of the volume of the cylinder.

Compression and cushioning.

79. Clearance affects the thermodynamic efficiency of the engine chiefly by altering the consumption of steam per stroke, and its influence depends materially on the *compression* (§ 72). If during the back stroke the process of exhaust is discontinued before the end, and the remaining steam is compressed, this cushion of steam will finally fill the volume of the clearance; and by a proper selection of the point at which compression begins the pressure of the cushion may be made to rise just up to the pressure at which steam is admitted when the valve opens. This may be called complete compression, and when it occurs the existence of clearance has no direct effect on the consumption of steam nor on the efficiency; the whole fluid in the cylinder may then be thought of as consisting of two parts,—a permanent cushion which is alternately expanded and compressed without net gain or loss of work, and the working part proper, which on admission fills the volume AB (Fig. 20), and which enters and leaves the cylinder in each stroke. But if compression be incomplete or absent there is, on the opening of the admission valve, an inrush of steam to fill up the clearance space. This increases the consumption to an extent which is only partly counterbalanced by the increased area of the diagram, and the result is that the efficiency is reduced. The action is, in fact, a case of unresisted expansion (§ 51), and consequently tends, so far as its direct effects go, to make the engine less than ever reversible. It is to be noted, however, that by such unresisted expansion the entering steam is dried to some extent, and this helps in a measure to counteract the cause of loss which will be described below. Compression has the mechanical advantage that it obviates the shock which the admission of steam would otherwise

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[1] The result of § 75 may be applied as follows to give the formula of § 67 for the adiabatic expansion of wet steam. For brevity we may write $V-0.017=u$. In adiabatic expansion the work done is equal to the loss of internal energy, or

$$Pd(qu)=-JdI=-Jd(h+q\rho).$$

Since $dh=d\tau$, and $\rho=L-Pu/J$, this may be written $Jd\tau+Jd(qL)-qudP=0$.

By § 75, $udP=\frac{JL}{\tau}d\tau$; hence $1+\frac{d}{d\tau}(qL)-\frac{qL}{\tau}=0$;

and by integration,

$$\log_e\tau+qL/\tau=\text{constant}=\log_e\tau_1+q_1L_1/\tau_1,$$

which is the equation of § 67.

cause, and that by giving the piston work to do while its velocity is being rapidly reduced it reduces those stresses in the mechanism which are due to the inertia of the reciprocating parts.

Influence of cylinder walls.

80. The third and generally by far the most important element of difference between the action of a real engine and that of our hypothetical engine is that alluded to at the end of chap. I., the difference which proceeds from the fact that the cylinder and piston are not non-conductors. As the steam fluctuates in temperature there is a complex give-and-take of heat between it and the metal it touches, and the effects of this, though not very conspicuous on the indicator diagram, have an enormous influence in reducing the efficiency by increasing the consumption of steam. Attention was drawn to this action by Mr. D. K. Clark as early as 1855 (*Railway Machinery*, or art. STEAM-ENGINE, *Ency. Brit.*, 8th edition[1]), and the results of his experiments on locomotives were confirmed some years later by Mr. Benj. F. Isherwood's trials of the engines of the United States steamer "Michigan." Rankine in his classical work on the steam-engine notices the subject only very briefly, and takes no account of the action of the cylinder walls in his calculations. Its importance has now been established beyond dispute, notably by the experiments of Messrs. Charles H. Loring and Emery on the engines of certain revenue steamers of the United States,[2] and by a protracted series of investigations carried out by M. Hallauer and other Alsatian engineers under the direction of Hirn,[3] whose name should be specially associated with the rational analysis of engine tests. In the next chapter some account will be given of how steam-engines are experimentally examined and how (following Hirn) we may deduce the exchanges of heat which occur between the steam and the cylinder throughout the stroke. The following is, in general terms, what experiments with actual engines show to take place.

Initial condensation.

81. When steam is admitted at the beginning of the stroke, it finds the metallic surfaces of the cylinder and piston chilled by having been in contact with low-pressure steam during the exhaust of the previous stroke. A portion of it is therefore liquefied, and, as the piston advances, more and more of the chilled cylinder surface is exposed and more and more of the hot steam is condensed. At the end of the admission, when communication with the boiler is cut off, the cylinder consequently contains a film of water spread over the exposed surface, in addition to saturated steam. The boiler has therefore been drawn upon for a supply greater than that corresponding to the volume of steam in the admission space. The importance of this will be obvious from the fact, demonstrated by experiment, that the steam which is thus condensed during admission frequently amounts to 30 and even 50 per cent. of the whole quantity that comes over from the boiler.

Re-evaporation.

82. Then, as expansion begins, more cold metal is uncovered, and some of the remaining steam is condensed upon it. But the pressure of the steam now falls, and the layer of water which has been previously deposited begins to be re-evaporated as soon as the temperature of the expanding steam falls below that of the liquid layer. On the whole, then, the amount of water present will increase during the earliest part of the expansion, but a stage will soon be reached when the condensation which occurs on the newly exposed metal is balanced by re-evaporation of older portions of the layer. The percentage of water present is then a maximum; and from this point onwards the steam becomes more and more dried by re-evaporation of the layer.

83. If the amount of initial condensation has been small this re-evaporation may be complete before release occurs. Very usually, however, there is still an undried layer at the end of the forward stroke, and the process of re-evaporation continues during the return stroke, while exhaust is taking place. In extreme cases, if the amount of initial condensation has been very great, the cylinder walls may fail to become quite dry even during the exhaust, and a residue of the layer of condensed water may either be carried over as water into the condenser, or, if the exhaust valves are so badly arranged as to prevent its discharge, this unevaporated residue may gather in the cylinder, requiring perhaps the drain-cocks to be left open to allow of its escape. When any water is retained in this way the initial condensation is enormously increased, for the hot steam then meets not only cold metal but cold water. The latter causes much condensation, partly because of its high specific heat, and partly because it is brought into intimate mixture with the entering steam.

Cooling effect of re-evaporation.

84. Apart, however, from this extreme case, whatever water is re-evaporated during expansion and exhaust takes heat from the metal of the cylinder, and so brings it into a state that makes condensation inevitable when steam is next admitted from the boiler. Mere contact with low-pressure steam during the exhaust stroke would cool the metal but little; the cooling which actually occurs is due mainly to the re-evaporation of the condensed water. Thus if an engine were set in action, after being heated beforehand to the boiler temperature, the cylinder would be only slightly cooled during the first exhaust stroke, and little condensation would occur during the next admission. But the metal would be more cooled in the subsequent expansion and exhaust, since it would part with heat in re-evaporating this water. In the third admission more still would be condensed, and so on, until a permanent régime would be established in which condensation and re-evaporation were exactly balanced. The same permanent régime is reached when the engine starts cold.

Wetness of steam during expansion.

85. The wetness of the working fluid to which the action of the walls of the cylinder gives rise is essentially superficial. A film of water forms on the walls, but except for this the body of the steam remains dry, until (by adiabatic or nearly adiabatic expansion) it becomes wet throughout its volume. The water formed by the act of expansion takes form as a mist diffused throughout the steam, and on it the sides of the cylinder exert practically no influence. This latter wetness is in fact increasing while the substance, as a whole, is getting dried by the re-evaporation of the liquid film. During expansion the working substance may be regarded as made up of two parts,—a core of steam, which is expanding adiabatically but is at the same time receiving additions to its amount in the form of saturated steam from the liquid layer, and a liquid layer which is turning into steam.

Waste of heat.

86. From a thermodynamic point of view all initial condensation of the steam is bad, for, however early the film be re-evaporated, this can take place only after its temperature has cooled below that of the boiler. The process consequently involves a misapplication of heat, since the substance, after parting with high temperature heat, takes it up again at a temperature lower than the top of its range. This causes a loss of efficiency (chap. II.), and the loss is greater the later in the stroke re-evaporation occurs. The heat that is drawn from the cylinder by re-evaporation of the condensed film becomes less and less effective for doing work as the end of the expansion is approached, and finally, whatever evaporation continues during the back stroke is an unmitigated source of waste. The heat it takes from the cylinder does no work; its only effect, indeed, is to increase the back pressure by augmenting the volume of steam to be expelled. A small amount of initial condensation reduces the efficiency of the engine but little; a large amount causes a much more than proportionally larger loss.

Effect of jacket.

87. The action of the cylinder walls is increased by any loss of heat which the engine suffers by radiation and conduction from its external surface. The entering steam has then to give up enough heat to provide for this waste, as well as enough to produce the subsequent re-evaporation of the condensed film. The consequence is that more steam is initially condensed. The loss of efficiency due to this cause will therefore be greater in an unprotected cylinder than in one which is well lagged or covered with non-conducting material. On the other hand, if the engine have a steam-jacket the deleterious action of the walls is reduced. The working substance is then on the whole gaining instead of losing heat by conduction during its passage through the cylinder. The jacket accelerates the process of re-evaporation and tends to make it finish at a point in the stroke when the temperature of the steam is still comparatively high. When the process is complete the cylinder walls give up very little additional heat to the steam during the remainder of the expansion and exhaust, for conduction and radiation between dry steam and the metal of the cylinder are incompetent to cause any considerable exchange of heat. The earlier, therefore, that evaporation is complete the less is the metal chilled, and the less is the subsequent condensation. Moreover, after this stage in the stroke has passed, a steam-jacket continues to give heat to the metal during the remainder of the double stroke, and so warms it to a temperature more nearly equal to that of the boiler steam before the next admission takes place.

88. Thus a steam-jacket, though in itself a thermodynamically imperfect contrivance, inasmuch as its object is

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[1] See also *Min. Proc. Inst. C. E.*, vol. lxxii. p. 275.

[2] A useful abstract of Messrs. Loring and Emery's reports is given in *Engineering*, vols. xix. and xxi., and in Mr. Maw's *Recent Practice in Marine Engineering*.

[3] *Bull. Soc. Industr. de Mulhouse*, from 1877. For other references, see chap. V.

to supply heat to the working substance at a temperature lower than the source, acts beneficially by counteracting, to some extent, the more serious misapplication of heat which occurs through the alternate cooling and heating of the cylinder walls. The heat which a jacket communicates to working steam often increases the power of an engine to an extent far greater than corresponds to the extra supply of heat which the jacket itself requires. Besides its thermodynamic effect a jacket has the drawback that it increases waste by external radiation, since it both enlarges the area of radiating surface and raises its temperature; notwithstanding this, however, many experiments have shown that in large and especially in slow-running engines, the influence of a steam-jacket on the efficiency is, in general, good; and this is to be ascribed to the fact that it reduces, though it does not entirely remove, the evils of initial condensation. To be effective, however, jackets must be well drained and kept full of "live" steam, instead of being, as many are, traps for condensed water or for air.

Influence of speed.

89. It is interesting to notice, in general terms, the effects which certain variations of the conditions of working may be expected to produce on the loss that occurs through the action of the cylinder walls. Initial condensation will be increased by anything that augments the range of temperature through which the inner surface of the cylinder fluctuates in each stroke, or that exposes a larger surface of metal to the action of a given quantity of steam, or that prolongs the contacts in which heat is exchanged. The influence of time is specially important; for it must be borne in mind that the whole action depends on the rate at which heat is conducted into the substance of the metal. The changes of temperature which the metal undergoes are in every case mainly superficial; the alternate heating and cooling of the inner surface initiates waves of high and low temperature in the iron whose effects are sensible only to a small depth; and the faster the alternate states succeed each other the more superficial are the effects. In an engine making an indefinitely large number of strokes per minute the cylinder sides would behave like non-conductors and the action of the working substance would be adiabatic.

We may conclude, then, that in general an engine running at a high speed will have a higher thermodynamic efficiency than the same engine running at a low speed, all the other conditions of working being the same in both cases.

Again, as regards range of temperature, the influence of the cylinder walls will be greater (other things being equal) with high than with low pressure steam, and in condensing than in non-condensing engines. On the other hand, high pressure has the good effect of reducing the surface of metal exposed to the action of each pound of steam.

Influence of size.

In large engines the action of the walls will be less than in small engines, since the proportion of wall surface to cylinder volume is less. This conclusion agrees with the well-known fact that no small engines achieve the economy that is easily reached with larger forms, especially with large marine engines, which eclipse all others in the matter of size.

Influence of variation in cut-off.

Cylinder condensation is increased when the ratio of expansion is increased, all the other circumstances of working being left unaltered. The metal is then brought into more prolonged contact with low-temperature steam. The volume of admission is reduced to a greater extent than the surface that is exposed to the entering steam, since that surface includes two constant quantities, the surface of the cylinder cover and of the piston. For these and perhaps other reasons, we may conclude that with an early cut-off the initial condensation is relatively large; and this conclusion is amply borne out by experiment. An important result is that increase of expansion does not, beyond a certain limit, involve increase of thermodynamic efficiency; when that limit is passed the augmentation of waste through the action of the cylinder walls more than balances the increased economy to which, on general principles, expansion should give rise, and the result is a net loss. With a given engine, boiler pressure, and speed, a certain ratio of expansion will give maximum efficiency. But the conditions on which this maximum depends are too complex to admit of theoretical solution; the best ratio can be determined only by experiment. It may even happen that an engine which is required to work at a specified power will give better results, in point of efficiency, with moderate steam-pressure and moderate expansion, than with high steam-pressure and a very early cut-off.

Experimental results.

90. The effect of increased expansion in augmenting the action of the sides and so reducing the efficiency, when carried beyond a certain moderate grade, is well illustrated by the American and Alsatian experiments alluded to above. The following figures (Table III.), relating to a single-cylinder Corliss engine, are reduced from one of Hallauer's papers:[1]

Ratio of Expansion.	Percentage of Water present.		Consumption of Steam per Indicated Horse-Power per Hour.
	At End of Admission.	At End of Expansion.	
			℔
7.3	24.2	17.8	17.8
9.4	30.8	18.6	17.6
15.1	37.5	20.8	17.7

Here a maximum of efficiency lies between the extreme grades of expansion to which the test extends. In the American experiments the best results were obtained with even more moderate ratios of expansion. The compound engines of the United States revenue steamer "Bache," when tested with steam in the jacket of the large cylinder, with the boiler pressure nearly uniform at 80 ℔ by gauge, or 95 ℔ per square inch absolute, and the speed not greatly varied, gave the results shown in Table IV. Here the efficiency is very little affected by a large variation in the cut-off, but when the ratio of expansion becomes excessive a distinct loss is incurred.

TABLE IV.

Ratio of Total Expansion.	Consumption of Steam per I. H. P. per Hour.
	℔
4.2	21.2
5.7	20
7.0	20.3
9.2	20.7
16.8	25.1

Experiments with engines, in the conditions which hold in ordinary practice, show that it is not unusual to find 20 or 30 per cent. of the steam that comes over from the cylinder condensed during admission. In favorable cases the amount is less than this; occasionally, on the other hand, the amount condensed is as much as half, or even more than half, the whole steam supply.

91. The action of the cylinder walls is reduced—(1) by jacketing, (2) by superheating, and (3) by using compound expansion. The advantage of the steam-jacket has been already mentioned. In high-speed engines its beneficial effect is necessarily small, and in certain cases the benefit may be even more than neutralized by the drawbacks which have been alluded to above (§ 88). In general, however, the steam-jacket forms a valuable means of reducing the wasteful action of the cylinder walls, especially when the ratio of expansion is considerable. Experiments made with and without a jacket, on the same engine, have shown that jacketing may increase the efficiency by 20 or 25 per cent. When a jacket is working properly it uses, in a single-cylinder engine, 4 or 5 per cent., and in a compound engine 8 to 12 per cent., of the whole steam supply.

Effect of superheating.

92. Superheating the steam before its admission reduces the amount of initial condensation, by lessening the quantity of steam needed to give up a specified amount of heat, and this in its turn lessens the subsequent cooling by re-evaporation. That it has a marked advantage in this respect has been experimentally demonstrated by Hirn. On general thermodynamic grounds superheating is good, because it extends the range of temperature through which the working substance is carried. In modern practice superheating (to any considerable extent) is seldom attempted. It occurs to a small extent whenever dry steam is throttled, and a slight superheating is occasionally given to steam in its passage from the high-pressure to the low-pressure cylinder of a compound engine. In former years superheated steam was a common feature of marine practice, but serious practical difficulties caused engineers to abandon its use and to seek economy rather by increasing the initial pressure and using compound expansion. In those days, however, the theoretical advantage of superheating was less understood than it is now. The economy of fuel which its employment would probably secure is so great as to warrant a fresh and energetic attempt to overcome the mechanical difficulties of construction and lubrication that have hitherto stood in the way.

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[1] *Bull. Soc. Industr. de Mulhouse*, May 26, 1880.

Effect of compound expansion.

93. The most important means of preventing cylinder condensation from becoming excessive is the use of compound expansion. If the vessels were non-conductors of heat it would be, from the thermodynamic point of view, a matter of indifference whether expansion was completed in a single vessel or divided between two or more, provided the passage of steam from one to the other was performed without introducing unresisted expansion (§ 51). But with actual materials the compound system has the important merit that it subjects each cylinder to a greatly reduced range of temperature variation. For this reason the amount initially condensed in the high-pressure cylinder is greatly less than if admission were to take place at once into the low-pressure cylinder and the whole expansion were to be performed there. Further, the steam which is re-evaporated from the first cylinder during its exhaust does work in the second, and it is only the re-evaporation that occurs during the exhaust from the second cylinder that is absolutely wasteful. The exact advantage of this division of range, as compared with expansion (through the same ratio) in a single cylinder, would be hard to calculate; but it is easy to see in a general way that an advantage is to be anticipated, and (though there are isolated instances to the contrary) experience bears out this conclusion. In large engines, working with high pressure, much expansion, and a slow stroke, the fact that compound engines are in general more efficient than single engines cannot be doubted. Additional evidence to the same effect is furnished when a compound engine is tested first with compound expansion and then as a simple engine with the same grade of expansion in the large cylinder alone. Thus in the American experiments the compound engine of the "Bache" when worked as a simple engine used 24 ℔ of steam per I.H.P. per hour, as compared with about 20 ℔ when the engine worked compound, with the same boiler pressure, the same total expansion, and steam in the jacket in both cases. The necessity for compounding, if efficiency is to be secured, becomes greater with every increase of boiler pressure. So long as the initial pressure is less than about 100 ℔ per square inch (absolute) it suffices to reduce the range of temperature into two parts by employing two-cylinder compound engines; with the higher pressures now common in marine practice triple and even quadruple expansion is being introduced.

The action of the cylinder walls would be greatly reduced if it were practicable to use a non-conducting material as an internal lining to the cylinder and to the exposed surfaces of the piston. No cure for the evils of initial condensation would be so effectual as this; and in view of the economy of heat which would result, it is a matter of some surprise that the use of a non-conducting lining has not received more serious attention.

Actual efficiency of steam-engines.

94. The principal reasons have now been named which make the actual results of engine performance differ from the results which would be obtained if the steam conformed in every respect to the simple theory stated in chap. III. It remains to state, very shortly, a few of the results of recent practice as to the actual efficiency of steam-engines considered as heat-engines.

The performance of a steam-engine, as regards economy in its consumption of heat, may be stated in a number of ways. In some of these the engine alone is treated as an independent machine; in others the engine, boiler, and furnace are considered as a whole.

Modes of statement.

The performance of the engine alone is best expressed by stating either (1) the thermodynamic "efficiency" or (2) the number of thermal units used per horse-power per minute. These terms require a short explanation. The "efficiency" of a heat-engine has already been defined as the ratio of the work done to the heat supplied. The "work done" ought in strictness to be reckoned as the net work done by the working substance in passing through a complete cycle of operations; it should therefore be determined by subtracting from the work which the substance does in the cylinder the work which is spent upon the substance in the feed-pump. The latter is a comparatively small quantity, and engineers generally neglect it in their calculations of thermodynamic efficiency. In making comparison, however, between the efficiency which is actually realized and the efficiency of a perfect engine or of an engine working under any assumed conditions, account should be taken of the negative work done in the feed-pump. Account should also in strictness be taken of that part of the work spent in driving the air-pump which is done upon the working substance, as distinguished from the water of injection. The "heat supplied" is the total heat of the steam delivered to the engine, less the heat contained in the corresponding amount of feed-water. This quantity depends on the amount of steam used, on the temperature of the feed, on the boiler pressure, and on the extent to which the boiler "primes." Priming is the delivery by the boiler of water mixed with the steam. Except where there is actual superheating the steam supply is always more or less wet; in a badly designed or overworked boiler large volumes of water may be carried over with the steam, but in a good boiler of adequate size the amount of priming is less (often much less) than 5 per cent. of the whole supply. The effect of priming is, of course, to reduce the supply of heat per ℔ of the working substance.

One horse-power is the mechanical equivalent of 42.75 thermal units per minute. The relation between the above two methods of stating engine performance is therefore expressed by the equation

$$\text{Efficiency} = \frac{42.75}{\text{Number of T.U. per I.H.P. per minute}} \cdot$$

Another very common mode is to give the number of pounds of steam supplied per horse-power per hour. This is unsatisfactory, even as a method of stating the comparative economy of different engines, or of one engine in different conditions, for several reasons. It ignores variations in boiler pressure, in feed-water temperature, and in the dryness of the supply, although each of these things affects the amount of heat required for the production of a pound of steam. But the total heat of production of dry steam does not vary greatly within the limits of practical pressures; moreover, since (in condensing engines) feed-water is generally taken from the hot-well, its temperature does not differ much from that of the air-pump discharge, or (say) 100° F. Finally, in many comparative trials the amount of priming is nearly if not quite constant. Hence it happens that this mode of statement often furnishes a fairly accurate test of the economy of engines, and it has the advantage of putting results in a way that is easy to understand and remember.

Efficiency of boiler and furnace.

95. None of these modes of statement include the efficiency of the boiler and furnace. The performance of a boiler is most usually expressed by giving the number of pounds of water at a stated temperature converted into steam at a stated pressure by the combustion of 1 ℔ of coal. The temperature commonly chosen is 212° F., and the water is supposed to be evaporated under atmospheric pressure; the result may then be stated as so many pounds of water evaporated from and at 212° F. per 1 ℔ of coal. But the term "efficiency" may also be applied to a boiler and furnace (considered as one apparatus) in the sense of the ratio between the heat that is utilized and the potential energy that is contained in the fuel. This ratio is, in good boilers, about 0.7. Thus, for example, 1 ℔ of Welsh coal contains about 15,500 thermal units of potential energy, an amount which is equal to the heat of production (L) of about 16 ℔ of steam from and at 212°. In practice, however, 1 ℔ of coal serves to evaporate only about 11 ℔ of water under these conditions, or about 9.5 ℔ when the feed-water enters at 100° F. and the absolute pressure is 100 ℔ per square inch.

The efficiency of the engine multiplied by that of the furnace and boiler gives a number which expresses the ratio between the heat converted into work and the potential energy of the fuel,—a number which is, in other words, the efficiency of the system of engine, boiler, and furnace considered as a whole. Instead, however, of expressing this idea by the use of the term efficiency, engineers are more usually in the habit of stating the performance of the complete system by giving the number of pounds of coal consumed per horse-power per hour. It must be borne in mind that this quantity depends on the performance of the boiler as much as on that of the engine, and that the difference in thermal value between one kind of coal and another makes it, at the best, a rough way of specifying economy. It is, however, an easy quantity to measure; and to most users of engines the size of the coal-bill is a matter of greater interest than any results of thermodynamic analysis.

"Duty."

Still another expression for engine performance, similar to this last, is the now nearly obsolete term "duty," or number of foot-pounds of work done for every 1 cwt. of coal consumed. Its relation to the pounds of coal per horse-power per hour is this:

$$\text{Duty} = \frac{112 \times 33000 \times 60}{\text{Number of ℔ of coal per I.H.P. per hour}} \cdot$$

A good condensing engine of large size, supplied by good boilers, consumes about 2 ℔ of coal per horse-power per hour; its duty is then about 110 millions.

96. To illustrate the subject of this chapter more fully the following summary is given of the results of tests of pumping engines by Mr. J. G. Mair, described in two excellent papers in *Min. Pro. Inst. Civ. Eng.* (vols. lxx. and lxxix.). The first group (Table V.) refers to single cylinder beam rotative engines, all of the same type, working at about 120 horse-power (in all except the last trial there were steam-jackets in use):

Results of trials.

Boiler Pressure (Abs.).	Total Ratio of Expansion.	Percentage of Water Present at Cut-off.	Lbs. of Dry Steam per I.H.P. per Hour.	Efficiency.
48	6.8	44	22.1	0.099
57	4.3	29	22.1	0.099
59	3.2	22	21.3	0.102
59	1.9	15	23.6	0.093
56	3.8	37	26.5	0.083

In these engines, which ran at the slow speed of about 20 revolutions per minute, the influence of steam jacketing was very marked. In the trials made with jackets in action, the percentage of water present at cut-off, when plotted in relation to the ratio of expansion, gives a diagram which is sensibly a straight line; by drawing this line it may be seen that with an expansion of 3.8 in a similar jacketed cylinder there would be about 25 per cent. of initial condensation instead of the much greater amount (37 per cent.) which the absence of a jacket caused in the last trial.

The next group of tests (Table VI.) refer to compound engines, of the types named (for explanation of the terms see chap. VI.):[1]

Type.	Boiler Pressure Abs.	Total Ratio of Expans'n.	Number of Revolutions per Minute.	Percentage of Water present at Cut-off.	Lbs. of Dry Steam per I.H.P. per Hour.	Efficiency.
Woolf beam, without jkt	58	9.3	18	51	26.6	0.082
" with jackets	62	15.8	20	41	17.3	0.126
" without jkts	39	7.3	34	34	19.2	0.118
" with jackets	38	9.6	34	38	17.4	0.125
" "	68	11.9	18	25	15.6	0.139
" "	78	16.5	23	31	15.5	0.140
" "	75	13.2	27	29	15.1	0.144
Woolf tandem, without jackets	86	11.5	30	43	21.6	0.101
Receiver beam, with jackets	76	13.6	24	34	14.8	0.147

V. THE TESTING OF STEAM-ENGINES.

Objects of tests.

97. Under this head we may include experiments made to determine—(*a*) the horse-power of an engine; (*b*) the thermodynamic efficiency, or some more or less nearly equivalent quantity, such as the relation of power to steam supply or to coal consumption (§ 95); (*c*) the distribution of steam, that is, the relation which the several events of steam-admission, expansion, exhaust, and compression bear to the stroke of the piston; (*d*) the amount of initial condensation, the wetness of the steam throughout the stroke, and the transfer of heat between it and the cylinder walls; (*e*) the efficiency of the mechanism, or the ratio which the work done by the engine on the machinery it drives bears to the work done by the steam in the cylinder.

Tests (*a*) and (*c*) are of common application; test (*b*), in the simple form of a comparison of horse-power with coal burnt per hour, is not unusual. The actual measurement of efficiency, whether thermodynamic (*b*) or mechanical (*e*), and the analysis involved in (*d*) have been carried out in comparatively few instances.

The indicator.

98. In all these operations the taking of indicator diagrams forms a principal part. The indicator, invented by Watt and improved by M'Naught and by Richards, consists of a small steam cylinder, fitted with a piston which slides easily within it and is pressed down by a spiral spring of steel wire. The cylinder of the indicator is connected by a pipe below this piston to one or other end of the cylinder of the engine, so that the piston of the indicator rises and falls in response to the fluctuations of pressure which occur in the engine cylinder. The indicator piston actuates a pencil, which rises and falls with it and traces the diagram on a sheet of paper fixed to a drum that is caused to rotate back and forth through a certain arc, in unison with the motion of the engine piston. In M'Naught's indicator the pencil is directly attached to the indicator piston, in Richards's the pencil is moved by means of a system of links so that it copies the motion of the piston on a magnified scale. This has the advantage that an equally large diagram is drawn with much less movement of the piston, and errors which are caused by the piston's inertia are consequently reduced. In high-speed engines especially it is important to minimise the inertia of the indicator piston and the parts connected with it. In Richards's indicator the linkage employed to multiply the piston's motion is an arrangement similar to the parallel motion introduced by Watt as a means of guiding the piston-rod in beam engines (see § 193). In several recent forms of indicator lighter linkages are adopted, and other changes have been made with the object of fitting the instrument better for high-speed work. One of these modified forms of Richards's indicator (the Crosby) is shown in Fig. 21. The pressure of steam in the engine cylinder raises the piston P, compressing the spring S and causing the pencil Q to rise in a nearly straight line through a distance proportional, on a magnified scale, to the compression of the spring and therefore to the pressure of the steam. At the same time the drum D, which carries the paper, receives motion through the cord C from the cross-head of the engine. Inside this drum there is a spiral-spring which becomes wound up when the cord is pulled, and serves to turn the drum in the reverse direction during the back stroke. The cap of the indicator cylinder has holes in it which admit air freely to the top of the piston, and the piston has room to descend, extending the spring S, when the pressure of the steam is less than that of the atmosphere. The spring is easily taken out and replaced by a more or less stiff one when higher or lower pressures have to be dealt with.

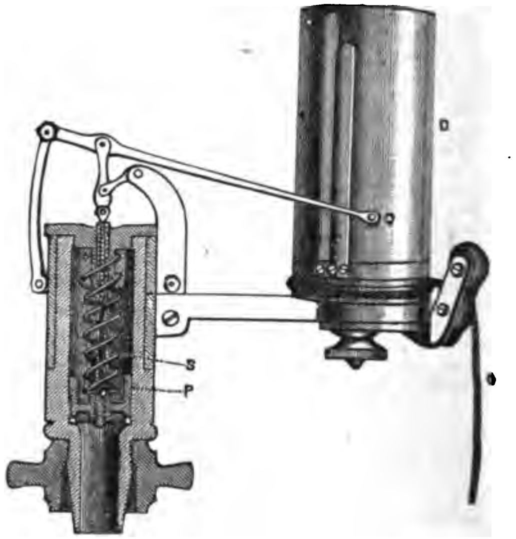

FIG. 21.—Crosby Indicator.

Errors in indicator diagrams.

99. To register correctly, an indicator must satisfy two conditions: (1) the motion of the piston must be proportional to the change of steam pressure in the engine cylinder; and (2) the motion of the drum must be proportional to that of the engine piston.

The first of these requires that the pipe which connects the indicator with the cylinder should be short and of sufficient bore, and that it should open in the cylinder at a place where the pressure in it will not be affected by the kinetic action of the inrushing steam. Frequently pipes are led from both ends of the cylinder to a central position where the indicator is set, so that diagrams may be taken from either end without shifting the instrument; much better results are obtained, especially when the cylinder is long, by using a pair of indicators, each fixed with the shortest possible connecting pipe, or by taking diagrams successively from the two ends of the cylinder with a single instrument set first at one end and then at the other. The general effect of an insufficiently free connection between the indicator and the engine cylinder is to make the diagram too small. The first condition is also invalidated to some extent by the friction of the indicator piston, of the joints in the linkage, and of the pencil on the paper. The piston must slide very freely; nothing of the nature of packing is permissible, and any steam that leaks past it must have a free exit through the cover. The pencil pressure must not exceed the minimum which is necessary for clear marking. By careful use of a well-made instrument the error due to friction in the piston and connected parts need not be serious. Another source of disturbance is the inertia of these parts, which tends to set them into oscillation whenever the indicator piston suffers a comparatively sudden displacement. These oscillations, superposed upon the legitimate motions of the piston, give a wavy outline to parts of the diagram, especially when the speed is great and when the last-named source of error (the friction) is small. When they appear on the diagram a continuous curve should be drawn midway between the crests and hollows of the undulations. To keep them within reasonable compass in high-speed work a stiff spring must be used and an indicator with light parts should be selected. Finally, to secure accuracy in the pencil's movement, the strain of the spring must be kept well within the limit of elasticity, so that the strain may be as nearly as possible proportional to the steam pressure. Care must be taken that the spring is graduated to suit the temperature (about 212° F.) to which it is exposed when in use; its stiffness at this temperature is about 3 per cent. less than when cold.

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[1] For other comparative trials, see Hallauer's papers, especially *Bull. Soc. Ind. de Mulhouse*, Dec. 30, 1878, and May 26, 1880.

With regard to the motion of the drum, it is, in the first place, necessary to have a reducing mechanism which will give a sufficiently accurate copy, on a small scale, of the engine piston's stroke. Many contrivances are used for this purpose; in some a rigorous geometrical solution of the problem is aimed at, in others a close approximation only. Fig. 22 shows a good form of indicator gear. A pendulum rod AB is pinned at one end to the cross-head A (the end of the piston-rod) of the engine. Its upper end is carried by a pin which is free to turn and slide in the fixed slot B. A cord from an intermediate point C. leads over pulleys to the indicator drum. The pendulum rod should be much longer than the piston stroke, and the cord should lead off for a considerable distance in the direction sketched, at right angles to the mean position of the rods. The accuracy of the drum's motion does not, however, depend merely on the geometrical condition of the gear. It depends also on the rigidity of the parts, and especially on the stretching of the cord. The elasticity of the cord will cause error if it is not maintained in a state of uniform tension throughout the double stroke, and this error will be greater the longer and the more extensible the cord is. Hence short cords are to be preferred; and fine wire, which stretches much less, may often be substituted for cord with great advantage. The stretching of the cord is perhaps the most serious and least noticed source of error the indicator is subject to in ordinary practice. The tension of the cord varies for three reasons,—the inertia of the drum, the varying resistance of the drum spring, and the friction of the drum, which has the effect of increasing the tension during the forward stroke and of reducing it during the back stroke. This last cause of variation can be minimized only by good construction and careful use of the instrument; but the other two causes can be made to neutralize one another almost completely. Since the motion is nearly simple harmonic, the acceleration of the drum varies in a nearly uniform manner from end to end of the stroke. The resistance of the drum spring also varies uniformly; and it is therefore only necessary to adjust the stiffness of the drum spring so that the increase in its resistance as the motion of the drum proceeds may balance the decrease in the force that the cord has to exert in setting the drum into motion. This adjustment will secure an almost uniform tension in the cord throughout the whole stroke; it must, of course, be altered to suit different engine speeds. The indicator plays so important a part in the testing of heat-engines, whether for practical or scientific purposes, that no pains should be spared to avoid the numerous and serious sources of error to which it is liable through faulty construction or unintelligent use.[1]

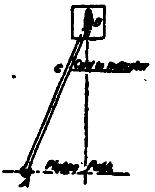

FIG. 22.—Indicator Gear.

Measurement of horse-power.

100. To determine the indicated horse-power, the mean effective pressure is found by dividing the area of the diagram by the length of its base. This gives a mean height, which, interpreted on the scale of pressures, is the mean effective pressure in pounds per square inch. This has to be multiplied by the effective area of the piston in square inches and by the length of the piston stroke in feet, to find the work done per stroke in foot-pounds on that side of the piston to which the diagram refers. Let A_1 be the area of the piston on one side and A_2 on the other; p_1 and p_2 the mean effective pressures on the two sides respectively; L the length of the stroke in feet; and n the number of complete double strokes or revolutions per minute. Then the indicated horse-power

$$\text{I.H.P.} = \frac{n\text{L}(p_1\text{A}_1 + p_2\text{A}_2)}{33000}.$$

In finding the mean pressure the area of the diagram may be conveniently measured by a planimeter or calculated by the use of Simpson's rule. A less accurate plan, frequently followed, is to divide the diagram by lines drawn at the middle of strips of equal width, as in Figs. 23 and 24, and to take the mean pressure as the average height of these lines.

Examples of indicator diagrams.

101. Space admits of no more than a few illustrations of actual indicator diagrams. Fig. 23 is a diagram taken from an antiquated non-condensing engine working without expansion. The line AB has been drawn at a height which represents the boiler pressure, in order to show the loss of pressure in admission. The line CD is drawn at atmospheric pressure by the indicator itself. In this engine admission continues till the end of the forward stroke, and as a result the back pressure is great, especially during the first stage of the exhaust. The diagram shows a slight amount of oscillation produced by the sudden admission of steam. This feature, however, is better illustrated by Fig. 24, which is another diagram taken from the same engine, at the same boiler pressure, but with the steam much throttled.

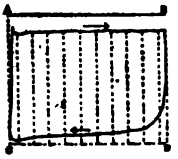

FIG. 23.

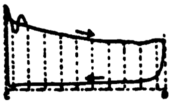

FIG. 24.

Fig. 25 shows a pair of diagrams taken from a condensing engine in which the distribution of steam is effected by a common slide valve (chap. VIII.). The two diagrams refer to opposite ends of the cylinder and are taken on the same paper by the plan already alluded to (§ 99) of fixing the indicator about midway between the ends of the cylinder, with a pipe leading from it to each end. Steam is cut off at a and a', release occurs at b and b', and compression begins at c and c'. The gradual closing of the slide valves throttles the steam considerably before the cut-off is complete. The line of no pressure EF is drawn 14.7 lb per square inch below CD, which is the atmospheric line; and the line of no volume AE or BF is drawn (for each end of the cylinder) at a distance (from the end of the diagram) equal to the volume of the clearance.

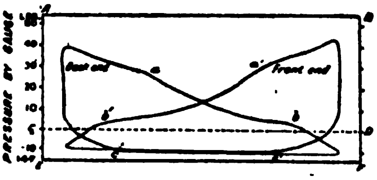

FIG. 25.—Indicator Diagram from Condensing Engine, with Slide-Valve.

Fig. 26 is a diagram taken from a Corliss engine working with a large ratio of expansion. The Corliss valve-gear, which will be described in chap. IX., causes the admission valve to close suddenly, and consequently defines the point of cut-off pretty sharply in the diagram. Through this

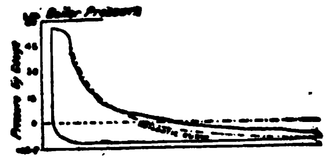

FIG. 26.—Indicator Diagram from Corliss Engine.

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[1] A valuable discussion and experimental investigation of the errors of the indicator will be found in papers by Prof. Osborne Reynolds and Mr. H. W. Brightmore (*Min. Proc. Inst. C. E.*, vol. lxxxiii., 1886). In the discussion which followed the reading of the papers a discription will be found of an ingenious apparatus which the makers of the Crosby indicator employ to test the uniformity of the cord's tension throughout the stroke.

point a dotted curve has been drawn (by aid of the equation $PV^n = \text{const.}$, § 67), which is the curve that would be followed if the expansion were adiabatic. In drawing this curve it has been assumed that at the end of admission the steam contains 25 per cent. of water. The actual curve first falls below and then rises above this adiabatic curve, in consequence of the continued condensation which takes place during the early stages of the expansion and the re-evaporation of condensed water during later stages (§ 82). Fig. 27 is another diagram from a Corliss engine, running light, and with the condenser not in action. Diagrams of this kind are often taken when engines are first erected, for the purpose of testing the setting of the valves. Other indicator diagrams, for compound engines, will be given in chap. VI.

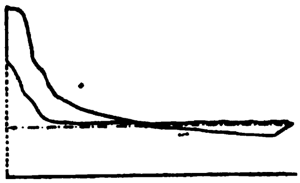

FIG. 27.

In place of the ordinary indicator an apparatus is occasionally used which integrates the two co-ordinates which it is the business of the indicator diagram to represent, and exhibits the power developed from stroke to stroke by the progressive movement of an index round a dial.

Tests of thermodynamic efficiency.

102. In tests of thermodynamic efficiency we may measure either the heat supplied or the heat rejected, and compare it with the work done. The heat supplied is on the whole capable of more exact measurement, but in any case a determination of the heat rejected furnishes a valuable check on the accuracy of the result. The trial must be continued for a period of some hours at least, during which the engine and boiler are to be kept working as uniformly as possible in all respects. The power is determined by taking indicator diagrams at short intervals. The heat supplied is found by noting the amount of feed-water required to keep the water-level in the boiler constant during the trial, the temperature of the feed, and the pressure of the steam. The only uncertainty which attaches to the measurement of heat-supply is due to priming. Every pound of water that passes over unevaporated to the engine takes less heat by the amount L (§ 60) than if it went over in the state of steam. To measure the degree of wetness in steam is a matter of some difficulty; it may be done by passing the steam into a known quantity of cold water, so as to condense it, and observing the rise of temperature which has taken place when the whole quantity of water present has increased by a measured amount.

Heat supplied.

If L_1 be the latent heat of steam at the boiler pressure, h_0 the heat in the feed-water per ℔, h_1 the heat in the boiler water per ℔, and q the dryness of the steam as it leaves the boiler, the heat taken in per ℔ of the substance supplied to the cylinder is

$$qL_1 + h_1 - h_0.$$

To this must be added, in the case of a jacketed engine, the heat supplied to the jacket, a quantity which depends on the amount of steam condensed there, and also on whether the water that gathers in the jacket is drained back into the boiler or allowed to escape into the hot-well.

Heat rejected.

The heat rejected by an engine fitted with an injection condenser is made up of the following parts: (*a*) heat rejected in the condensed water, less the heat returned to the boiler in the feed (if the feed is directly drawn from the hot-well without giving the water time to cool sensibly, this quantity vanishes; in a jacketed engine this item must include the heat rejected in the jacket drains); (*b*) heat used in warming the condenser water from the temperature of injection to the temperature of the air-pump discharge; (*c*) heat rejected in air and vapor from the air-pump; (*d*) heat lost by radiation, conduction to supports, and aerial convection,—or, more properly, the excess of this heat over the heat developed within the engine by the friction of piston, valves, etc. Of these quantities (*a*) is found without difficulty from a knowledge of the amount of the feed-water, its temperature, the temperature of the air-pump discharge, and amount and temperature of water drained from the jacket; (*b*) is measured by gauging the whole discharge from the pump, deducting from it the amount returned to the boiler as feed-water, and measuring its temperature and that of the injection water; (*c*) does not admit of direct measurement; (*d*) may be approximately estimated for a jacketed engine by filling the jacket with steam while the engine is out of action, and observing the amount of steam condensed in the jacket during a long interval, through radiation, etc., from the external surface.

In calculating the supply of heat by the boiler it is convenient to take the temperature 32° F. as a starting point from which to reckon what may be termed the gross supply, and then to deduct from this the heat which is restored to the boiler in the feed-water. The difference, which may be called the net supply, is the true consumption of heat, and is to be used in calculating the efficiency of the engine. A similar convention may be followed in dealing with the heat rejected.

Example.

103. This subject is most easily made intelligible by help of a numerical example. For this purpose the following data of an actual engine-test have been taken from one of Mr. Mair's papers;[1] the data have been independently reduced, with results that differ only to a small and unimportant extent from those stated by Mr. Mair. The engine under trial was a compound beam engine, steam-jacketed, with an intermediate receiver between the cylinders. The cylinders were 21 inches and 36 inches in diameter, and the stroke 5½ feet. The total ratio of expansion was 13.6.

Data.

Boiler pressure, absolute, 76 lb. per sq. in.

Time of trial	6 hours.
Revolutions	8632, or 24.0 per min.
I.H P.	127.4.
Feed-water	12,032 ℔, or 1.394 ℔ per rev. (M.).
Air-pump discharge	1226 ℔ per min., or 51.1 ℔ per rev.
Water drained from jackets	1605 ℔, or 0.186 ℔ per rev. (M_j).
Percentage of priming	4.
Temperature of feed, t_0	59°.
Temperature of injection, t_2	50°.
Temperature of air-pump discharge, t_3	73.4°

Results.

Dryness of boiler steam, $q = 0.96$.
Supply to cylinder, $M_c = M - M_j = 1.208$ ℔ per rev.
Injection water per rev. $= 51.1 - 1.208 = 49.9$ ℔.
$L_1 = 898$, $h_1 = 278$, $h_2 = 18$, $h_3 = 41.4$, $h_0 = 27$.
Gross supply of heat from boiler to cylinder per revolution

$$= M_c(qL_1 + h_1)$$
$$= 1.208\,(0.96 \times 898 + 278) = 1377 \text{ T.U.}$$

Gross supply of heat from boiler to jackets per revolution

$$= M_j\,(qL_1 + h_1)$$
$$= 0.186\,(0.96 \times 898 + 278) = 212 \text{ T.U.}$$

Total gross supply per revolution $= 1377 + 212 = 1589$ T.U.
Heat restored to boiler per revolution,
By feed water $= Mh_0 = 1.394 \times 27 = 38$ T.U.
By jacket drains $= 0$.
Net supply of heat per revolution $= 1589 - 38 = 1551$ T.U.
Heat converted into work, per revolution

$$= \frac{\text{I.H.P.} \times 42.75}{24} = 227 \text{ T.U.}$$

Total heat rejected per revolution $= 1551 - 227 = 1324$ T.U.

The rejected heat is accounted for as follows:

Net heat rejected in air-pump discharge = Gross heat rejected in air-pump discharge — heat in injection water — heat restored to the boiler by the feed

$$= 51.1 \times 41.4 - 49.9 \times 18 - 38 = 1179 \text{ T.U.}$$

Heat rejected in jacket drains $= M_j h_1 = 0.186 \times 278 = 52$ T.U.

These two items account for 1231 units of rejected heat and leave a balance of 93 units unaccounted for. The balance is made up of heat rejected in air and vapor by the air-pump, heat lost by radiation, etc., and errors of experiment. In the example considered the loss by radiation was estimated at 45 thermal units, which reduces the discrepancy between the two sides of the account to 48 units, or only about 3 per cent. of the whole heat supplied.

The efficiency of the engine is $\frac{227}{1551}$ or 0.146. The efficiency of a perfect engine working between the same limits of temperature, 308° F. and 50° F., would be 0.335.

Calculation of wetness of the steam.

104. When it is desired to deduce from the test of an engine not only the thermodynamic efficiency but also the amount of initial condensation and the subsequent changes of wetness which the working fluid undergoes during expansion, it is necessary to know, in addition to the above data, the volume of cylinder and clearance, the relation of pressure to volume during the several stages of the stroke, and the whole amount of working substance present in the

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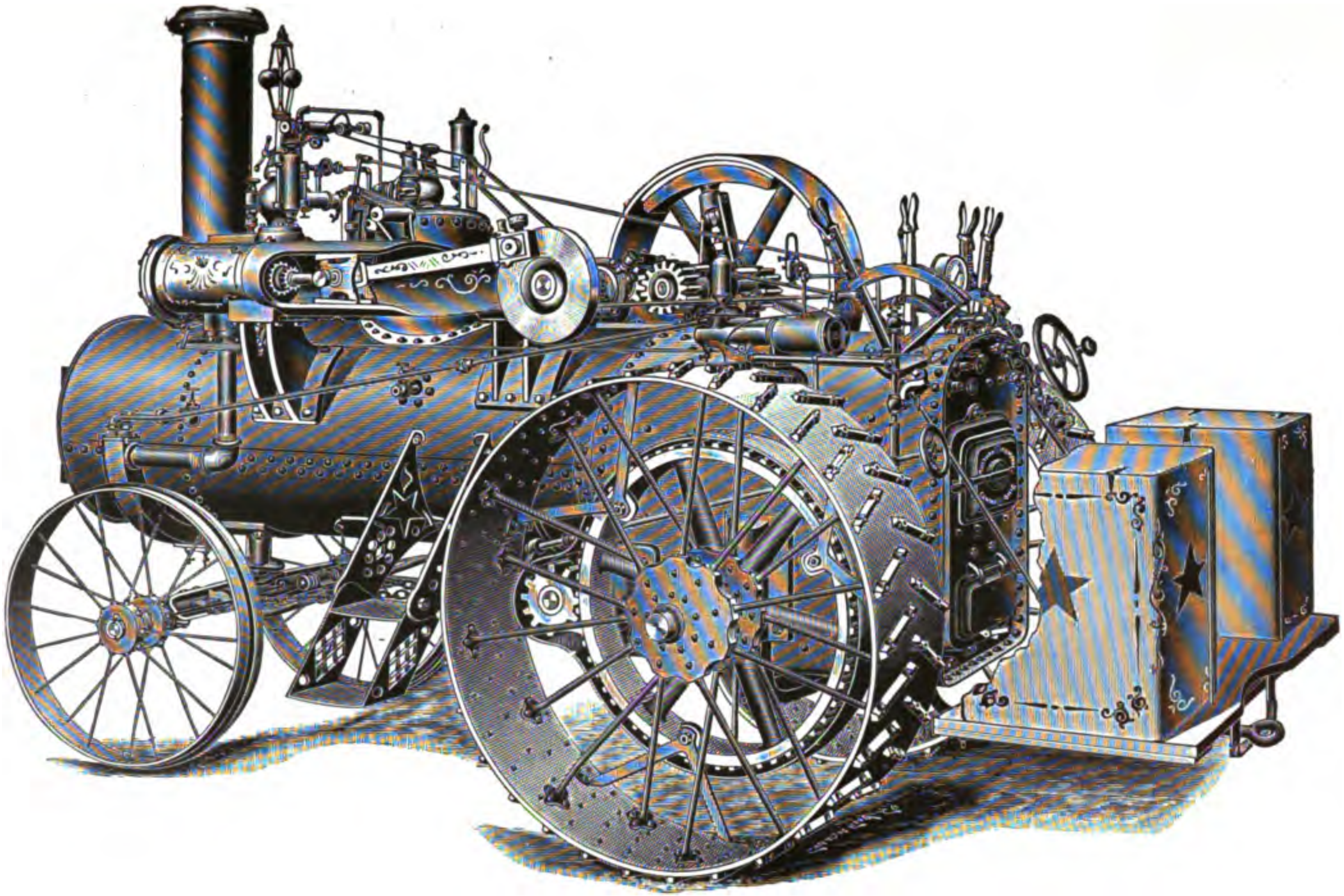
[1] *Min. Proc. Inst. C. E.*, vol. lxx.



THE STAR TRACTION—FOR COAL OR WOOD

cylinder. This last is a quantity whose precise value is not easily ascertained. Assuming that the point at which compression begins can be distinguished on the diagram, we have the pressure and the volume of the steam that is afterwards compressed into the clearance space. From its pressure and volume we can infer its amount, if only its degree of dryness be known. The assumption usually made is that at the beginning of compression the steam shut up in the cylinder is dry. This assumption is to a certain extent supported by the fact that re-evaporation has been going on during expansion and exhaust; in good engines it is probably not far from the truth, though there are cases where, owing to excessive initial condensation and to the exhaust ports being badly situated for draining the cylinder, water may accumulate in considerable quantities. Except in extreme cases of this kind, however, the assumption that the steam is dry when compression begins does not introduce an error which can seriously affect the subsequent calculations. Having found the quantity shut up in the clearance, we add to it the quantity delivered from the boiler per single stroke, to find the whole quantity of working substance in the cylinder. The substance is, and continues, a mixture in varying proportions of steam and water. Its volume may practically be taken as the volume of the dry steam it contains, the volume of the water being comparatively small. Taking any point of the stroke, and measuring the pressure and the volume there, we can say how much steam (at that pressure) would be required to fill the volume which the mixture then occupies. This quantity will always be less than the actual amount of the mixture; and the difference between them is the amount of water that is present. This calculation is of special interest at two places in the stroke—the point of cut-off and the point of release.

Example.

105. To illustrate it we may continue the numerical example quoted above. In the high-pressure cylinder of the engine to which the test refers the volume at the beginning of compression (including clearance) was 1.52 cubic feet. The pressure, just before compression began, is shown by the indicator diagram (of which Fig. 28 is a copy) to have been 14.8 ℔ per square inch. At this pressure the density (or mass of 1 cubic foot) of steam is 0.038 ℔. Hence (on the above assumption that the steam was then dry) the quantity shut up in the clearance was 1.52 × 0.038 = 0.058 ℔. The amount delivered to the cylinder per single stroke (or half revolution) was 0.604 ℔. The whole quantity of working substance present from the end of the admission to the beginning of the exhaust was, therefore, 0.662 ℔.

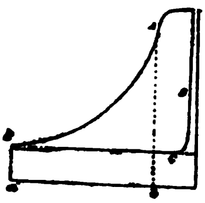


FIG. 28.

At the point of cut-off the pressure is shown by the diagram to have been 64 ℔ per square inch (absolute), and the volume, including clearance, was 2.92 cubic feet. The density of steam for this pressure is 0.151 ℔ per cubic foot. Hence, out of the whole mixture, the amount of steam was 2.92 × 0.151 = 0.441 ℔. The water present at the point of cut-off was therefore 0.662 — 0.440 or 0.222 ℔. This is 33.5 per cent. of the whole amount of the mixture, and shows (after allowing for the priming water) that about 32 per cent. of the steam admitted was condensed on admission.

Next, to find the amount of water present at the end of the expansion. The diagram shows that at this point the pressure was 15.2 ℔ per square inch and the volume 13.235 cubic feet. Steam of this pressure has a density of 0.0392 ℔ per cubic foot. The quantity of steam at release was therefore 13.235 × 0.0392 or 0.519 ℔, and the quantity of water 0.662 — 0.519 = 0.143 ℔. It appears therefore that re-evaporation from the cylinder walls during expansion reduced the amount of water present by 0.079 ℔, so that the percentage of water fell from 33.5 at the point of cut-off to 21.6 at the point of release. The same method of calculation can obviously be applied to any other point in the expansion curve, and can be extended to the low-pressure cylinder of an engine which (like the one in this example) is compound. The amount of dry steam present at the point of release is sometimes spoken of as the "steam accounted for by the indicator diagram."

Transfers of heat.

106. Having completed this analysis of the working substance, we may proceed to find the quantity of heat which it gives to or takes from the walls of the cylinder during any stage of its action, by considering the changes of internal energy which the working substance undergoes, along with the external work done, from stage to stage. If we write m for the amount of steam and m' for the amount of water present in the cylinder at any one stage, the internal energy of the mixture is (§ 62)

$$(m + m')h + m_\rho.$$

Let the value of this quantity be denoted by I_A at any one stage in the expansion or compression of the mixture, such as the point of cut-off A, and by I_B at a later stage, such as the point of release B, the corresponding volumes of the whole mixture being V_A and V_B respectively. Then in passing from the first condition to the second the substance loses $I_A - I_B$ of internal energy. It also does an amount of external work W_{AB} measured by $\int_{V_A}^{V} PdV$, or the area of the figure AB*ab*. If W_{AB} is equal to $I_A - I_B$ the process is adiabatic; otherwise the amount of heat taken up (from the cylinder walls) during the process is

$$Q_{AB} = W_{AB} - (I_A - I\quad).$$

If A is the point of cut-off and B that of release, the quantity so calculated is the heat taken up from the cylinder walls during the whole process of expansion. The calculation applies equally, however, in determining the heat taken up during any stage of the process. When this has a negative value heat has been given up by the substance to the cylinder walls. In the numerical example which has been cited above the internal energy of the mixture at the beginning of expansion was 540 thermal units. At the end of expansion the internal energy was 584 thermal units. Between these points the indicator diagram (Fig. 28) shows that the work done was equivalent to 55 thermal units. 44 + 55 = 99 units of heat were therefore taken from the cylinder walls during the process of expansion. A similar calculation, applied to the compression curve, shows that in that part of the operation heat was given up to the cylinder walls. During compression W is of course negative, since work is then spent upon the steam.

107. During admission and also during exhaust another item enters into the account,—the amount of the working substance is then undergoing change. To find the heat given up by the steam during admission we have first to calculate (by the method already described) the internal energy of the mixed steam and water that is shut into the clearance space at the end of the previous stroke; this may be called I_D. The steam which then enters brings with it an additional amount of internal energy which we may calculate from a knowledge of the quantity of steam, its pressure at admission, and its dryness. Let I_O denote this additional supply of internal energy. At the end of admission the state of the mixture is known from the indicator diagram; hence its internal energy I_A may be found. The work done during admission, W_{DA}, is also determined from the diagram. Then we have, for the heat given up by the steam during admission,

$$Q_{DA} = I_D + I_O - I_A - W_{DA}.$$

In attempting to apply the same method of calculation to determine the heat taken up from the cylinder walls during exhaust (Q_{BC}), we are met by the difficulty that we do not know the state, as regards dryness, of the mixture during its expulsion from the cylinder. We may, however, estimate the value of Q_{BC} as follows: Let Q_{CD} and Q_{DA} be, as before, the heat given up by the steam to the cylinder walls during compression and admission respectively, and let Q_{AB} be the heat taken from the cylinder walls during exhaust; also let Q_R be the heat which the cylinder loses (per single stroke) by radiation (less the heat produced by piston and valve friction), and Q_J the heat which it gains by condensation of steam in the jacket, if there is one. Then, as the cylinder neither gains nor loses heat on the whole, after a uniform régime has been arrived at, we have

$$Q_{BC} = Q_{CD} + Q_{DA} + Q_J - Q_R.$$

The quantity Q_{BC} may also be calculated directly from a knowledge of the gross heat rejected to the condenser, since the gross heat rejected is

$$I_B + W_{BC} + Q_{BC},$$

I_B being the internal energy of the mixture at release and W_{BC} being the work done upon the steam in expelling it from the cylinder.

Waste of heat by action of cylinder walls.

108. This heat Q_{BC}, which is taken up by the steam from the cylinder walls during exhaust, is a part of the heat deposited there during admission. It has passed through the cylinder without contributing in the smallest degree to the work of the engine. Probably for this reason it is treated by some writers as a quantity which measures the wasteful influence of the cylinder walls. This, however, is not strictly the case. The mag-

nitude of Q_{BC} is certainly in some sense an index of the extent to which the alternate heating and cooling of the metal causes inefficiency; it is so much heat absolutely lost, and lost by the action of the walls. [In the high-pressure cylinder of a compound engine this loss is, of course, absolute only as regards that cylinder; the heat represented by Q_{BC} assists in the work of the low-pressure cylinder.] But besides this loss there is another which the walls cause by taking heat from the steam on admission and restoring it during the later stages of expansion. That part of the heat abstracted during admission which is restored before the point of release does not appear in $Q_{BC'}$; nevertheless it is a source of inefficiency. With steam that is dry at the end of the expansion the value of Q_{BC} is almost negligible; still the cylinder walls may cause a very sensible loss by abstracting heat from the hot steam as it enters and restoring it as the mixture expands. The quantity which has been denoted here by Q_{BC}—that heat, namely, which the steam takes up from the cylinder walls after release and during exhaust—appears in the writings of Hirn and his followers under the symbol R_c. He terms it "le refroidissement au condenseur," and refers to it, somewhat inexactly, as "l'effet réel des parois."[1] Prof. Cotterill applies the name "exhaust waste" to the sum of the two quantities Q_{BC} and Q_R.[2]

109. It is obvious that the above analysis depends fundamentally on the strict accuracy with which the indicator diagram not only gives a measure of the work done by the engine under test, but shows the relation of pressure to volume at each stage in the process. Engine tests of a complete kind have now been made and discussed by a number of independent observers, working with widely different data. The results are in good general agreement. They demonstrate the influence of the sides beyond question, showing that 30 per cent. is no unusual amount of water to be present in the mixture at the point of cut-off, even in compound engines of the best types; that half of this water, or even more, is frequently found at the end of expansion; and that the heat denoted above by Q_{BC} ranges from about 10 to 20 per cent. of the whole heat supplied.[3]

Efficiency of the mechanism.

110. An engine employed to drive other machinery delivers to it an amount of power less than the indicated power by an amount which is wasted in overcoming the friction of piston and piston-rod, slides, valves, journals, etc. The efficiency of the mechanism is the ratio of the "effective" or "brake" horse-power to the indicated horse-power. It may be tested by measuring the power delivered by the engine when at work, either by using a transmission dynamometer or by substituting an absorption dynamometer for the mechanism usually driven. In the case of a pumping engine the efficiency of the engine and pumps together may be determined by observing the actual work done in raising water or in delivering a measured volume against a known pressure. Attempts are sometimes made to find the amount of power wasted in engine friction by testing the indicated power needed to drive the engine against no other resistance than its own friction. This, however, fails to show the power which will be spent in overcoming friction when the engine runs under ordinary conditions, since the pressures at the slides, the journals, and elsewhere are then widely different from what they are when the engine is running without load. Experiments with large engines show that the efficiency of the mechanism may, in favorable cases, be 0.85 or even 0.9; in small engines, or in large engines running under light loads, it is generally much less than this.

VI. COMPOUND EXPANSION.

Woolf engine.

111. In the original form of compound engine, invented by Hornblower and revived by Woolf, steam passed directly from the first to the second cylinder; the exhaust from the first and admission to the second went on together throughout the whole of the back stroke. This arrangement is possible only when the high and low pressure pistons begin and end their strokes together, that is to say, when their movements either coincide in phase or differ by half a revolution. Engines of the "tandem" type satisfy this condition—engines, namely, whose high and low pressure cylinders are in one line, with one piston-rod common to both pistons. Engines in which the high and low pressure cylinders are placed side by side, and act either on the same crank or on cranks set at 180° apart, may also discharge steam directly from one to the other cylinder; the same remark applies to beam engines, whether of the class in which both pistons act on one end of the beam, or of the class introduced by M'Naught, in which the high and low pressure cylinders stand on opposite sides of the centre. By a convenient usage which is now pretty general the name "Woolf engine" is restricted to those compound engines which discharge steam directly from the high to the low pressure cylinders without the use of an intermediate receiver.

Receiver engine.

112. An intermediate receiver becomes necessary when the phases of the pistons in a compound engine do not agree. With two cranks at right angles, for example, a portion of the discharge from the high-pressure cylinder occurs at a time when the low-pressure cylinder cannot properly receive steam. The receiver is in some cases an entirely independent vessel connected to the cylinders by pipes; very often, however, a sufficient amount of receiver volume is afforded by the valve casings and the steam-pipe which connects the cylinders. The receiver, when it is a distinct vessel, is frequently jacketed.

The use of a receiver is of course not restricted to engines in which the "Woolf" system of compound working is impracticable. On the contrary, it is frequently applied with advantage to beam and tandem compound engines. Communication need not then be maintained between the high and low pressure cylinders during the whole of the stroke; admission to the low-pressure cylinder is stopped before the stroke is completed; the steam already admitted is allowed to expand independently; and the remainder of the discharge from the high-pressure cylinder is compressed into the intermediate receiver. Each cylinder has then a definite point of cut-off, and by varying these points the distribution of work between the two cylinders may be adjusted at will. In general it is desirable to make both cylinders of a compound engine contribute equal quantities of work. If they act on separate cranks this has the effect of giving the same value to the mean twisting moment on both cranks.

Compound diagrams.

113. Wherever a receiver is used, care should be taken that there is no unresisted expansion into it; in other words, the pressure in the receiver should be equal to that in the high-pressure cylinder at the moment of release. If the receiver pressure is less than this there will be what is termed a "drop" in the steam pressure between the high-pressure cylinder and the receiver, which will show itself in an indicator diagram by a sudden fall at the end of the high-pressure expansion. This "drop" is, from the thermodynamic point of view, irreversible, and therefore wasteful. It can be avoided by selecting a proper point of cut-off in the low-pressure cylinder. When there is no "drop" the expansion that occurs in a compound engine has precisely the same effect in doing work as the same amount of expansion in a simple engine would have, provided the law of expansion be the same in both and the waste of energy which occurs by the friction of ports and passages in the transfer of steam from one to the other cylinder be negligible. The work done in either case depends merely on the relation of pressure to volume throughout the process; and so long as that relation is unchanged it is a matter of indifference whether the expansion be performed in one vessel or in more than one. It has, however, been fully pointed out in chap. IV. that in general a compound engine has a thermodynamic advantage over a simple engine using the same pressure and the same expansion, inasmuch as it reduces the exchange of heat between the working substance and the cylinder walls and so makes the process of expansion more nearly adiabatic. The compound engine has also a mechanical advantage which

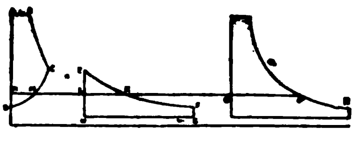


FIG. 29.—Compound Diagrams: Woolf type.

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[1] *Bull. Soc. Ind. de Mulhouse*, 1881.

[2] *The Steam-Engine considered as a Heat-Engine*, p. 54.

[3] In this connection reference should be made to the data supplied by the American experiments (of Messrs. Emery and Loring), some of which are discussed fully by Prof. Cotterill; also to the writings of Hirn and the extensive researches of the Alsatian engineers alluded to in chap. IV.; also to Mr. Mair's paper (§ 96) and to Mr. M. Longridge's *Reports*, as engineer to the Engine, Boiler, and Employers' Liability Association, for 1880, 1881, and 1884. The *Report* for 1884 especially exhibits the results of a test with unique fulness and clearness. The *Journal* of the Franklin Institute for 1885 contains an account of experiments by Messrs. Gately and Kletzsch on one engine, under varied conditions of boiler pressure, expansion, and speed; these, so far as they go, confirm the conclusions stated, on general grounds, in chap. IV. For a synopsis of Hirn's method of analysis reference should be made to a paper by M. Poupardin, *Bull. Soc. Ind. de Mulhouse*, March 31, 1875.

will be presently described. The ultimate ratio of expansion in any compound engine is the ratio of the volume of the low-pressure cylinder to the volume of steam admitted to the high-pressure cylinder. Fig. 29 illustrates the combined action of the two cylinders in a hypothetical compound engine of the Woolf type, in which for simplicity the effect of clearance is neglected and also the loss of pressure which the steam undergoes in transfer from one to the other cylinder. ABCD is the indicator diagram of the high-pressure cylinder. The exhaust line CD shows a falling pressure in consequence of the increase of volume which the steam is then undergoing through the advance of the low-pressure piston. EFGH is the diagram of the low-pressure cylinder drawn alongside of the other for convenience in the construction which follows. It has no point of cut-off; its admission line is the continuous curve of expansion EF, which is the same as the high-pressure exhaust line CD, but drawn to a different scale of volumes. At any point K, the actual volume of the steam is KL + MN. By drawing OP equal to KL + MN, so that OP represents the whole volume, and repeating the same construction at other points of the diagram, we may set out the curve QPR, the upper part of which is identical with BC, and so complete a single diagram which exhibits the equivalent expansion in a single cylinder.

In a tandem compound engine of the receiver type the diagrams resemble those shown in Fig. 30. During CD (which corresponds to FG) expansion is taking place into the large or low-pressure cylinder. D and G mark the point of cut-off in the large cylinder, after which GH shows the independent expansion of the steam now shut within the large cylinder, and DE shows the compression of steam by continued discharge from the small cylinder into the receiver. At the end of the stroke the receiver pressure is OE, and this must be the same as the pressure at C, if there is to be no "drop." Diagrams of a similar kind may be sketched without difficulty for the case of a receiver engine with any assigned phase relation between the pistons.[1]

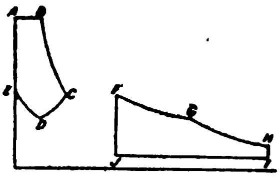

FIG. 30.—Compound Diagrams: Receiver type.

"Drop" in the receiver.

114. By making the cut-off take place earlier in the large cylinder we increase the mean pressure in the receiver; the work done in the small cylinder is consequently diminished. The work done in the large cylinder is correspondingly increased, for the total work (depending as it does on the initial pressure and the total ratio of expansion) is unaffected by the change. The same adjustment serves, in case there is "drop," to remove it. By selecting a suitable ratio of cylinder volumes to one another and to the volume of the receiver, and also by choosing a proper point for the low-pressure cut-off, it is possible to secure absence of drop along with equality in the division of the work between the two cylinders.

To determine that point of cut-off in the low-pressure cylinder which will prevent drop when the ratio of cylinder and receiver volumes is assigned is a problem most easily solved by a graphic process. The process consists in drawing the curve of pressure during admission to the low-pressure cylinder until it meets the curve of expansion which is common to both cylinders.[2] Thus in Fig. 31 (where for the sake of simplicity the effects of clearance are neglected) AB represents the admission line and BC the expansion line in the small cylinder. Release occurs at C, and from C to D steam is being taken by the large cylinder. D corresponds to the cut-off in the large cylinder, which is the point to be found. From D to E steam is being compressed into the receiver. To avoid drop the receiver pressure at E is to be the same as the pressure at C. E is therefore known, and may be employed as the starting-point in drawing a curve EF which is the admission line of the low-pressure diagram EFGHI. This line is drawn by considering at each point in the low-pressure piston's stroke what is then the whole volume of the steam. The place at which EF intersects the continuous expansion curve BCG determines the proper point of cut-off. The sketch (Fig. 31) refers to the case of a tandem receiver engine; but the process may also be applied to an engine with any assumed phase relation between the cranks. Fig. 32 shows a pair of theoretical indicator diagrams determined in the same way for an engine with cranks at right angles, the high-pressure crank leading. In using the graphic method any form may be assigned to the curve of expansion. Generally this curve may be treated without serious inaccuracy as a common hyperbola, in which the pressure varies inversely as the volume.

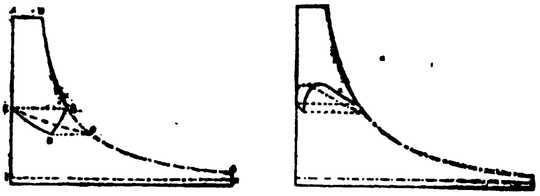

FIG. 31. FIG. 32.

FIGS. 31 and 32.—Determination of the point of cut-off in the low-pressure cylinder of a compound engine.

115. If this simple relation between pressure and volume be assumed, it is practicable to find algebraically the low-pressure cut-off which will give no drop, with assigned ratios of cylinder and receiver volumes. Taking the simplest case—that of a tandem engine, or of an engine with parallel cylinders whose pistons move together or in opposition—we may proceed thus: Since the point of cut-off to be determined depends on volume ratios we may for brevity treat the volume of the small cylinder as unity. Let R be the ratio to it of the receiver's volume, and L that of the low-pressure cylinder. Let x be the required fraction of the stroke at which cut-off is to occur in the large cylinder; and let p be the pressure at release from the small cylinder. As there is to be no drop, p is also the pressure in the receiver at the beginning of admission to the large cylinder. During that admission the volume changes from $1+\mathrm{R}$ to $1-x+\mathrm{R}+x\mathrm{L}$, and the pressure at cut-off is therefore $\frac{p(1+\mathrm{R})}{1-x+\mathrm{R}+x\mathrm{L}}$. The steam that remains is now compressed into the receiver, from volume $1-x+\mathrm{R}$ to volume R. Its pressure therefore rises to $\frac{p(1+\mathrm{R})}{1-x+\mathrm{R}+x\mathrm{L}}\cdot\frac{(1-x+\mathrm{R})}{\mathrm{R}}$, and this, by assumption, is to be equal to p. We therefore have

$$(1+\mathrm{R})\,(1-x+\mathrm{R})=\mathrm{R}(1-x+\mathrm{R}+x\mathrm{L}),$$

whence

$$x=(\mathrm{R}+1)/(\mathrm{RL}+1).$$

Thus, with $\mathrm{R}=1$ and $\mathrm{L}=3$, cut-off should occur in the large cylinder at half-stroke; with a greater cylinder ratio the cut-off should be earlier.

A similar calculation[3] for a compound engine whose cranks are at right angles, and in which cut-off occurs in the large cylinder before half-stroke, shows that the condition of no drop is secured when

$$2\mathrm{R}(x\mathrm{L}-1)=1-2\sqrt{x(1-x)}.$$

In some compound engines a pair of high-pressure cylinders discharge into a common receiver; in some a pair of low-pressure cylinders are fed from a receiver which takes steam from one high-pressure cylinder, or in some instances from two. With these arrangements the pressure in the receiver may be kept much more nearly constant than is possible with the ordinary two-cylinder type.

Uniformity of effort in a compound engine.

116. An important mechanical advantage belongs to the compound engine in the fact that it avoids the extreme thrust and pull which would have to be borne by the piston-rod of a single-cylinder engine working at the same power with the same initial pressure and the same ratio of expansion. If all the expansion took place in the low pressure cylinder, the piston at the beginning of the stroke would be exposed to a thrust much greater than the sum of the thrusts on the two pistons of a compound engine in

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[1] An intermediate receiver has the thermodynamic advantage that it reduces the range of temperature in the high-pressure cylinder, and so helps to prevent initial condensation of the steam. This will be made obvious by a comparison of Fig. 29 and Fig. 30. The lowest temperature reached in the high-pressure cylinder is that corresponding to the pressure at D, and is materially higher in Fig. 30 than in Fig. 29.

[2] See a paper by Prof. R. H. Smith, "On the Cut-off in the Large Cylinder of Compound Engines," *The Engineer*, November 27, 1885.

[3] Examples of calculations dealing with particular arrangements of two and three cylinder compound engines will be found in an Appendix to Mr. R. Sennett's *Treatise on the Marine Steam Engine.*

which a fair proportion of the expansion is performed in the small cylinder. Thus in the tandem engine of Fig. 29 the greatest sum of the thrusts will be found to amount to less than two-thirds of the thrust which the large piston would be subjected to if the engine were simple. The mean thrust throughout the stroke is of course not affected by compounding; only the range of variation in the thrust is reduced. The effort on the crank-pin is consequently made more uniform, the strength of the parts may be reduced, and the friction at slides and journals is lessened. The advantage in this respect is obviously much greater when the cylinders are placed side by side, instead of tandem, and work on cranks at right angles. As a set-off to its advantage in giving a more uniform effort, the compound engine has the drawback of requiring more working parts than a simple engine with one cylinder. But in many instances—as in marine engines—two cranks and two cylinders are almost indispensable, to give a tolerably uniform effort and to get over the dead points; and the comparison should then be made between a pair of simple cylinders and a pair of compounded cylinders. Another point in favor of the compound engine is that, although the whole ratio of expansion is great, there need not be a very early cut-off in either cylinder; hence the common slide-valve, which is unsuited to give an early cut-off, may be used in place of a more complex arrangement. The mechanical advantage of the compound engine has long been recognized, and had much to do with its adoption in the early days of high-pressure steam.[1] Its subsequent development has been due in part to this, but probably in much greater part to the thermodynamic advantage which has been discussed above (§ 93).

Indicator diagrams.

117. Indicator diagrams taken from compound engines show that the transfer of steam from one cylinder to another is never, under the most favorable conditions, performed without loss of energy. Fig. 33 shows a pair of diagrams from the two cylinders of a tandem Woolf engine, in which the steam passed as directly as possible from the small to the large cylinder. The diagrams are drawn to the same scale of *stroke* and therefore to different scales of *volume*, and the low-pressure diagram is turned round so that it may fit into the high-pressure diagram. There is some drop at the high-pressure release, and, apart from this, there is a loss through friction of the passages, which shows itself by the admission line to the large cylinder lying below the exhaust line from the small one.

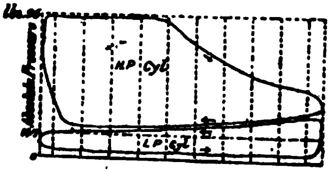

FIG. 33.

118. Fig. 34 is a pair of diagrams taken from a compound tandem receiver engine running at 50 revolutions per minute, with cylinders 30 inches and 52 inches in diameter, and with a 6-feet stroke. The ratio of cylinder volumes is therefore 3 to 1. The capacity of the receiver is nearly 1½ times that of the small cylinder. There is a comparatively early cut-off in both cylinders, and a nearly complete absence of drop. The small cylinder, however, does more work than the large one, in the ratio of nearly 3 to 2.

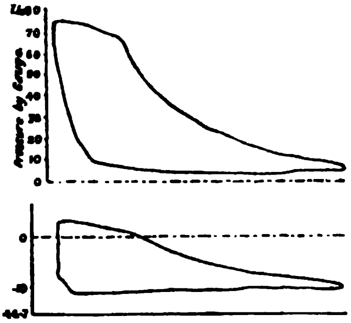

FIG. 34.

Combination of diagrams from compound engines.

Fig. 35 shows the same pair of diagrams combined by drawing both to the same scale of volume and of pressure, and by setting out each by an amount equal to the clearance space from the line of no volume. This makes the expansion curve in each diagram represent correctly the relation of the pressure to the absolute volume of the expanding steam. The broken line is a continuous curve of *adiabatic* expansion drawn from the point of high-pressure cut-off, on the assumption that the steam then contained about 25 per cent. of condensed water. If the expansion were actually adiabatic, and if there were no loss in the transfer of the steam, the expansion curves for both cylinders would fall into this line.

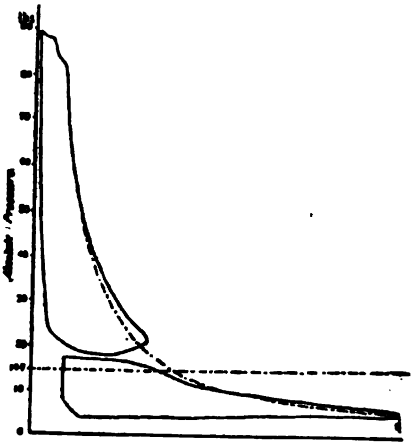

FIG. 35.—Diagrams of Fig. 34 combined.

119. Fig. 36 exhibits, in the same manner as Fig. 35, a set of diagrams taken by Mr. Kirk from the triple expansion engines of the S. S. "Aberdeen." Each diagram is set out from the line of no volume by a distance which represents the clearance in the corresponding cylinder. The boiler pressure is 125 lb per square inch. The cylinders are 30 inches, 46 inches, and 70 inches in diameter, and the stroke is 4½ feet. The cranks make 120° with each other. The means of the diagrams for the two ends of each cylinder have been used in drawing this and the next figure, a practice which should be followed in drawing combined diagrams of the kind here exemplified.

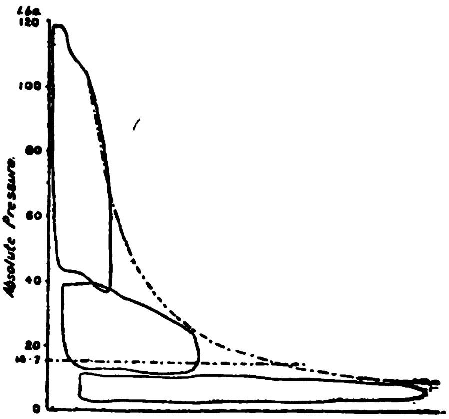

FIG. 36.

120. Fig. 37 shows in the same way a set of diagrams taken by Mr. Brock from the *quadruple* expansion engines of the S. S. "Lohara" (by Messrs. Denny & Co.). Here the boiler pressure was 154 lb by gauge, or 169 lb absolute, the cylinders were 24 inches, 34 inches, 48 inches, and 68 inches in diameter, the stroke was 4 feet, and the number of revolutions 65 per minute.

121. In all these cases a continuous curve, shown by a broken line, has been drawn to represent the result of adiabatic expansion, on the same assumption as before—that the steam contains about 25 per cent. of water at the point of

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[1] See a paper by Dr. W. Pole. "On the Double Cylinder Expansive Engine," *Proc. Inst. M. E.*, 1862.

cut-off in the first cylinder. The equation to the curve may then be taken as $PV^{\frac{10}{9}} = \text{constant}$ (§ 67). In the absence of data regarding the wetness of the steam this assumption may be considered fair.

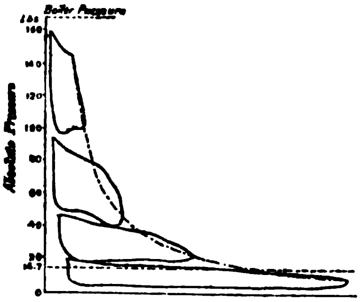


FIG. 37.

122. Lastly, Fig. 38 shows a pair of diagrams, treated in the same manner, for a two-cylinder compound engine with cranks at right angles to each other, the high-pressure crank being 90° degrees in advance. During the back stroke of the high-pressure piston there is at first compression into the receiver until the large cylinder opens; the high-pressure diagram consequently takes a peculiar form, which should be compared with the diagram already given for a tandem engine (§ 118). In this example there is a considerable amount of drop and also of loss between the two cylinders.

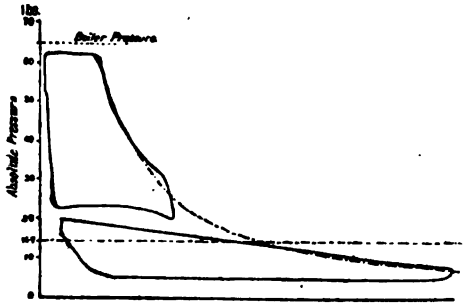


FIG. 38.

VII.—THE PRODUCTION OF STEAM.—BOILERS.

Furnace efficiency.

123. The first step in the production of steam is to convert the potential energy of fuel into actual heat; the second step is to transfer the heat to water in the boiler. The efficiency of furnace and boiler is the ratio which the amount of heat taken up by the water bears to the whole potential energy of the fuel. In good boilers this efficiency is about 0.7. The loss is due partly to incomplete combustion of the fuel and partly to incomplete transfer of heat from the products of combustion to the boiler water. Under the first head may be classed: (1) waste of fuel in the solid state by bad stoking, and (2) waste of fuel in the gaseous and smoky states by imperfect combustion. Under the second head are comprised: (1) waste by external radiation and conduction, and (2) waste by heat contained in the hot gases which escape by the chimney, due (*a*) to their still high temperature and (*b*) to the fact that they contain as one of the products of combustion steam-gas which passes away uncondensed. Loss of heat by the hot gases is the most important source of waste. Not only are the actual products of combustion rejected at a high temperature, but along with them goes the nitrogen of the air whose oxygen has been used, and also a quantity of additional air which is needed to dilute the products in order that combustion may be fairly complete. Roughly speaking, about 12 lb of air are required to supply oxygen enough for the combustion of 1 lb of coal. Over and above this quantity, about 12 lb more generally pass through the furnace as air of dilution. In furnaces with forced draught, in which the consumption of coal per square foot of grate surface is much more rapid, the air of dilution may be reduced to half or less than half of this quantity, though to some extent at the expense of completeness in the combustion.

Heating surface.

124. The extent to which heat is taken from the hot gases depends on the *heating surface* through which heat passes into the water. The heating surface is made up of the surface of the furnace or combustion-chamber, so far as that is brought into contact with the water, and of the flues or tubes through which the hot gases pass on their way to the chimney. Its efficiency depends on the conductivity of the metal, on the difference in temperature between the gases on one side and the water on the other, and on the freedom with which steam, when formed, can escape from the surface. Differences in specific conductivity and in thickness of metal affect the result less than might be expected, on account of the resistance which is offered to the passage of heat through the film of scale and also through the film of water vapor which forms on the metallic surface.

By extending the heating surface sufficiently the hot gases may be deprived of heat to an extent which is only limited by the temperature of the boiler water. This temperature, however, need not form a limit, for after leaving the boiler the gases may be further cooled by being brought into contact with a vessel termed a feed-water heater, through which the feed-water passes on its way to the boiler. Even with a feed-water heater, however, the temperature of the hot gases is never, in practice, reduced so low as that of the boiler.

Draught.

125. In nearly all land engines and most marine engines the draught is produced by means of a chimney which acts in virtue of the column of air within it being specifically lighter than the air outside, so that the pressure within the chimney at its base is less than the atmospheric pressure at the same level outside. The composition of the chimney gases is such that they are heavier than air at the same temperature, and to make them sufficiently lighter to cause a draught they must retain a certain considerable portion of their heat. On the other hand, if they are left too hot the mass of air drawn through the furnace is actually diminished, since then the chimney gases are so much expanded that the increased volume of the draught does not compensate for its diminished density. With a given chimney and furnace the maximum draught is obtained when the gases escape at a temperature about that of melting lead; by making the chimney more capacious a lower temperature will suffice to give the same draught, and this will of course increase the efficiency of the boiler.

126. In place of using a chimney draught depending merely on the temperature of the rejected hot gases, the air required for combustion and dilution may be forced through the furnace either by producing a partial vacuum in the chimney or by supplying air to the grate at a pressure higher than that of the atmosphere. In locomotives, for example, a partial vacuum is produced in the chimney by means of a blast of exhaust steam from the engine; and in many naval and a few mercantile steamers a forced draught is produced by having a closed stokehole or a closed ashpit, which is supplied with air at a pressure above that of the atmosphere by the use of a blowing fan.

If heat were thoroughly extracted from the products of combustion, a forced draught would be more efficient, from the thermodynamic point of view, than a chimney draught, for a chimney is in fact an extremely inefficient heat-engine, and requires a very large amount of heat to be expended in order to effect the comparatively trifling work of maintaining the draught. But where forced draught has been substituted for chimney draught this has hitherto been done for the purpose of increasing not the efficiency but the *power* of boilers. The motive has been to burn more coal per square foot of grate surface and so to evaporate more water with a boiler of given weight. This is incompatible with very high efficiency. When more coal is burnt by forcing the draught it is true that the products of combustion have a higher temperature (since less air is required for dilution) and the effectiveness of the heating surface is therefore increased. But the heating surface has more hot gas to deal with, and the result is that the boiler is less efficient than when the draught is not forced. The same efficiency could be secured, with forced draught, by increasing the heating surface to a sufficient extent; and a still greater efficiency could be realized if the heating surface were still further enlarged so that the gases left the flues at a temperature lower than would be needful if the draught depended on the lightness of the chimney's contents. The most efficient boiler would be one in which the draught was forced by mechanical means, and the gases were then cooled as far as possible by contact with a very extensive heating surface, first in the boiler itself and then in a feed-water heater. None of the forced-draught boilers that have hitherto been introduced have a heating surface so large as to make them more efficient than good chimney-draught boilers (in which the rate of combustion is much slower), although the heating surface bears a much larger ratio to the grate area than is usual with chimney draughts.

Boilers for stationary engines.

127. Most modern boilers are internally fired; that is to say, the furnaces are more or less completely inclosed within the boiler. Externally fired boilers are for the most part much less efficient than internally fired boilers; they are, however, used to a considerable extent where fuel is specially cheap or where the waste heat of other furnaces is to be utilized. Their usual form is that of a horizontal cylinder with convex ends; the strength both of the main shell and the ends is derived from their curvature, and no staying is necessary. The heating surface is entirely external and is of very limited extent.

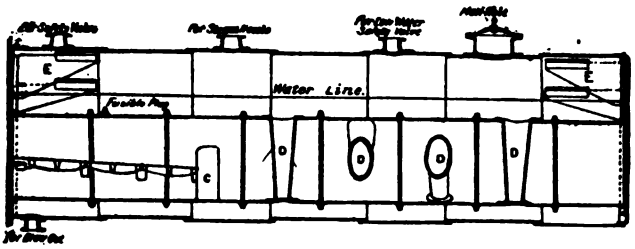


FIG. 39.—Cornish Boiler: longitudinal section.

Cornish and Lancashire boilers.

In large stationary boilers the forms known as the "Lancashire" (or double flue) and the "Cornish" (or single flue) are most common. Figs 39 and 40 show in section a Cornish boiler by Messrs. Galloway, and Fig. 41, a Lancashire boiler by the same makers. In both the shell is a round horizontal cylinder with flat ends. In the Cornish boiler there is one internal flue, at the front end of which is the furnace. The hot gases pass through the flue to the back; they then return to the front end by two external side flues (A, A, Fig. 40), and finally pass to the back again by an under-

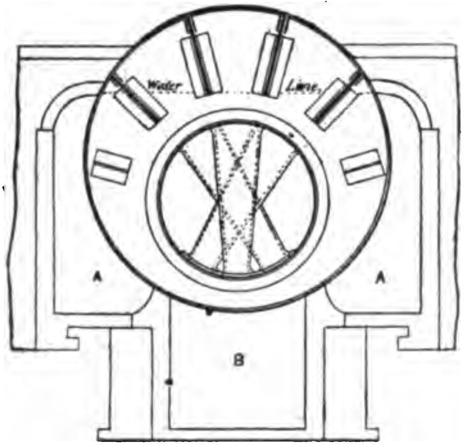


FIG. 40.—Cornish Boiler: transverse section, showing flues.

neath flue B. The arrangement in the Lancashire boiler is the same, except that there are two internal flues, each with its own furnace. The shell is made up of rings of riveted plates, larger and smaller in diameter alternately to allow the circumferential seams to be made without bending the edges. The flue is made up of a series of welded rings, joined to each other by a flanged joint with a stiffening ring. This form of joint was introduced by Mr. Adamson to stiffen the flue against collapse under external pressure. Other joints, designed with the same object, are shown in Figs. 42 and 43. The grate is made up of fire-bars sloping down towards the back, where they terminate at the "bridge" of fire-brick (C, Fig. 39). Beyond the flue is crossed by a number of tapered "Galloway" tubes D, D, which increase the heating surface, promote circulation of the water, and stiffen the flue. The end plates are strengthened by gusset stays E, E, riveted to them and to the circumference of the shell by means of angle-irons. The gusset-stays do not extend so far in as to the circumference of the flue (Fig. 40), in order that the end-plates may retain enough flexibility to allow the flue to expand and contract under change of temperature. To provide for unequal expansion is one of the most important points in the design of boilers; when it is neglected the boiler is

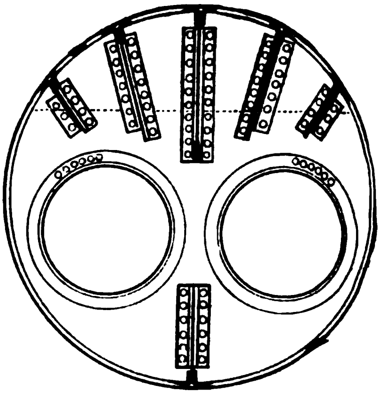
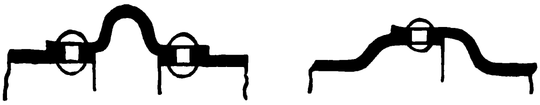


FIG. 41.—Lancashire Boiler: transverse section.

subjected to a racking action which induces leakage at joints and tends to rupture the plates. For this reason the flue is attached to the boiler shell at the ends only, so that it may be free to take an upward camber in consequence of the greater heating of the upper side.



FIGS. 42 and 43.— Joints for Furnace Tubes.

Mild steel is now very generally used for boiler plates, being superior even to the best Yorkshire iron in the qualities of ductility and tensile strength. The following particulars refer to the Lancashire boiler of Figs. 41, which may be taken as representative of a large number of stationary boilers.

Details of Lancashire boiler.

128. The shell is 28 feet long and 7 feet in diameter, and is made up of 9 rings, each of two semi-cylindrical plates. The shell plates are ⅜ inch thick; their edges are planed and fullered, and the rivet holes are drilled. The longitudinal seams, which break joint from ring to ring, are lap-joints double-riveted; the circular seams are single-riveted. Each end-plate is a solid piece of steel ¾ inch thick; the front plate is attached to the shell by riveting to an angle ring; the back plate is flanged. The flues are each 2 feet 9½ inches in diameter, made up of rings of steel ⅜ inch thick; the longitudinal joints are welded and the circular joints are flanged and strengthened with stiffening rings. The flues are tapered somewhat at the back end to facilitate expansion, and are attached to the end plates by welded angle-rings. Each flue contains 5 Galloway tubes, tapering from 10½ inches diameter at top to 5½ inches at

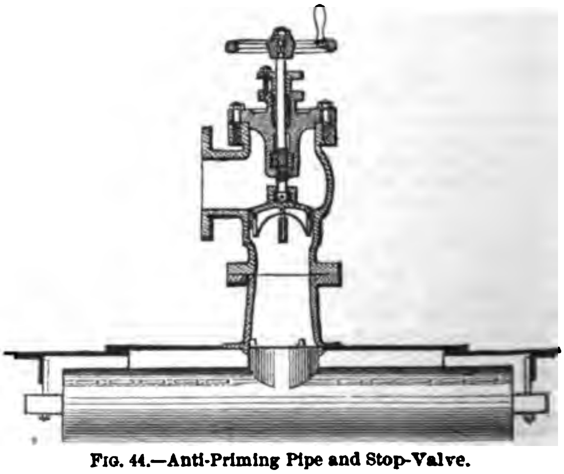


FIG. 44.—Anti-Priming Pipe and Stop-Valve.

bottom. On the top of the boiler is the manhole, covered with a cast-iron plate; also a nozzle for the steam-pipe and two others for safety-valves. One of the safety-valves is connected with a float so that it opens if the water-level becomes too low. At the bottom, in front, is another nozzle for the blow-out tap; and in the front plate below the flues is another manhole. Feed-water is supplied by a pipe which enters through the front plate on one side, near the top of the water, and extends for a considerable distance along the boiler, distributing the water by holes throughout the length. A pipe at the same level on the other side serves to collect scum. The fire doors are provided with sliding shutters by means of which the amount of air admitted above the fire may be regulated. On the top of each furnace is fitted a fusible plug which melts if the furnace crown becomes overheated. No separate steam dome is used; the steam is collected by an "anti-priming" pipe shown in Fig. 44, which also illustrates the stop-valve by which the delivery of steam from the boiler is started or stopped at will. On the front plate are a pair of glass gauge-tubes for showing the water-level, and a Bourdon pressure-gauge. This last important fitting consists of a bent tube of oval section, one end of which is closed and free to move while the other is open to the steam and is fixed. The pressure within the tube tends to straighten it, and the extent to which this takes place is shown by a pointer which travels over a circular dial. A common lever safety-valve is shown in Fig. 45. In other forms the valve is kept down by a weight directly applied to it, or by means of springs. Spring safety-valves are liable to the objection that when the valve opens the load on it increases; to remedy this, forms have been proposed in which the spring acts through a bent lever in such a way that when the strain on it increases the leverage at which it acts is reduced. If the spring is of reasonable length, however, the objection is not serious.

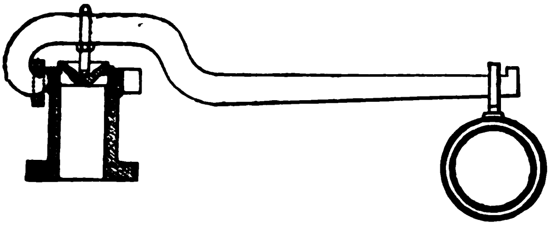


FIG. 45.—Lever Safety-Valve.

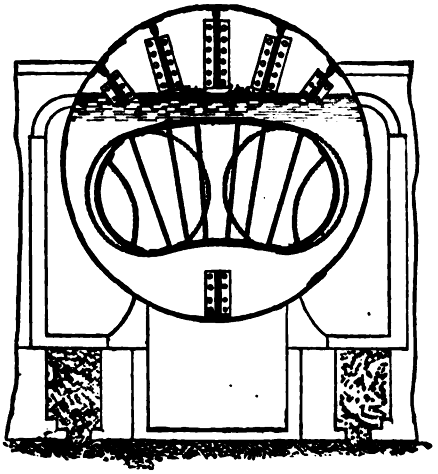


FIG. 46.—Galloway Boiler: Section beyond the Bridge.

Galloway boiler.

129. A modification of the Lancashire type—the "Galloway" boiler—is shown in sectional elevation in Fig. 46. In it the two flues are joined beyond the bridge into a single flue, of the form shown in the figure, which is traversed by numerous Galloway tubes and is also fitted with water-pockets at its sides.

Multitubular boilers.

130. In other types of boiler an extensive heating surface is obtained by the use of a large number of small tubes through which the hot gases pass. This construction is universal in locomotive and marine boilers. It is applied in some instances to boilers of the ordinary cylindrical form by making small tubes take the place of that part of the flue or flues which lies behind the bridge, or by using small tubes as channels through which the gases return from back to front after passing through the main flue. Another form of tubular boiler is an externally fired horizontal cylinder fitted with tubes which carry the hot gases from the back to the front.

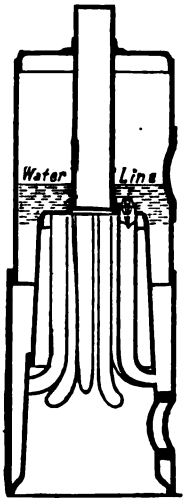


FIG. 47.—Vertical Boiler with Vertical Water Tubes.

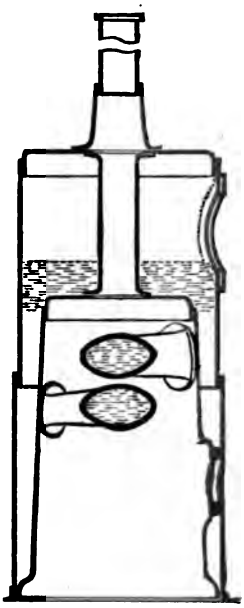


FIG. 48.—Vertical Boiler with Horizontal Water Tubes.

Vertical boilers.

131. Vertical boilers are extensively used in connection with small engines. Examples are shown in Figs. 47–49. Fig. 48 is an ordinary vertical boiler filled with cross tubes of the Galloway type. Fig. 47 (by Messrs. Davey, Paxman & Co.) is a boiler with curved water tubes, each of which has fitted in the top a loose cap whose function is to deflect the stream of water which circulates up the tubes. Fig. 49 is a form of multitubular boiler by the same makers, in which the hot gases escape at the side after passing from the smoke-box through horizontal tubes grouped in circular arcs. In all these boilers the grate is at the foot, and the fire-door is at a mouthpiece in the side of the boiler near the base. In other forms of vertical boiler the heating surface is increased by water tubes (Fig. 50) which hang from the crown

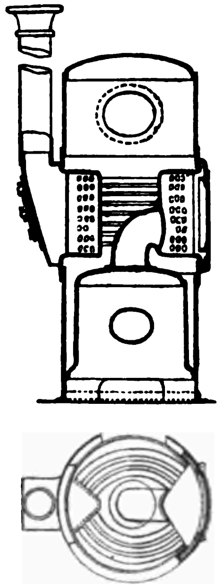


FIG. 49.—Vertical Boiler: Tubular Form.

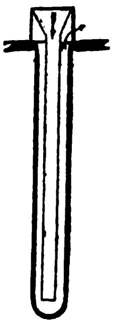


FIG. 50.—Field Tube.

of the fire-box, closed at the lower end but fitted internally with smaller tubes which are open at the bottom. Water circulates down the inner tubes and up between them and the outer. Tubes of this kind (called Field tubes) are used in fire-engine boilers and in other cases where it is necessary to get up steam with the least possible delay. Vertical boilers of large size are sometimes used for utilizing the waste heat of iron furnaces.

Sectional or tubulous boilers.

132. A great variety of boilers have been designed in which the firing is external, and the water space consists of groups of tubes or other small sections whose outer surface is exposed to heat. Boilers of this type are called sectional or tubulous boilers, in distinction to tubular boilers, or boilers with tubes in which the hot gases circulate. A successful example of the tubulous or sectional type is the Babcock & Wilcox water-tube boiler, which consists of a series of inclined welded tubes up which water circulates. These are joined at their ends by cast-iron connecting boxes to one another and to a horizontal drum on the top in which the mixture of steam and water which rises from the tube undergoes separation. At the lowest point of the boiler is another drum for the collection of sediment. Root's boiler is another in which water is heated by circulating through inclined tubes exposed to the fire; it differs from the above form chiefly in having the water-level below the top of the tube. Harrison's boiler is a group of small globular vessels of cast-iron strung like beads on rods which tie them together. Sectional boilers may be constructed without difficulty to bear pressures greatly in excess of those for which other types are suited. Mr. Perkins has employed a tubulous boiler to deliver steam at a pressure of 500 ℔ per square inch.[1] The Herreshof boiler is a continuous coil of tube, arranged as a dome over the fire. Feed-water is pumped slowly through the coil, and turns to steam before it reaches the end.

Locomotive boilers.

133. The locomotive boiler consists of a nearly rectangular fire-box, inclosed above and on the sides by water, and a cylindrical part called the barrel extending horizontally from the fire-box to the front part of the locomotive and filled with numerous tubes. Figs. 51 and 52 show in longitudinal and transverse section a boiler of the London and North Western Railway, which may be taken as typical of modern English practice.

The barrel is ten feet long and a little more than 4 feet in diameter, and is made up of three rings of steel plates, $\frac{11}{32}$ inch thick, arranged telescopically. It contains 198 brass tubes, each $1\frac{7}{8}$ inches in external diameter. The front tube-plate in which the tubes terminate is of steel $\frac{3}{4}$ inch thick; it is stayed to the back tube-plate by the tubes themselves, and the upper part of the front tube-plate is also tied by longitudinal rods to the back end-plate. The fire-box is of copper ½ inch thick. It is nearly rectangular, with a horizontal grate. (A grate sloping down in front is often preferred.) Round its sides, front, and back (except where the fire-door interrupts) is a water space about 3 inches wide, which narrows slightly towards the bottom. The flat sides of the fire-box are tied to the flat sides of the shell by copper stay-bolts, 4 inches apart, which are secured by screwing them into both plates and riveting over the ends. The roof of the fire-box is stiffened by a number of girders on the top, to which the plates are secured by short bolts. The girders are themselves hung from the top of the shell above them by slings which are secured to angle-irons riveted on the inside of the shell plates. A sloping bridge of fire-brick partially separates the upper part of the fire-box from the lower and prevents the flame from striking the tubes too directly. Under the grate is an ashpan, to which the supply of air is regulated by a damper in front. The fire-door opens inwards, and can be set more or less open, to regulate the amount of air admitted above the fire. On top of the barrel is a steam-dome, from which the steam supply is taken through a pipe S traversing the forward part of the steam space and passing down to the valve-chest through the smoke-box. The stop-valve or "regulator" R is situated in the smoke-box, and is worked by a rod through the boiler from the cab at the back. Above the fire-box end of the shell are a pair of Ramsbottom safety-valves, V, V—two valves pressed down by a single spring attached to the middle of a cross bar, which is prolonged to form a hand lever by which the valves may be lifted. In front of the forward tube-plate is the smoke-box, containing the blast-pipe B by which the exhaust steam is used to produce a partial vacuum and so force a draught through the furnace.

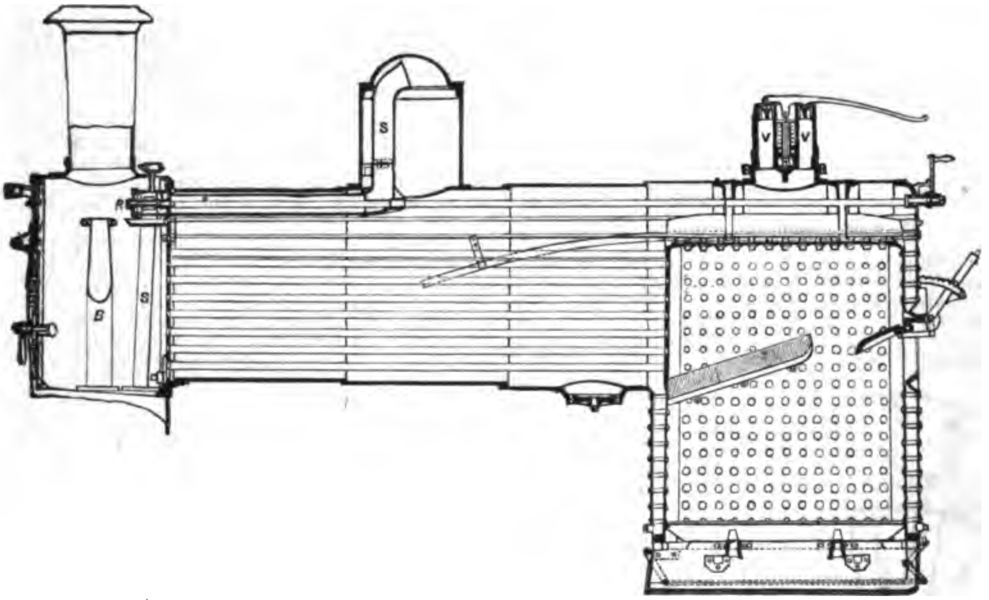


FIG. 51.—Locomotive Boiler.

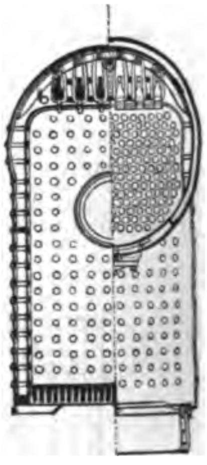


FIG. 52.

134. Instead of stiffening the fire-box roof by the use of girder stays, the plan is sometimes followed of staying it directly to the shell above. The outer shell above the fire-box is generally cylindrical; but to facilitate this method of staying it is sometimes made flat. This construction is not unusual in American locomotive boilers, another feature of which is that the grate is made much larger than in English practice, for the purpose of burning anthracite coal. An extreme instance is furnished by the Wooton engines of the Philadelphia and Reading Railroad, which burn small coal of poor quality in a fire-box 9½ feet long by 8 feet wide, extending over the trailing wheels of the engine. In some cases the fire-box is divided by a sloping partition of plates with water between, which crosses the fire-box diagonally from front to back and has in its centre an opening resembling a fire-door mouthpiece to allow the products of combustion to pass. In others the fire-bridge is supported by water tubes, and water tubes are also used as grate-bars. This is done rather to promote circulation of the water than to give heating surface. The practice of American and English locomotive engineers differs widely as regards the materials of construction. American shells are of mild steel, English shells generally of mild steel but often of wrought-iron. In English practice the fire-boxes

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[1] *Proc. Inst. Mech. Eng.*, 1877. See also a paper by Mr. Flannery, "On High-Pressure Steam Boilers," *Min. Proc. Inst. C. E.*, 1878.

are of copper and the tubes of brass; in America the fire-boxes are of mild steel and the tubes of wrought-iron.[1]

The locomotive type of boiler is used for stationary engines of the portable, semi-portable, and semi-fixed types, and also to a limited extent for marine engines in cases where lightness is of special advantage.

Marine boilers.

135. So long as marine engines used steam of a pressure less than about 35 ℔ per square inch the marine boiler was generally a box with flat sides, elaborately stayed, with a row of internal furnaces near the bottom opening into a spacious combustion-chamber inclosed within the boiler at the back, and a set of return tubes leading from the upper part of the chamber to the front of the boiler, where the products of combustion entered the uptake and passed off to the funnel. The use of higher pressures has made this form entirely obsolete. The normal marine boiler is now a short circular horizontal cylinder of steel with flat ends, with internal furnaces in cylindrical flues, internal combustion-chambers, and return tubes above the flues. In one variety, called the double-ended boiler, there are furnaces at both ends of the shell, each pair leading to a combustion-chamber in the centre that is common to both, or to separate central chambers with a water space between them.

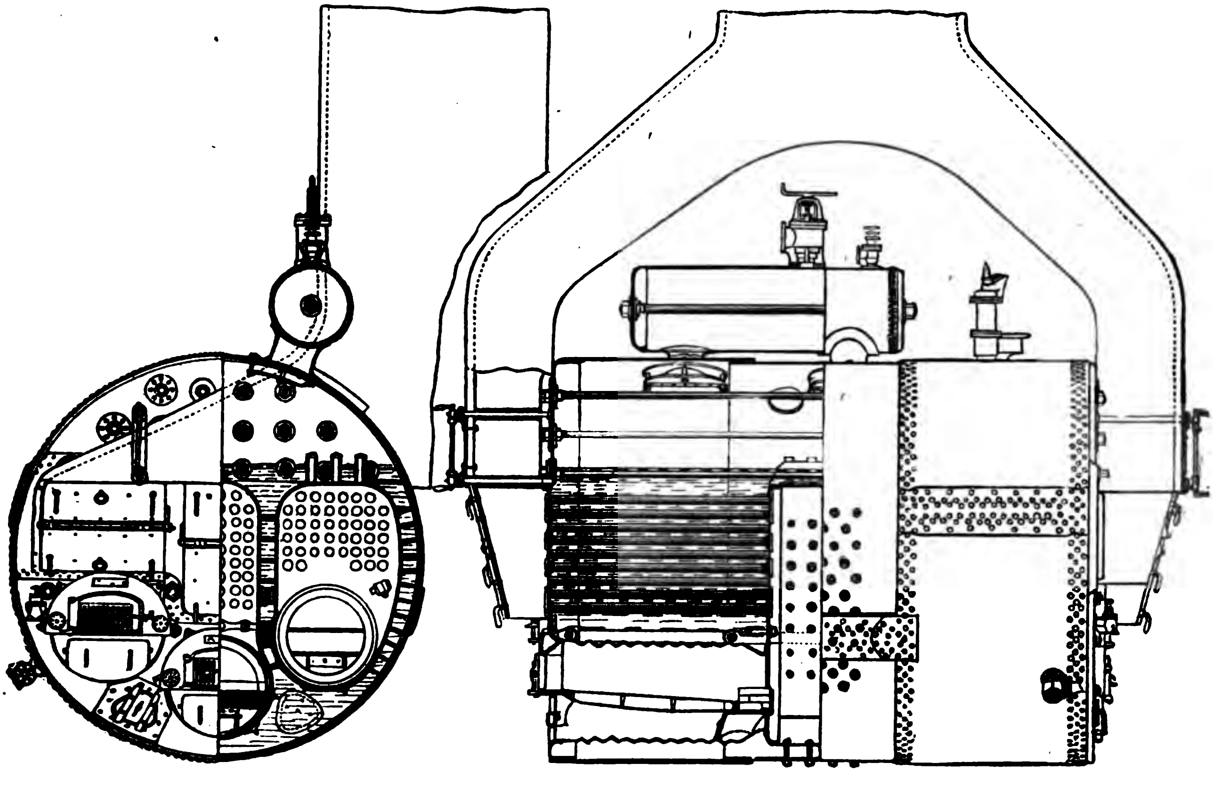
FIG. 53.
FIG. 54.

FIGS. 53, 54.—Double-Ended Marine Boiler.

Details of double-ended marine boiler.

Figs. 53 and 54 show with some completeness a double-ended marine boiler of the most modern construction for high-pressure steam. At each end there are three furnaces in flues made of welded corrugated steel plates. The use of corrugated plates for flues, introduced by Mr. Fox, makes thin flues able to resist collapse, and allows the flues to accommodate themselves easily to changes of temperature. One combustion-chamber is common to each pair of furnaces. It is strengthened on the top by girder stays and on the sides by stay-bolts to the neighboring chamber and to the shell. The tubes are of iron, and a certain number of them are fitted with nuts so that they serve as stays between the tube-plate of the combustion-chamber and the front of the boiler. The upper part of the front plate is tied to the opposite end of the boiler by long stays. The uptakes from both ends converge to the funnel base above the centre of the boiler's length. The boiler shown is one of a pair, which lie side by side in the vessel, the uptake at each end being common to both. Each boiler has a steam-dome, from which the steam-pipe leads to the engine; this consists of a small cylindrical vessel, with flat ends tied together by a central stay. Short pipes connect the dome near each end with the steam space of the main shell. The boilers of Figs. 53 and 54, which are by Messrs. Gourlay Brothers of Dundee, work at a pressure of 165 ℔ per square inch above the atmosphere, and are used with triple expansion engines. The shell is 12¼ feet in diameter, and 16½ feet long. The plates are of mild steel 1⅛ inches thick round the shell and 1 inch in the ends. The tube plates are ⅞ inch and 13/16 inch thick, and the corrugated flues ½ inch. The longitudinal seams are treble-riveted, with inside and outside covering plates. The circumferential seams are lap-joints double-riveted. There are 127 tubes at each end, 46 of which are stay-tubes. The tubes are of iron, 3¼ inches in external diameter. Above these are 18 longitudinal steel stays 2⅝ inches in diameter. The steam-dome is a cylinder 2½ feet in diameter and 8 feet long, stayed by a central 3½-inch rod of steel. The short fire-box stays are also of steel 1½ inches in diameter, of 7⅞ inches pitch, and are secured by nuts and washers at both ends. The central combustion-chamber has a round and unstayed roof. The top of each side combustion-chamber is stayed by three steel girders 8⅝ inches × 2¼ inches in section, secured by four bolts to the roof-plate below. A single-ended marine boiler by the same makers is shown in Fig. 55. Boilers of this class are in some instances set athwartship instead of longitudinally, and bevelled on the bottom, at the back, to accommodate them to the shape of the hull. A modification of the cylindrical form is occasionally used, in which the section is an oval, with round top and bottom and flat sides. The combustion-chambers are sometimes made with rounded tops, which are tied to the back plate by gusset-stays and angle-irons. In naval practice the tubes are frequently of Muntz metal in place of iron. Another form of boiler, used to a considerable extent in the British navy, is a long horizontal cylinder with two internal furnaces opening into a large combustion-chamber about the middle of the length. From this a set of tubes distributed over nearly the whole water space extend to the back, where the uptake is situated.

Navy type.

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[1] See a paper by Mr. Fernie, *Min. Proc. Inst. C. E.*, 1883.

Locomotive type of marine boiler.

136. The locomotive type of boiler has been successfully adapted to marine use by Mr. Thornycroft and others, especially for torpedo boats. This form gives much greater heating surface than others in proportion to its weight, and allows, especially when worked with forced draught, a large amount of power to be got from a small boiler. It is probable that, if any further rise is to occur in the steam pressure used in marine engines, comparable to that which has occurred during the last two or three years, the present normal marine boiler will give place to a form more nearly resembling the locomotive type.

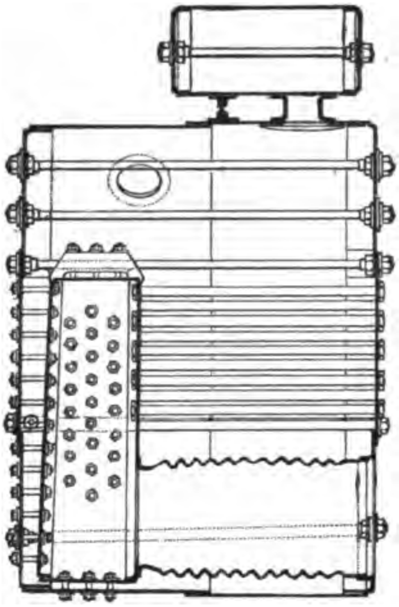

FIG. 55.—Single-Ended Marine Boiler.

Feeding boilers. Injector.

137. Boilers are usually fed either by a feed-pump driven by the engine, or by a distinct auxiliary engine called a "donkey," or by an injector. The *injector*, invented by the late M. Giffard, and now very generally used on locomotive and other boilers, is illustrated in Fig. 56. Steam enters from the boiler at A and blows through an annular orifice B, the size of which is regulated by the handle C. The feed-water flows in at D, and meeting the steam at B causes it to condense. This produces a vacuum at B, and consequently the water rushes in with great velocity, and streams down through the combining nozzle I, its velocity being augmented by the impact of steam on the back of the column. In the lower part of the nozzle E the stream expands; it therefore loses velocity, and, by a well-known hydrodynamic principle, gains pressure, until at the bottom its pressure is so great that it enters the boiler through a check-valve which opens only in the direction of the stream. The escape orifice F and the overflow pipe G allow the injector to start into action, by providing a channel through which steam and water may escape before the stream acquires enough energy to force its way into the boiler. The opening for admitting water between D and B is regulated by the wheel H. The *exhaust-steam injector* works by steam from the exhaust of non-condensing engines, instead of boiler steam. The steam orifice is then larger in proportion to the other parts, and the steam supply more liberal. In *self-starting injectors* an arrangement is provided by which overflow will take place freely until the injector starts into action and then the openings are automatically adjusted to suit delivery into the boiler. One plan of doing this is to make the combining nozzle under the steam orifice in a piece which is free to slide in the outer casing. Until the injector starts it lies at some distance from the steam orifice, and allows free overflow; but when the vacuum forms it rises, in consequence of pressure at the base. In self-adjusting injectors this rise of the combining nozzle is made use of to contract the water-way round the steam orifice. In another form of self-starting injector one side of the combining nozzle is in the form of a hinged flap, opening backwards to allow overflow, but closing up when a vacuum is formed and the injector starts into action.[1]

Hydrokineter.

Weir's *hydrokineter* for large marine boilers is another apparatus in which the principle of the injector is made use of with the object of promoting circulation of the water during the time steam is being raised. It consists of a series of nozzles, with water-inlets between them, through which water is drawn by means of a central jet of steam supplied from a donkey boiler.

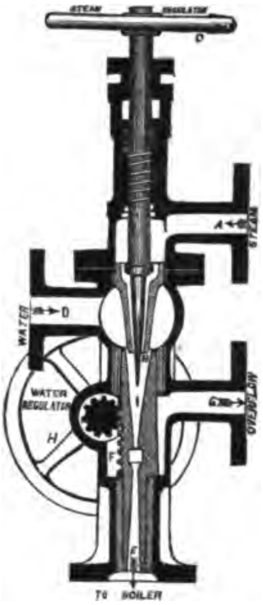

FIG. 56.—Giffard's Injector.

Feed-water heaters.

138. In stationary engine boilers the feed-water is frequently heated by the products of combustion before these reach the chimney, in what is virtually an extension of the boiler itself. Green's economizer is a contrivance for this purpose, in which the water passes through tubes whose outer surface is exposed to the hot gases and kept clear of deposited soot by the continuous action of a mechanical scraper. In locomotives and other non-condensing engines a portion of the exhaust steam is frequently made use of to heat the feed-water. When an exhaust-steam injector is employed it serves the purpose of a feed-water heater as well as that of a feed-pump. Besides increasing the efficiency of the boiler by utilizing what would otherwise be waste heat, a feed-water heater has the advantage that by raising the temperature of the water it removes air, and also, in the case of hard water, causes lime and other substances held in solution to be deposited in the heater instead of being carried into the boiler, where they would form scale. In Weir's feed-heater for marine engines the temperature of the feed-water is raised to about 200° Fahr. by injecting steam from the intermediate receiver.

Separator. Steam-trap.

139. In stationary and marine boilers the steam, after leaving the boiler, is frequently taken through a *separator*, the function of which is to separate the dry steam from particles of water held in suspension. Steam is led round a sharp corner, and the water particles thrown off by centrifugal force collected in a *trap* below, from which they are discharged by a pipe which is kept open so long as the trap contains water, but is closed by a valve at the foot when the trap is empty. Traps are also fitted in many cases to steam-pipes for the purpose of returning condensed water to the boiler.

Use of zinc in boilers.

140. To prevent corrosion in boilers it is very usual to introduce blocks of zinc in metallic connection with the shell. These are set in the water space, preferably at places where corrosion has been found specially liable to occur. Their function is to set up a galvanic action, in which zinc plays the part of the negative element, and is dissolved while the metal of the shell is kept electro-positive. Otherwise there would be a tendency for difference of electric quality between different parts of the shell to set up galvanic actions between the parts themselves, by which some parts, being negative to others, would be attacked. The zinc raises the potential of the whole shell enough to make all parts positive.

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[1] See papers in *Proc. Inst. Mech. Eng.*, 1860, 1866, 1884.

Forced draught. 141. Allusion has already been made to the system which is universal in locomotive boilers of forcing the draught by a blast of exhaust steam in the chimney. A jet of boiler steam is occasionally used in marine furnaces for the same purpose; but of late years the system which has found most favor is to box in the stokehole and keep the air in it at a pressure of from 1 to 3 inches of water by the use of blowing fans. This system has been applied largely in naval practice, with the result that the power of the boiler is increased in the ratio of about 3 to 2, or even more, as compared with its power under chimney draught. The efficiency of the boiler is, in general, slightly but not very materially reduced. An ordinary marine boiler burns 16 to 20 ℔ of coal per hour per square foot of grate with natural draught, and 30 ℔ or more with forced draught. In torpedo-boat boilers of the locomotive type the consumption has in some cases been forced to more than 100 ℔.

In Mr. Howden's system of forced draught the stokehole is open, and air is supplied by a blowing fan to a reservoir formed by inclosing the ashpit and also to another reservoir from which it gets access to the grate above and through the fire-door. On its way to the reservoir the air is heated by passing across a part of the uptake in which the hot gases from the furnace are led through tubes. This method of restoring to the furnace what would otherwise be waste heat forms an interesting alternative to the method of restoring heat to the boiler by passing the hot gases through a feed-water heater; it is in fact an application to boiler furnaces of the regenerative principle alluded to in chap. II.[1]

Mechanical stokers. 142. Many appliances have been devised for the mechanical supply of coal to boiler furnaces, but these have hitherto taken the place of hand-firing to only a very limited extent. In Juckes's furnace the fire-bars are in short lengths, jointed by pins to form a continuous chain or web, which rests on rollers and is caused to travel slowly in the direction of the furnace's length by pin-wheels round which the web is carried at the front and back. Coal is allowed to drop continually on the travelling grate from a hopper in front of the furnace. A more usual form of mechanical stoker is a reciprocating shovel or ram, supplied from a coal-hopper, which throws or pushes a small quantity of coal into the fire at each stroke. Along with this devices are employed for making the grate self-cleansing, by giving alternate fire-bars a rocking or sliding motion through a limited range. In Mr. Crampton's dust-fuel furnace the coal is ground to powder and fed by rollers into a pipe from which it is blown into the furnace by an air-blast. The mixture of fuel and air is so intimate that the excess of air required for dilution is only one-fifth of the amount required for combustion.[2] A similar advantage attends the use of gaseous fuel, and of liquid fuel that is blown into the furnace in the form of spray.

Dust fuel.

Liquid fuel. 143. The use of liquid fuel for boilers has of late acquired considerable importance in connection with the discovery of crude petroleum, in large quantity, at Baku on the Caspian Sea. The petroleum refuse which is left after distilling paraffin from the crude oil forms an exceedingly cheap fuel, with a calorific value per ℔ about one-third greater than that of coal. It has now superseded coal in the steamers of the Caspian, and has been largely employed for locomotives in the south-eastern part of Russia. The oil is injected in the form of spray near the foot of the fire-box by a steam-jet arranged in such a way that air will be drawn into the furnace along with the petroleum. In the arrangement for burning petroleum used in Russian locomotives by Mr. T. Urquhart the flame impinges on a structure of fire-brick, built in the fire-box with numerous openings to allow the products of combustion to diffuse themselves throughout the combustion-chamber. This guards against too intense action on the metallic surfaces, and at the same time serves as a reservoir of heat to rekindle the flame if combustion is intermittent. In getting up steam an auxiliary boiler is used to supply the jet.[3] [4]

VIII. THE DISTRIBUTION OF STEAM.—VALVES AND VALVE MOTIONS.

144. In early steam-engines the distribution of steam was effected by means of conical valves, worked by tappets from a rod which hung from the beam. The slide-valve, the invention of which in the form now known as the long D-slide is credited to Murdoch, an assistant of Watt, came into general use with the introduction of locomotives, and is now employed, in one or other of many forms, in the great majority of engines.

Slide-valve.

The common or locomotive slide-valve is illustrated in Fig. 57. The seat, or surface on which the valve slides, is a plane surface formed on or fixed to the side of the cylinder, with three ports or openings, which extend across the greater part of the cylinder's width. The central opening is the exhaust-port through which the steam escapes; the others, or steam ports, which are narrower, lead to the two ends of the cylinder respectively. The valve is a box-shaped cover which slides over the seat, and the whole is inclosed in a chamber called the valve-chest, to which steam from the boiler is admitted. When the valve moves a sufficient distance to either side of the central position, steam enters one end of the cylinder from the valve-chest and escapes from the other end of the cylinder through the cavity of the valve into the exhaust-port. The valve is generally moved by an eccentric on the engine-shaft (Fig. 58), which is mechanically equivalent to a crank whose radius is equal to the eccentricity, or distance of O, the centre of the shaft, from P, the centre of the eccentric sheave. The sheave is encircled by a strap forming the end of the eccentric rod, and the rod is connected by a pin-joint to the valve-rod, which comes out of the valve-chest through a steam-tight stuffing-box. The eccentric rod is generally so long that the motion of the valve is sensibly the same as that which it would receive were the rod infinitely long. Thus if a circle (Fig. 59) be drawn to represent the path of the eccentric centre during a revolution of the engine, and a perpendicular PM be drawn from any point P on a diameter, AB, the distance CM is the displacement of the valve from its middle position at the time when the eccentric centre is at P. AB is the whole travel of the valve.

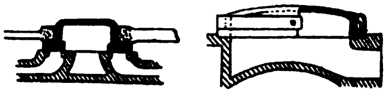

FIG. 57.—Common Slide-Valve.

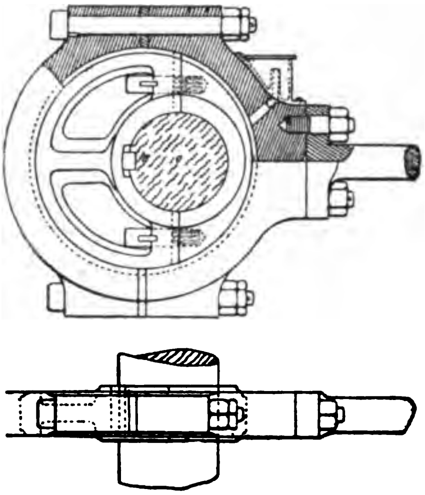

FIG. 58.—Eccentric.

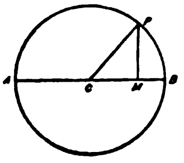

FIG. 59.

Lap and lead. 145. If the valve when in its middle position did not overlap the steam ports (Fig. 60), any movement to the right or the left would admit steam, and the admission would continue until the valve had returned to its middle position, or, in other words, for half a revolution of the engine. Such a valve would not serve for expansive working, and as regards the relative position of the crank and eccentric it would have to be set so that its middle position coincided with the extreme position of the piston; in other words, the eccentric radius would make a right angle with the crank. Expansive working, however, becomes possible when we give the valve what is called "lap," by making it project over the edges of the steam ports, as in Fig. 61, where *o* is the "outside lap" and *i* is the "inside lap." Admission of steam (to either side) then begins only when the displacement of the valve from its middle position exceeds the amount of the outside lap, and continues only until the valve has returned to the same distance from its middle position. Further, exhaust begins only when the valve has moved past the middle by a distance equal to *i*, and continues until the valve has again returned to a distance *i* from its middle position. Thus on the diagram of the eccentric's travel (Fig. 62) we find, by setting off *o* and *i* on the two sides of the centre, the positions *a*, *b*, *c*, and *d* of the eccentric radius at which the four events of admission, cut-off, release, and compression occur for one side of the piston. As to the other side of the piston, it is only necessary to set off *o* to the right and *i* to the left of the centre, but for the sake of clearness we may confine our attention to one of the two sides. Of the whole revolution, the part from *a* to *b* is the arc of steam admission, from *b* to *c* is the arc of expansion, from *c* to *d* the arc of exhaust, and from *d* to *a* the arc of compression. The relation of these, however, to the piston's motion is still undefined. If the eccentric were set in advance of the crank by an angle equal to AC*a*, the opening of the valve would be coincident with the beginning of the piston's stroke. It is, however, desirable, in order to allow the steam free entry, that the valve be already some way open when the piston stroke begins, and thus the eccentric may be set to have a position C*a'* at the beginning of the stroke. In that case the valve is open at the beginning of the stroke to the extent of *mm'*, which is called the "lead." The amount by which the angle between C*a'* (the eccentric) and CA (the crank) exceeds a right angle is called the *angular advance*, this being the angle by which the eccentric is set in advance of the position it would occupy if the primitive arrangement without lap were adopted. The quantities lap, lead, and angular advance (θ) are connected by the equation.

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[1] The methods and results of these systems of forcing draught are described in papers read before the Institution of Naval Architects, April, 1886.

[2] *Proc. Inst. Mech. Eng.*, 1869.

[3] See a paper by Mr. T. Urquhart, *Min. Proc. Inst. C. E.*, 1884; also *Engineering*, June 11-25, 1886.

[4] [Petroleum fuel was successfully employed in an engine running on the western division of the Pennsylvania railroad in June, 1887.—AM. ED.]

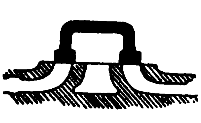
FIG. 60.—Slide-Valve without Lap.

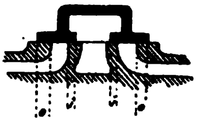
FIG. 61.—Slide-Valve with Lap.

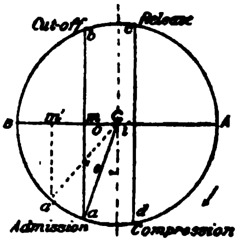

FIG. 62.

$$\text{outside lap} + \text{lead} = \text{half travel} \times \cos \theta.$$

Graphic method of finding the distribution of steam.

An effect of lead is to cause *preadmission*, that is to say, admission before the end of the back stroke, which, together with the compression of steam left in the cylinder when the exhaust port closes, produces the mechanical effect of "cushioning," to which reference has already been made. To examine the distribution of steam throughout the piston's stroke, we may now draw a circle to represent the path of the crank pin (Fig. 63, where the dotted lines have been added to show the assumed configuration of piston, connecting-rod, and crank) and transfer to it from the former diagram the angular positions, *a*, *b*, *c*, and *d*, at which the four events occur. To facilitate this transfer the diagrams of eccentric path and of crank-pin path may by a suitable choice of scales be drawn of the same actual size. Then by projecting these points on a diameter which represents the piston's path, by circular arcs drawn with a radius equal to the length of the connecting-rod, we find *p*, the position of the piston at which admission occurs during the back stroke, also *q* and *r*, the position at cut-off and release, during the stroke which takes place in the direction of the arrow, and *s*, the point at which compression begins. It is obviously unnecessary to draw the two circles of Figs. 62 and 63 separately; the single diagram (Fig. 64) contains the solution of the steam distribution with a slide-valve, whose laps, travel, and angular advance are known, the same circle serving, on two scales, to show the motion of the crank and of the eccentric.

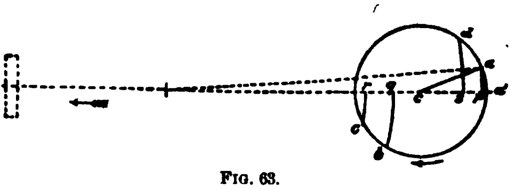

FIG. 63.

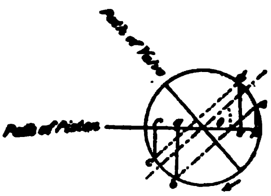

FIG. 64.

Oval diagram.

146. A method of representing graphically the relations of valve and piston motion, sometimes convenient in dealing with valve-gears of a more complex character than the single eccentric is to set off the valve's and the piston's simultaneous displacement at right angles to each other, as in Fig. 65, the valve's motion being exaggerated by using a coarser scale for it than for that of the piston. The result is an oval curve, from which the events in the steam distribution are determined by drawing lines AB and CD parallel to the piston's path and distant from it by the amount of the outside and inside lap respectively. Then *a*, *b*, *c*, and *d*, and the corresponding points, *p*, *q*, *r*, and *s* determine the four events as in former diagrams. Fig. 65 shows at a glance the amount of steam-opening at any part of the period of admission. AE is the lead. The events for the other side of the piston are determined by drawing AB above and CD below the middle line.

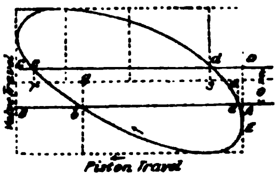

FIG. 65.—Oval Diagram of Slide-Valve Motion.

Zeuner's diagram.

147. The graphic construction most usually employed in slide-valve investigations is the ingenious diagram published by Dr. G. Zeuner in the *Civilingenieur* in 1856.[1] On the line AB (Fig. 66), which represents the travel of the valve, let a pair of circles (called valve-circles) be drawn, each with diameter equal to the half travel. A radius vector CP, drawn in the direction of the eccentric at any instant, is cut by one of the circles at Q, so that CQ represents the corresponding displacement of the valve from its middle position. That this is so will be seen by drawing PM (as in Fig. 59) and joining QB, when it is obvious that CQ = CM, which is the displacement of the valve. The line AB with the circles on it may now be turned back through an angle of 90° + θ (θ being the angular advance), so that the valve-circles take the position shown to a larger scale in Fig. 67. This makes the direction of CQ (the eccentric) coincide on the paper with the simultaneous direction of the crank, and hence to find the displacement of the valve at any position of the crank we have only to draw CQ in Fig. 67 parallel to the crank, when CQ represents the displacement of the valve to the scale on which the diameter of each valve circle represents the half-travel of the valve. CQ_0 is the valve displacement at the beginning of the stroke shown by the arrow. Draw circular arcs *ab* and *cd* with C as centre and with radii equal to the outside lap *o* and the inside lap *i* respectively. C*a* is the position of the crank at which preadmission occurs. The lead is a_0Q_0. The greatest steam opening is a_1B. The cut-off occurs when the crank has the

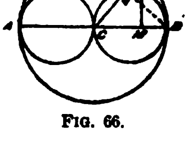

FIG. 66.

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[1] Zeuner, *Treatise on Valve Gears*, transl. by M. Müller, 1868.

direction C*b*. C*c* is the position of the crank at release, and C*d* marks the end of the exhaust.

148. In this diagram radii drawn from C mark the angular positions of the crank, and their intercepts by the valve circles determine the corresponding displacement of the valve. It remains to find the corresponding displacement of the piston. For this Zeuner employs a supplementary graphic construction, shown in Fig. 68. Here *ab* or *a'b'* represents the connecting rod, and *bc* or *b'c* the crank. With centre *c* and radius *ac* a circle *ap* is drawn, and with centre *b* and radius *ab* another circle *aq*. Then for any position of the crank, as *cb'*, the intercept *pq* between the circles is easily seen to be equal to *aa'*, and is therefore the distance by which the piston has moved from its extreme position at the beginning of the stroke. In practice this diagram is combined with that of Fig. 67, by drawing both about the same centre and using different scales for valve and piston travel. A radius vector drawn from the centre parallel to the crank in any position then shows the valve's displacement from the valve's middle position by the intercept CQ of Fig. 67, and the piston's displacement from the beginning of the piston's motion by the intercept *pq* of Fig. 68.

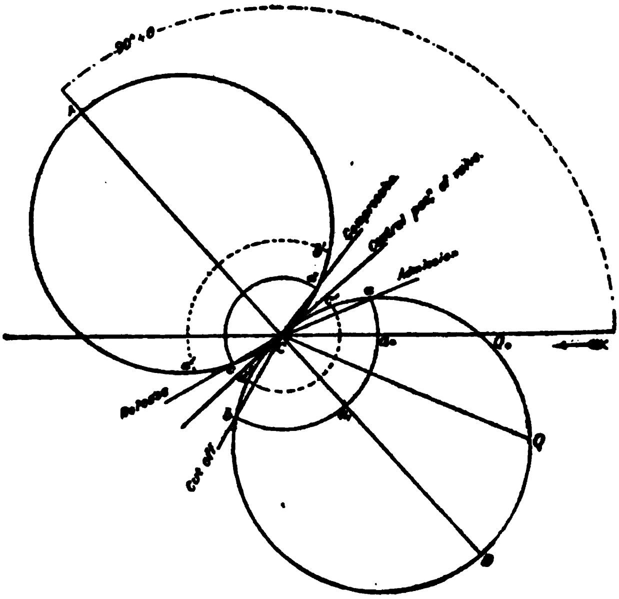

FIG. 67.—Zeuner's Slide-Valve Diagram.

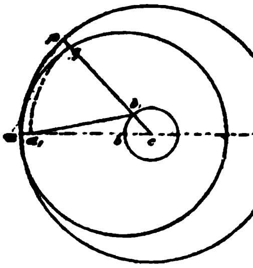

FIG. 68.

149. In all the figures which have been sketched the events refer to the front end of the cylinder, that is the end nearest to the crank (see Fig. 63). To determine the events of steam distribution at the back end, the lap circles shown by dotted lines in Fig. 67 must also be drawn, C*a'* being the outside lap for the back end, and C*c'* the inside lap. These laps are not necessarily equal to those at the other end of the valve. From Fig. 65 it is obvious that, especially with a short connecting-rod, the cut-off and release occur earlier and the compression later at the front than at the back end if the laps are equal, and a more symmetrical steam distribution can be produced by making the inside lap greater and the outside lap less on the side which leads to the front end of the cylinder. On the other hand, an unsymmetrical distribution may be desirable, as in a vertical engine, where the weight of the piston assists the steam during the down-stroke and resists it during the up-stroke, and this may be secured by a suitable inequality in the laps.

150. By varying the ratio of the laps *o* and *i* to the travel of the valve, we produce effects on the steam distribution which are readily traced in the oval diagram of Fig. 65 or in the other figures. Reduction of travel (which is equivalent to increase of both *o* and *i*) gives later preadmission, earlier cut-off, later release, and earlier compression; the ratios of expansion and of compression are both increased. The effect of a change in the angular advance is more easily seen by reference to Zeuner's diagram, which shows that to increase θ accelerates all the events and causes a slight increase in the ratio of expansion.

151. In designing a slide-valve the breadth of the steam ports in the direction of the valve's motion is determined with reference to the volume of the exhaust steam to be discharged in a given time, the area of the ports being generally such that the mean velocity of the steam during discharge is less than 100 feet per second. The travel is made great enough to keep the cylinder port fully open during the greater part of the exhaust; for this purpose it is 2½ or 3 times the breadth of the steam port. To facilitate the exit of steam the inside lap is always small, and is often wanting or even *negative*. During admission, the steam port is rarely quite uncovered, especially if the outside lap is large and the travel moderate. Large travel has the advantage of giving freer ingress and egress of steam, with more sharply-defined cut-off, compression, and release, but this advantage is secured at the cost of more work spent in moving the valve and more wear of the faces. To lessen the necessary travel without reducing the area of steam ports, double- and even treble-ported valves are often used. An example of a double-ported valve is shown in Fig. 85. Fig. 69 shows the Trick valve, an ingenious device for the same purpose.

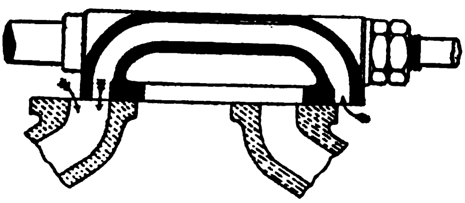

FIG. 69.—Trick Valve.

Reversal of motion with slide-valve.

152. The eccentric must stand in advance of the crank by the angle 90° + θ, as in Fig. 70, where CK is the crank, and CE the corresponding position of the eccentric when the engine is running in the direction of the arrow *a*. To set the engine in gear to run in the opposite direction (*b*) it is only necessary to shift the eccentric into the position CE', when it will still be 90° + θ in advance of the crank. In the older engines this reversal was effected by temporarily disengaging the eccentric-rod from the valve-rod, working the valve by hand until the crank turned back through an angle equal to ECE', the eccentric meanwhile remaining at rest, and then re-engaging the gear. The eccentric sheave, instead of being keyed to the shaft, was driven by a stop fixed to the shaft, which abutted on one or other of two shoulders projecting from the sheave. In some modern forms of reversing gear means are provided for turning the eccentric round on the shaft, but the arrangement known as the link-motion is now the most usual gear in locomotive, marine, winding, and other engines which require to be often and easily reversed.

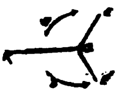

FIG. 70.

Link-motion. Stephenson's.

153. In the link-motion two eccentrics are used, and the ends of their rods are connected by a link. In Stephenson's link-motion—the earliest and still the most useful form—the link is a slotted bar or pair of bars curved to the same radius as the eccentric rods (Fig. 71), and capable of being shifted up or down by a suspension rod. The valve-rod ends in a block which slides within the link, and when the link is placed so that this block is nearly in line with the forward eccentric rod (R, Fig. 71) the valve moves in nearly the same way as if it were driven directly by a single eccentric. This is the position of "full forward gear." In

"full backward gear," on the other hand, the link is pulled up until the block is in nearly a line with the backward eccentric rod R′. The link-motion thus gives a ready means of reversing the engine,—but it does more than this. By setting the link in an intermediate position the valve receives a motion nearly the same as that which would be given by an eccentric of shorter radius and of greater angular advance, and the effect is to give a distribution of steam in which the cut-off is earlier than in full gear, and the expansion and compression are greater. In mid gear the steam distribution is such that scarcely any work is done in the cylinder. The movement of the link is effected by a hand lever, or by a screw, or (in large engines) by an auxiliary steam-engine. A usual arrangement of hand lever, sketched in Fig. 71, has given rise to the phrase "notching up," to describe the setting of the link to give a greater degree of expansion.

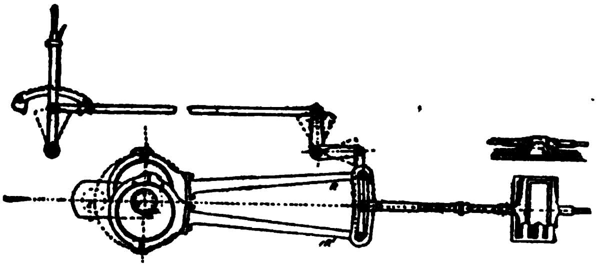
FIG. 71.—Stephenson's Link-Motion.

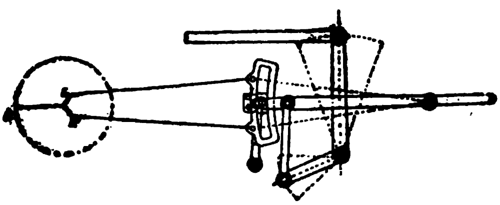
FIG. 72.—Gooch's Link-Motion.

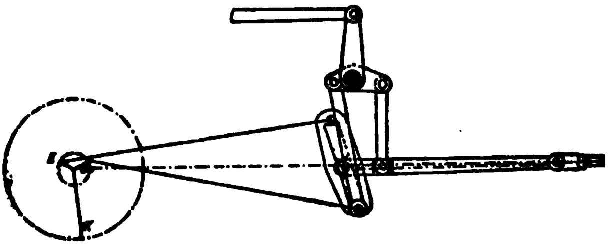
FIG. 73.—Allan's Link-Motion.

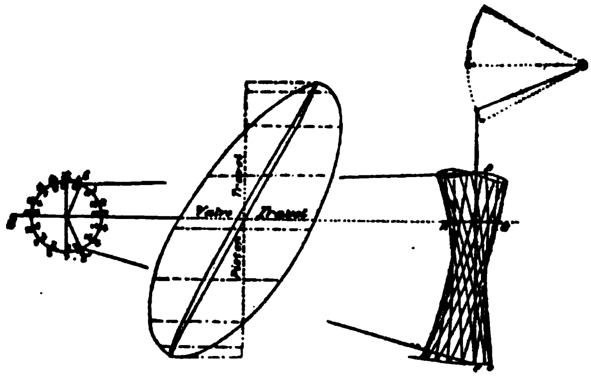

FIG. 74.

Gooch's link-motion.

154. In Gooch's link-motion (Fig. 72) the link is not moved up in shifting from forward to backward gear, but a radius rod between the valve-rod and the link (which is curved to suit this radius rod) is raised or lowered—a plan which has the advantage that the lead is the same in all gears. In Allan's motion (Fig. 73) the change of gear is effected partly by shifting the link and partly by shifting a radius rod, and the link is straight.

Allan's.

Graphic solution of link-motion.

155. The movement of a valve driven by a link-motion may be very fully and exactly analyzed by drawing with the aid of a template the positions of the centre line of the link corresponding to a number of successive positions of the crank. Thus, in Fig. 74, two circular arcs passing through *e* and *e′* are drawn with E and E′ as centres and the eccentric rods are radii. These are loci of two known points of the link, and a third locus is the circle *a* in which the point of suspension must lie. By placing on the paper a template of the link, with these three points marked on it, the position of the link is readily found, and by repeating the process for other positions of the eccentrics a diagram of positions (Fig. 74) is drawn for the assigned state of the gear. A line AB drawn across this diagram in the path of the valve's travel determines the displacements of the valve, and enables the oval diagram to be drawn (as in Fig. 65), which is shown to a larger scale in another part of Fig. 74. The example refers to Stephenson's link-motion in nearly full forward gear; with obvious modification the same method may be used in the analysis of Gooch's or Allan's motion. The same diagram determines the amount of slotting or sliding motion of the block in the link. In a well-designed gear this sliding is reduced to a minimum for that position of the gear in which the engine runs most usually. In marine engines the suspension-rod is generally connected to the link at the end of the link next the forward eccentric, to reduce this sliding when the engine is in forward gear. A less laborious, but less accurate, solution of link-motion problems is reached by the use of what is called the equivalent eccentric—an imaginary eccentric, which would give the valve nearly the same motion as it gets from the joint action of the actual eccentrics. The following rule for finding the equivalent eccentric, in any state of gear, is due to Mr. M'Farlane Gray:

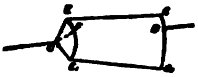
FIG. 75.

Connect the eccentric centres E and E′ (Fig. 75) by a circular arc whose radius =

$$\frac{EE' \times \text{length of eccentric rod}}{2 \times ee'}.$$

Then, if the block is at any point B, take EF such that EF : EE′ : : *e*B : *ee′*. CF then represents the equivalent eccentric both in radius and in angular position. If the rods of the link-motion are crossed instead of open,—an arrangement seldom used,—the arc EFE′ is to be drawn convex towards C.

Equivalent eccentric.

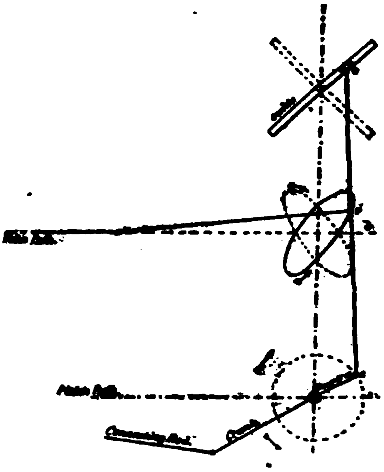
FIG. 76.—Hackworth's Valve-Gear.

156. Many forms of gear for reversing and for varying

Other reversing gears.

Hackworth's.

expansion have been devised with the object of escaping the use of two eccentrics, and of obtaining a more perfect distribution of steam than the link-motion can often be made to give. Hackworth's gear, the parent of several others, has a single eccentric E (Fig. 76) opposite the crank, with an eccentric-rod EQ, whose mean position is perpendicular to the travel of the valve. The rod ends in a block Q, which slides on a fixed inclined guide-bar or link, and the valve-rod receives its motion through a connecting rod from an intermediate point P of the eccentric-rod, the locus of which is an ellipse. To reverse the gear the guide-bar is tilted over to the position shown by the dotted lines, and intermediate inclinations give various degrees of expansion without altering the lead. The steam distribution is excellent, and the cut-off is sharper than in the usual link-motion, but an objection to the gear is the wear of the sliding-block and guide.

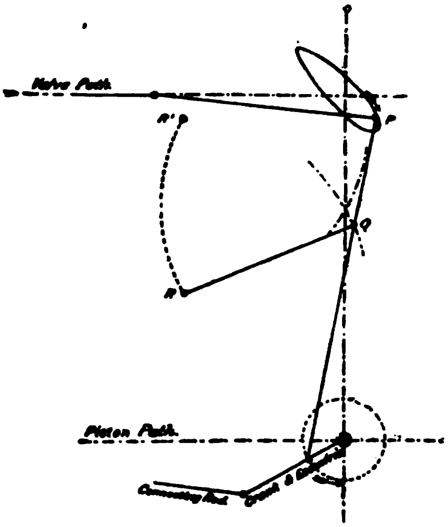

FIG. 77.—Bremme's or Marshall's Valve-Gear.

Bremme's or Marshall's.

In Bremme's or Marshall's form this objection is obviated with some loss of symmetry in the valve's motion by constraining the motion of the point Q, not by a sliding-guide, but a suspension-link, which makes the path of Q a circular arc instead of a straight line; to reverse the gear the centre of suspension R of this link is thrown over to the position R' (Fig. 77). In the example sketched P is beyond Q, but P may be between Q and the crank (as in Fig. 76), in which case the eccentric is set at 180° from the crank. This gear has been applied in a number of marine engines.

Joy's.

In Joy's gear, which is extensively used in locomotives, no eccentric is required; and the rod corresponding to the eccentric rod in Hackworth's gear receives its motion from a point in the connecting rod by the linkage shown in Fig. 78, and is either suspended, as in Marshall's form, by a rod whose suspension centre R is thrown over to reverse the motion, or constrained, as in Hackworth's, by a slot-guide whose inclination is reversed. Fig. 79 shows Joy's gear as applied to a locomotive. A slot-guide E is used, and it is curved to allow for the obliquity of the valve connecting-rod AE. C is the crank-pin, B the piston path, and D a fixed centre. The reversing gears of Walschaert, Brown, and Kitson also dispense with eccentrics, and are closely related to the invention of Hackworth.[1] A method of reversing with a common slide-valve, which is used in steam steering engines[2] and some others, is to supply steam to what was (before reversal) the exhaust side of the valve and connect the exhaust to what was the steam side. This is done by means of a separate reversing valve through which the steam and exhaust pipes pass.

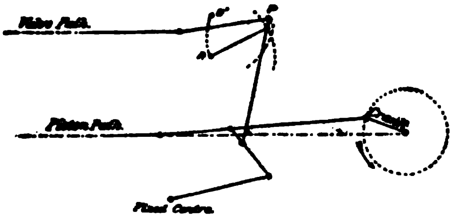

FIG. 78.—Diagram of Joy's Valve-Gear.

Separate expansion valves.

157. When the distribution of steam is effected by the slide-valve alone the arc of the crank's motion during which compression occurs is equal to the arc during which expansion occurs, and for this reason the slide-valve would give an excessive amount of compression if it were made to cut off the supply of steam earlier than about half-stroke. Hence, where an early cut-off is wanted it is necessary either to use an entirely different means of regulating the distribution of steam or to supplement the slide-valve by another valve,—called an expansion-valve, usually driven by a separate eccentric,—whose function is to effect the cut-off, the other events being determined as usual by the slide-valve. Such expansion-valves belong generally to one or other of two types. In one the expansion-valve cuts off the supply of steam to the chest in which the main valve works. This may be done by a disk or double-beat valve (§ 163), as in the Proëll gear mentioned in § 175 below, or by a slide-valve working on a fixed seat (furnished with one or more ports), which forms the back or side of the main valve-chest. Valves of this last type are usually made in the "gridiron" or many-ported form to combine large steam-opening with small travel. Expansion-valves working in a fixed seat may be arranged so that the ports are either fully open (Fig. 80) or closed (Fig. 81) when the valve is in its middle position. In the latter case the expansion-valve eccentric is set in line with or opposite to the crank, if the engine is to run in either direction with the same grade of expansion. Cut-off then occurs at P, Fig. 82, when the shaft has turned through an angle ϕ from the beginning of the stroke. The expansion valve reopens at

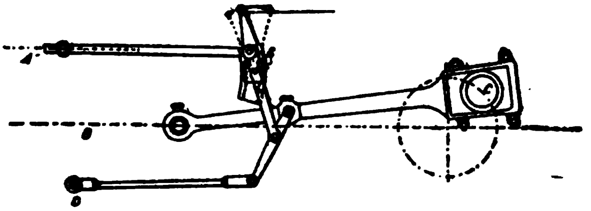

FIG. 79.—Joy's Gear as applied to a Locomotive.

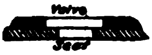

FIG. 80.

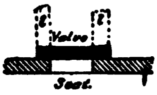

FIG. 81.

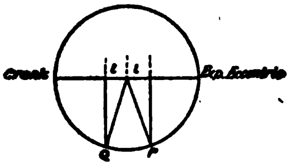

FIG. 82.

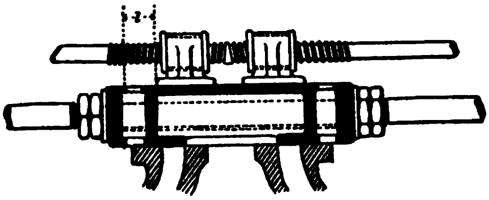

FIG. 83.—Expansion-Valve on back of Main Slide-Valve.

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[1] Reversing gears of this type are generally termed radial gears. A discussion of Mr. Joy's and other arrangements will be found in *Proc. Inst. Mech. Eng.*, 1880. Mr. Kirk, Mr. Bryce-Douglas, and others have designed forms which more or less resemble those mentioned in the text.

[2] *Proc. Inst. Mech. Eng.*, 1867.

Q, and the slide-valve must therefore have enough lap to cut off earlier than 180° — ϕ from the beginning of the stroke, in order to prevent a second admission of steam to the cylinder. In the valve of Fig. 80 the expansion eccentric is set at right angles to the crank, if the action is to be the same in both directions. If not, these angles may be deviated from, and in this way a more rapid travel at the instant of cut-off may be secured for one direction of running.

158. The other and much commoner type of expansion-valve is one sliding on the back of the main slide-valve, which is provided with through ports which the expansion-valve opens and closes. Fig. 83 shows one form of this type. Here the resultant relative motion of the expansion-valve and main-valve has to be considered. If r_a and r_b (Fig. 84) are the eccentrics working the main and expansion valves respectively, then CR drawn equal and parallel to ME is the *resultant* eccentric which determines the motion of the expansion-valve relatively to the main-valve. Cut-off occurs at Q, when the shaft has turned through an angle ϕ, which brings the resultant eccentric into the direction OQ and makes the relative displacement of the two valves equal to the distance l. Another form of this valve (corresponding to Fig. 81) cuts off steam at the inside edges of the expansion-slides.

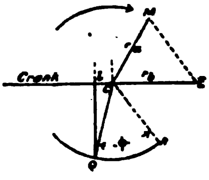

FIG. 84.

Variation of cut-off. 159. Expansion-valves furnish a convenient means of *varying* the expansion, which may be done by altering their lap, travel, or angular advance. Alteration of lap, or rather of the distance l in the figures, is often effected by having the expansion-valve in two parts (as in Fig. 83) and holding them on one rod by right- and left-handed screws respectively; by turning the valve-rod the parts are made to approach or recede from each other. In large valves the adjustment is more conveniently made by varying the travel of the valve, which is done by connecting it to its eccentric through a link which serves as a lever of variable length.

Relief-rings. 160. To relieve the pressure of the valve on the seat, large slide-valves are generally fitted with a steam-tight ring, which excludes steam from the greater part of the back of the valve. The ring fits steam-tight into a recess in the cover of the steam-chest, and is pressed by springs against the back of the valve, which is planed smooth to slide under the ring. Fig. 85 shows a relief ring of this kind fitted on the back of a large double-ported slide-valve for a marine engine. Another plan is to fit the ring into a recess on the back of the valve, and let it slide on the inside of the steam-chest cover. Steam is thus excluded from the space within the ring, any steam that leaks in being allowed to escape to the condenser (or to the intermediate receiver when the arrangement is fitted to the high-pressure cylinder of a compound engine). A flexible diaphragm has also been used instead of a recess, to hold the ring.

161. The pressure of valves on cylinder faces is still more completely obviated by making the back of the valve similar to its face, and causing the back to slide in contact with the valve-chest cover, which has recesses corresponding to the cylinder ports. This arrangement is most perfectly carried out in the piston slide-valves now very largely used in the high-pressure cylinders of marine engines.

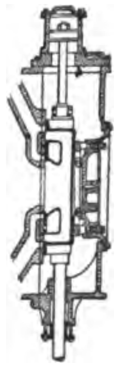

FIG. 85.

Piston slide-valve. The piston slide-valve may be described as a slide-valve in which the valve face is curved to form a complete cylinder, round whose whole circumference the ports extend. The pistons are packed like ordinary cylinder pistons by metallic rings, and the ports are crossed here and there by diagonal bars to keep the rings from springing out as the valve moves over them. Figs. 86 and 87 show two forms of piston valve designed by Mr. Kirk for the supply of high-pressure steam to large marine engines. P, P are the cylinder ports in each.

Balance-piston. Fig. 85 illustrates an arrangement common in all heavy slide-valves whose travel is vertical—the *balance-piston*, which is pressed up by steam on its lower side and so equilibrates the weight of the valve, valve-rod, and connected parts of the mechanism.

162. The slide-valve sometimes takes the form of a disk revolving or oscillating on a fixed seat, and sometimes of a rocking cylinder (Fig. 88). This last kind of sliding motion is very usual in stationary engines fitted with the Corliss gear, which will be described in the next chapter, in which case four distinct rocking slides are commonly employed to effect the steam distribution, one giving admission and one giving exhaust at each end of the cylinder (see Fig. 127).

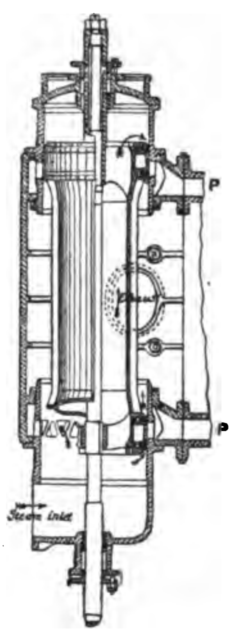

FIG. 86.—Piston Slide-Valve.

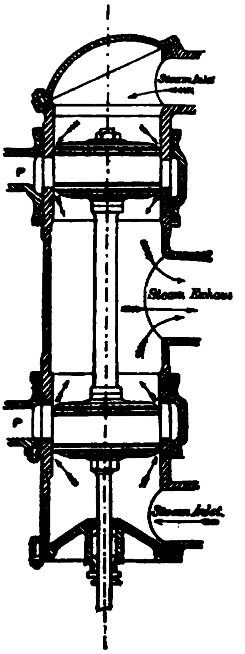

FIG. 87.—Piston Slide-Valve.

Double-beat valve. 163. In many stationary engines *lift* or *disk* valves are used, worked by tappets, cams, or eccentrics. Lift valves are generally of the Cornish or double-beat type (Fig. 89), in which equilibrium is secured by the use of two conical faces which open or close together. In Cornish pumping engines, which retain the single action of Watt's early engine, three double-beat valves are used, as steam-valve, equilibrium-valve, and exhaust-valve respectively. These are closed by tappets on a rod moving with the beam, but are opened by means of a device called a cataract, which acts as follows: **Cornish cataract.** The cataract is a small pump with a weighted plunger, discharging fluid through a stop-cock which can be adjusted by hand when it is desired to alter the speed of the engine. The weighted plunger is raised by a rod from the beam, but is free in its descent, so that it comes down at a rate depending on the extent to which the stop-cock is opened. When it comes down a certain way it opens the steam and exhaust valves, by liberating catches which hold them closed; the "out-door" stroke then begins and admission continues until the steam-valve is closed: this is done directly by the motion of the beam, which also, at a later point in the stroke, closes the exhaust. Then the equilibrium-valve is opened, and the "in-door" stroke takes place, during which the plunger of the cataract is raised. When it is completed, the piston pauses until the cataract causes the steam-valve to open and the next "out-door" stroke begins. By applying a cataract to the equilibrium-valve also, a pause is introduced at the end of the "out-door"

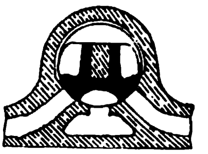

FIG. 88.—Rocking Slide-Valve.

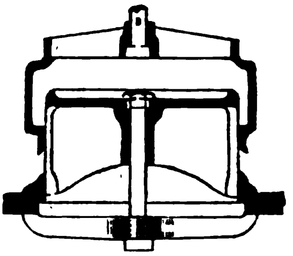

FIG. 89.—Double-Beat Lift-Valve.

stroke. Pauses have the advantage of giving the pump time to fill and of allowing the pump-valves to settle in their seats without shock.

IX. Governing.

Methods of regulating.

164. To make an engine run steadily an almost continuous process of adjustment must go on, by which the amount of work done by the steam in the cylinder is adapted to the amount of external work demanded of the engine. Even in cases where the demand for work is sensibly uniform, fluctuations in boiler-pressure still make regulation necessary. Generally the process of government aims at regularity of speed; occasionally, however, it is some other condition of running that is maintained constant, as when an engine driving a dynamo-electric machine is governed by an electric regulator to give a constant difference of potential between the brushes.

The ordinary methods of regulating are either (*a*) to alter the pressure at which steam is admitted by opening or closing more or less a throttle-valve between the boiler and the engine or (*b*) to alter the volume of steam admitted to the cylinder by varying the point of cut-off. The former plan was introduced by Watt and is still common, especially in small engines. From the point of view of heat economy it is wasteful, since the process of throttling is essentially irreversible, but this objection is to some extent lessened by the fact that the wire-drawing of steam dries or superheats it, and consequently reduces the condensation which it suffers on coming into contact with the chilled cylinder walls. On the other hand, to hasten the cut-off involves a gain rather than a loss of efficiency unless the ratio of expansion is already very great. The second plan of regulating is much to be preferred, especially when the engine is subject to large variations of load, and is very generally followed in stationary engines of the larger types.

Centrifugal speed governors.

165. Within certain limits regulation by either plan can be effected by hand, but for the finer adjustment of speed some form of automatic governor is necessary. Speed governors are commonly of the *centrifugal* type: a pair of masses revolving about a spindle which is driven by the engine are kept from flying out by a certain controlling force. When an increase of speed occurs this controlling force is no longer able to keep the masses revolving in their former path; they move out until the controlling force is sufficiently increased, and in moving out they act on the regulator of the engine, which may be a throttle-valve or some form of automatic expansion gear. In the conical pendulum governor of Watt (Fig. 90) the revolving masses are balls attached to a vertical spindle by links, and the controlling force is furnished by the weight of the balls, which, in receding from the spindle, are obliged to rise. When the speed exceeds or falls short of its normal value they move out or in, and so raise or lower a collar C which is in connection by a lever with the throttle-valve. The suspension-links may be hung from a cross-bar (Figs. 94, 95) instead of being pivoted in the axis of the spindle.

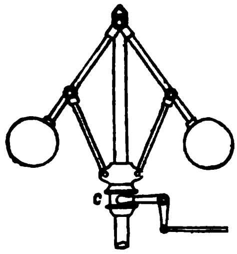

Fig. 90.—Watt's Governor.

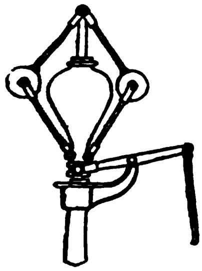

Fig. 91.—Loaded Governor.

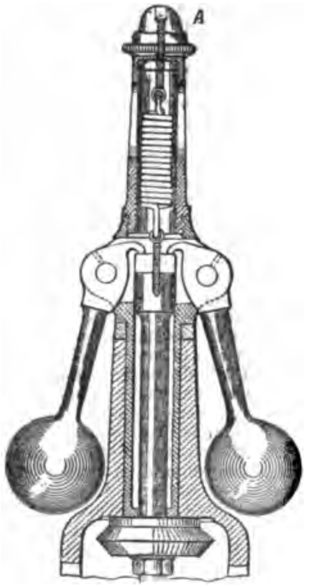

Fig. 92.—Spring Governor (Tangye).

Load governor.

166. In a modified form of Watt's governor, known as Porter's, or the loaded governor, a supplementary controlling force is given by placing a weight on the sliding collar (Fig. 91). This is equivalent to increasing the *weight* of the balls without altering their *mass*. In other governors the controlling force is wholly or partly produced by springs. Fig. 92 shows a governor by Messrs. Tangye in which the balls are controlled partly by their own weight and partly by a spring, the tension of which is regulated by turning the cap A.

Equilibrium of governor.

167. In whatever way the revolving masses are controlled, the controlling force may be treated as a force F acting on each ball in the direction of the radius towards the axis of revolution. Then, if M be the mass of the ball, n the number of revolutions per second, and r the radius of the ball's path, the governor will revolve in equilibrium when $F = 4\pi^2 n^2 r M$ (in absolute units), or

$$n = \frac{1}{2\pi}\sqrt{\frac{F}{Mr}}$$

Condition of stability.

Gravity governor.

In order that the configuration of the governor should be stable, F must increase more rapidly than r, as the balls move outwards. In the simple conical pendulum governor, any of the three forms shown in Fig. 93, 94, and 95, where the balls have no load to raise but their own weight, the controlling force F is the resultant of T, the tension in the link, and Mg, the weight of the ball (Fig. 96). Let the height of the pendulum, that is, the distance above the plane of the balls of the point where the suspending-link, or the link produced, cuts the axis, be called h. Then $F : Mg :: r : h$. Hence

$$F = \frac{Mgr}{h}, \text{ and } n = \frac{1}{2\pi}\sqrt{\frac{g}{h}}.$$

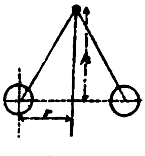

Fig. 93.

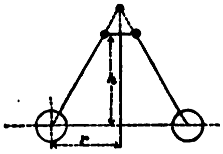

Fig. 94.

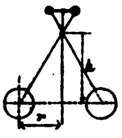

Fig. 95.

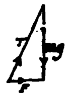

Fig. 96.

Sensibility.

Any change of n tends to produce a change of h, and, if the governor itself and the regulating mechanism attached to it were free from friction, only one position of the governor would be possible for any one value of n. It is obvious that neither this governor nor any other *stable* governor maintains a strictly constant speed in the engine which it controls. If the boiler pressure or the demand for work is changed, a certain amount of permanent displacement of the balls is necessary to alter the steam supply, and the balls can retain their displaced position only by virtue of a permanent change in the speed. The maximum range of speed depends on that amount of change of n which suffices to alter the configuration of the governor from the position which gives no steam-supply to the position which gives full steam-supply; and the governor is said to be sensitive if this range is a small fraction of n.

Loaded gravity governor.

168. If the governor is loaded, let M′ be the amount of the load per ball, and q the velocity ratio of the vertical movement of the load to the vertical movement of the ball. Then $qM'g$ is the equivalent increase in the weight of each ball. The effect of the load is to increase the controlling force F from Mgr/h to $(M + qM')gr/h$, and the speed at which the governor must now turn, to maintain any assigned height h, is

$$n = \frac{1}{2\pi}\sqrt{\frac{(M+qM')g}{Mh}}.$$

The speed of the loaded governor must therefore be greater than that of an unloaded governor of the same height in the ratio $\sqrt{(M + qM')}$ to $\sqrt{M}$.

Power.

The sensibility is then the same as that of an unloaded governor of the same height h, but the loaded governor has an important advantage in another respect—namely, its *power* or capability of overcoming frictional resistance to a change of configuration. This quality in a governor is increased whenever the controlling force F is increased, whether by the addition of a load or by the use of springs.

For, let f be the frictional resistance to be overcome per ball, resolved as a force resisting the displacement of each ball in the direction of the radius r. Then, if n be the speed normal to any configuration, this speed must change by a certain amount Δn before friction is overcome and the balls begin to be displaced. The controlling force is now $F+f$ when the balls are moving outwards, and $F-f$ when the balls are moving inwards. Hence

$$n+\Delta n=\frac{1}{2\pi}\sqrt{\frac{F+f}{Mr}},$$

$$n-\Delta n=\frac{1}{2\pi}\sqrt{\frac{F-f}{Mr}}.$$

From this, if Δn be small compared with n, we have $\Delta n/n = f/2F$.

Thus, when a given amount of frictional resistance is to be overcome before the governor can act, the limits within which this friction allows the speed to vary are less the greater is the controlling force F. A loaded governor is more powerful in this respect than an unloaded governor of the same configuration in the proportion in which F is greater—namely, as $M+qM'$ is to M. A loaded governor may therefore have much lighter revolving masses without loss either of sensibility or of power.

General solution: graphic method.

169. The same results are applicable to governors in which the controlling force is supplied by springs as well as by gravity, or by springs alone. To find the configuration which the governor will assume at any particular speed, or the speed corresponding to a particular configuration, it is only necessary to determine the whole controlling force F per ball acting along the radius towards the axis for various values of r. Let a curve ab (Fig. 97) be drawn showing the relation of F to r. At any assigned value of r set up an ordinate $QC=4\pi^2n^2rM$. Join OC. The point c, in which OC cuts the curve, determines the value of r at which the balls will revolve at the assigned speed n. Or, if that is given, and the value of n is to be found, the line Oc produced will determine C, and then $n^2=QC/4\pi^2rM$. The sensibility of the governor is determined by taking points a and b corresponding to full steam and no steam respectively, and drawing lines through them to determine the corresponding values of QA and QB.[1] When the frictional resistance f is known, an additional pair of curves drawn above and below ab, with ordinates $F+f$ and $F-f$ respectively, serve to show the additional variations in speed which are caused by friction. The governor is stable throughout its whole range when the curve ab has a steeper gradient than any line drawn from O to meet it.

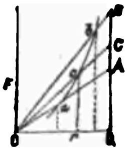

FIG. 97.

Isochronism.

170. By § 167 it is evident that, if, when the balls are displaced, the controlling force F changes proportionately to the radius r, the speed is constant. In other words, the equilibrium of the governor is then neutral; it can revolve in equilibrium at one, and only at one, speed. At this speed it assumes, indifferently, any one of its possible configurations. The slightest variation of speed drives it to the extremity of its range; hence its sensibility is indefinitely great. Such a governor is called *isochronous*. A gravity governor is isochronous when h is constant for all positions of the balls (since $n \propto \sqrt{g/h}$). This will be the case if the balls are constrained to move in a parabolic path (Fig. 98), it being a property of the parabola that the subnormal QM, which is h, is constant. A useful approximation to the same condition, through a limited range, is secured in Farcot's governor by the device of hanging the balls by crossed links from the distant ends of a T piece (Fig. 95). If each centre of suspension were at the centre of curvature of a parabolic arc which coincided with the actual circular locus of the balls at the position of normal speed, the governor would be sensibly isochronous at that speed; by taking the centres of suspension rather nearer the axis, a suitable margin of stability is secured, but the governor is still nearly enough isochronous to be exceedingly sensitive.[2] Where springs furnish the controlling force, an approach to isochronism can be secured by adjusting the initial tension of the springs, and this forms a convenient means of regulating the sensibility. Thus, in Mr. Hartnell's apparatus (Fig. 99), where the balls move in a nearly horizontal direction, and gravity has little to do with the control, the governor can be made isochronous by screwing down the spring, so that the initial force exerted by the spring is to its increase by displacement of the balls as the initial radius of the balls' path is to the increase of radius by displacement. When the initial force is increased beyond this the governor becomes unstable. In Fig. 97 the condition of isochronism is secured when the line ab coincides with a straight line through O.

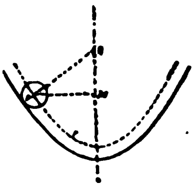

FIG. 98.

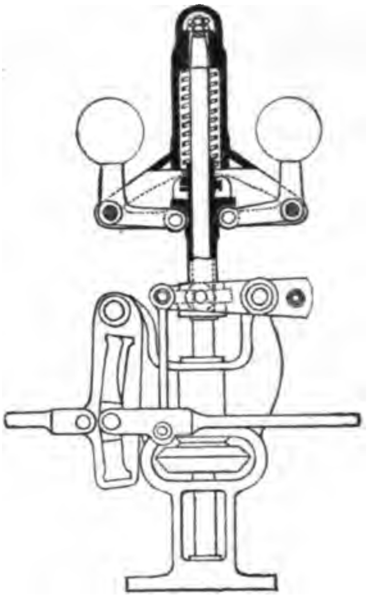

FIG. 99.—Hartnell's Governor.

Hunting.

171. In practice no governor can be absolutely isochronous. It is indispensable to leave a small margin of stability for the sake of preventing violent change in the supply of steam, especially when there is much frictional resistance to be overcome by the governor, or where the influence of the governor takes much time to be felt by the engine. An over-sensitive governor is liable to fall into a state of oscillation called *hunting*. When an alteration of speed begins to be felt, however readily the governor alters its form, the engine's response is more or less delayed. If the governor acts by closing a throttle-valve, the engine has still a capacious valve-chest on which to draw for steam. If it acts by changing the cut-off, its opportunity is passed if the cut-off has already occurred, and the control only begins with the next stroke. This lagging of effect is specially felt in compound engines, where that portion of the steam which is already in the engine continues to do its work for nearly a whole revolution after passing beyond the governor's control. The result of this storage of energy in an engine whose governor is too nearly isochronous is that, whenever the demand for power suddenly falls, the speed rises so much as to force the governor into a position of over-control, such that the supply of steam is no longer adequate to meet even the reduced demand for power. Then the speed slackens, and the same kind of excessive regulation is repeated in the opposite direction. A state of forced oscillation is consequently set up. The effect is aggravated by the momentum which the governor balls acquire in being displaced, and also, to a very great degree, by the friction of the governor and the regulating mechanism. Hunting is to be avoided by giving the governor a fair degree of stability, by reducing as far as possible the static frictional resistances, and by introducing a viscous resistance to the displacement of the governor, which prevents the displacement from occurring too suddenly, without affecting the ultimate position of equilibrium. For this purpose many governors are furnished with a *dash-pot*, which is an hydraulic or pneumatic brake, consisting of a piston connected to the governor, working loosely in a cylinder which is filled with oil or with air.

Dash-pot.

172. In some high-speed engines the governor balls or blocks revolve in a vertical plane, about a horizontal axis, and the control is given wholly by springs. An example

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[1] See a paper by Mr. W. Hartnell, "On Governing Engines by Regulating the Expansion," *Proc. Inst. Mech. Eng.*, 1882.

[2] See also a paper by Mr. J. Head, *Proc. Inst. Mech. Eng.*, 1871.

is shown in Fig. 100, which is the governor of the Armington and Sims engine referred to in § 197 below. Another

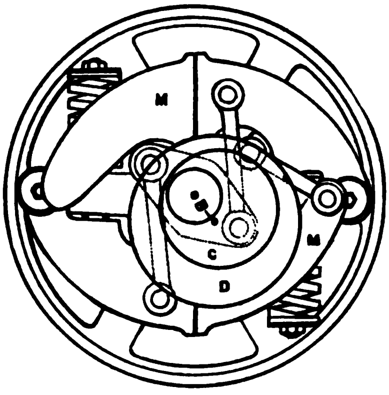

FIG. 100.—Governor of Armington & Sims Engine.

example is furnished by the governor of Brotherhood's engine (§ 203, Fig. 128).

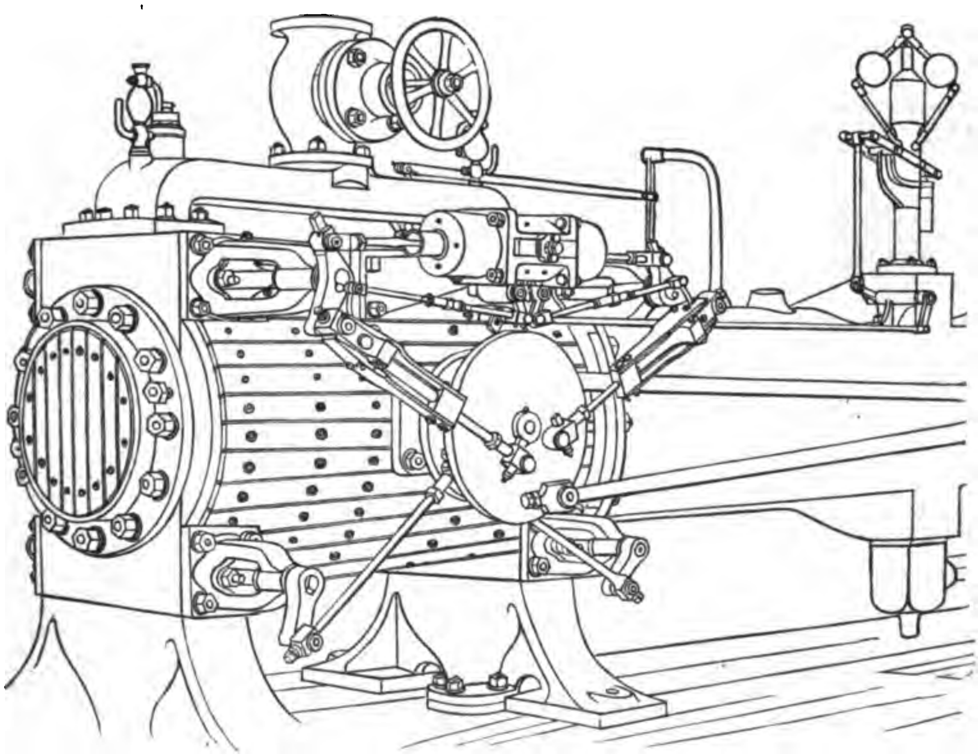

FIG. 101.—Corliss Engine, with Spencer Inglis Trip-Gear.

Throttle-valve.

173. The throttle-valve, as introduced by Watt, was originally a disk turning on a transverse axis across the centre of the steam-pipe. It is now usually a double-beat valve (Fig. 89) or a piston-valve. When regulation is effected by varying the cut-off, and an expansion valve of the slide-valve type is used, the governor generally acts by changing the travel of the valve. Fig. 99 illustrates a common mode of doing this, by giving the expansion-valve its motion from an eccentric-rod through a link, the throw of which is varied by the displacement of the governor balls. In Fig. 100, the governor acts on the main slide-valve of the engine (there being no separate expansion-valve), and the displacement of the revolving masses M, M changes both the throw and the angular advance of the eccentric, thereby producing a change in the steam supply similar to that produced by "notching up" a link-motion. The eccentricity B is altered by the relative displacement of two parts C, D into which the eccentric sheave is divided. In other forms of automatic expansion-gear the lap of the valve is altered; in others the governor acts by shifting the expansion-valve eccentric round on its shaft, and so changing its angular advance.

Automatic variation of cut-off.

Corliss gear.

174. In large stationary engines the most usual plan of automatically regulating the expansion is to employ some form of trip-gear, the earliest type of which was introduced in 1849 by G. H. Corliss[1] of Providence, U. S. In the Corliss system the valves which admit steam are distinct from the exhaust-valves. The latter are opened and closed by a reciprocating piece which takes its motion from an eccentric. The former are opened by a reciprocating piece, but are closed by springing back when released by a trip- or trigger-action. The trip occurs earlier or later in the piston's stroke according to the position of the governor. The admission-valve is opened by the reciprocating piece with equal rapidity whether the cut-off is going to be early or late. It remains wide open during the admission, and then, when the trip-action comes into play, it closes suddenly. The indicator diagram of a Corliss engine consequently has a nearly horizontal admission-line and a sharply defined cut-off. Generally the valves of Corliss engines are cylindrical plates turning in hollow cylindrical seats which extend across the width of the cylinder. Often, however, the admission-valves are of the disk or double-beat type, and spring into their seats when the trip-gear acts. Many forms of Corliss gear have been invented by Corliss himself and by others. One of these, the Spencer Inglis[2] trip-gear, by Messrs. Hick, Hargreaves & Co., is shown in Figs. 101 and 102. A wrist-plate A, which turns on a pin on the outside of the cylinder, receives a motion of oscillation from an eccentric. It opens the cylindrical rocking-valve B by pulling the link C, which consists of two parts, connected to each other by a pair of spring clips, *a*, *a*. Between the clips there is a rocking-cam *b*, and as the link is pulled down this cam places itself more and more athwart the link, until at a certain point it forces the clips open. Then the upper part of the link springs back and allows the valve B to close by the action of a spring in the dash-pot D. When the wrist-plate makes its return stroke the clips re-engage the upper portion of the link C, and things are ready for the next stroke. The rocking-cam *b* has its position controlled by the governor through the link E in such a way that when the speed of the engine increases it stands more athwart the link C, and therefore causes the clips to be released at an earlier point

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[2] *Proc. Inst. Mech. Eng.*, 1868.

[1] [George Henry (1817–88), inventor, born in Washington Co., N. Y., educated in a near academy, settled in Providence, R. I., in 1844, and died there. He built the great engine used in working the machinery at the Centennial Exposition of 1876, and received many foreign decorations.—AM. ED.]

in the stroke. A precisely similar arrangement governs the admission of steam to the other end of the cylinder. The exhaust-valves are situated on the bottom of the cylinder, at the ends, and take their motion from a separate wrist-plate which oscillates on the same pin with the plate A.[1]

Proëll's trip-gear.

175. Fig. 103 shows a compact form of trip-gear by Dr. Proëll. A rocking-lever *ab* is made to oscillate on a fixed pin through its centre by a connection to the crosshead of the engine. When the end *a* rises, the bell-crank lever *c* engages the lever *d*, and when *a* is depressed the lever *d* is forced down and the valve *e* is opened to admit steam to one end of the cylinder. As *a* continues moving down a point is reached at which the edge of *c* slips past the edge of *d*, and the valve is then forced to its seat by a spring in the dash-pot *f*. This disengagement occurs early or late according to the position of the fulcrum piece *g*, on which the heel of the bell-crank *c* rests during the opening of the valve. The position of *g* is determined by the governor. A similar action, occurring at the other end of the rocking-bar *ab*, gives steam to the other end of the cylinder. In one form of Proëll's gear both ends of *ab* act on the same steam-valve, which is then a separate expansion-valve fixed on the back of a chest in which an ordinary slide-valve works.

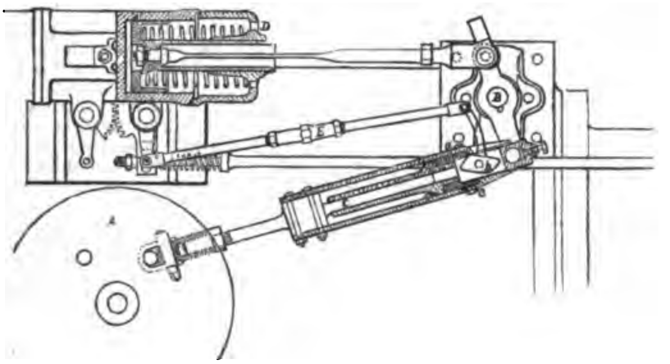

FIG. 102.—Corliss Valve-Gear, Spencer Inglis form.

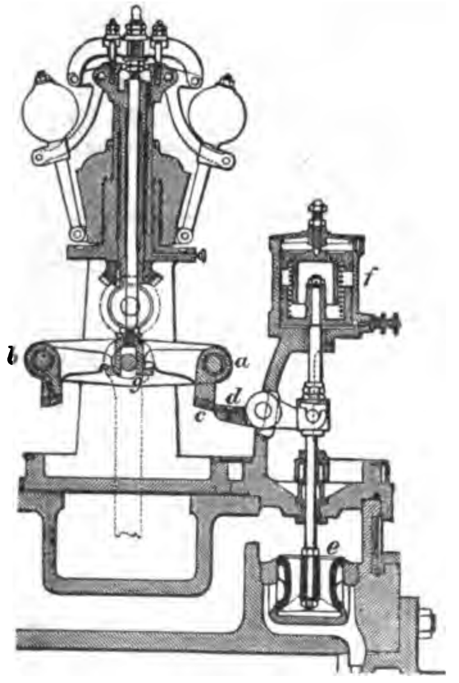

FIG. 103.—Proëll's Automatic Expansion Gear.

Disengagement governors.

176. In the ordinary form of centrifugal governor the position of the throttle-valve, or the expansion-link, or the Corliss trigger depends on the configuration of the governor, and is definite for each position of the balls. In disengagement governors, of which the governor A shown on the right-hand side in Fig. 104 is an example, any reduction of speed below a certain value sets the regulating mechanism in motion, and the adjustment continues until the speed has been restored. Similarly a rise of speed above a certain value sets the regulating mechanism in motion in the other direction. If the spindle *a* (Fig. 104) is connected to the regulator so as to give more steam if it turns one way and less if it turns the other, the speed at which the engine will run in equilibrium must lie between narrow limits, since at any speed high enough to keep *b* in gear with *a* the supply of steam will go on being reduced, and at any speed low enough to bring *c* into gear with *a* the supply will go on being increased. This mode of governing, besides being sensibly isochronous, has the advantage that the power of the governor is not limited by the controlling force on the balls, since the governor acts by deflecting a portion of the power that is being developed by the engine to the work of moving the regulator. It is rarely applied to steam engines, probably because its action is too slow. This defect has been ingeniously remedied in the supplementary governor of Mr. W. Knowles, who has combined a disengagement governor with one of the ordinary type in the manner shown in Fig. 104.[2] Here the spindle *a*, driven by the supplementary or disengagement governor A, acts by lengthening the rod *d* which connects the ordinary governor B with the regulator. It does this by turning a coupling nut *e* which unites two parts of *d*, on which right- and left-handed screws are cut. Any sudden fluctuation in speed is immediately responded to by the ordinary governor. Any more or less permanent change of load or of steam-pressure gives the supplementary governor time to act. It goes on adjusting the supply until the normal speed is restored, thereby converting the control of the ordinary governor, which is stable, and therefore not isochronous, into a control which is isochronous as regards all fluctuations of long period. The power of the combination is limited to that of the common governor B.

Knowles's supplementary governor.

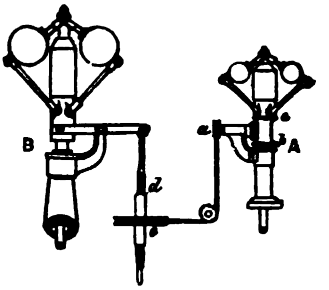

FIG. 104.—Knowles's Supplementary Governor.

Relay governors.

177. Other governors which deserve to be classed as disengagement governors are those in which the displacement of the governor affects the regulator, not directly by a mechanical connection, but by admitting steam or other fluid into what may be called a relay cylinder, whose piston acts on the regulator. In order that a governor of this class should work without hunting, the piston and valve of the relay cylinder should be connected by what is termed differential gear, the effect of which is that for each displacement of the valve by the governor the piston moves through a distance proportional to the displacement of the valve. An example of differential gear is shown in Fig. 105. Suppose that the rod *a* is connected with the governor so that it is raised by an acceleration of the engine's speed. The rod *c* which leads from the relay piston *b* to the regulator serves as a fulcrum, and the valve-rod *d* is consequently raised. This admits steam to the upper side of the piston and depresses the piston, which pulls down *d* with it, since the end of *a* now serves as a fulcrum. Thus by the downward movement of the piston the valve is again restored to its middle position

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[1] Numerous forms of Corliss gears are illustrated in W. H. Uhland's work on Corliss engines, translated by A. Tolhausen (London, 1879). A more recent form of gear by Mr. Inglis is described in *Engineering*, vol. xl. p. 251.

[2] *Proc. Inst. Mech. Eng.*, 1884.

and the action of the regulator then ceases until a new change of speed occurs. A somewhat similar differential contrivance is used in steam-steering engines to make the position of the rudder follow step by step, every movement of the hand wheel;[1] also, in the steam reversing gear which is applied to large marine engines, to make the position of the drag-link follow that of the hand-lever; and also in certain electrical governors.[2] The effect of adding a differential gear such as this to a relay governor or other disengagement governor is to convert it from the isochronous to the stable type.

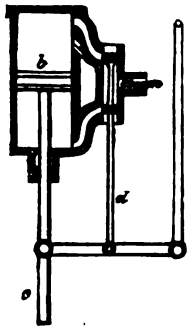

Fig. 105.

Fig. 105.—Differential Gear for Relay Governor.

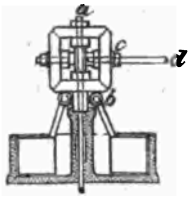

Fig. 106.

Fig. 106.—Siemen's Governor.

Differential or dynamometric governors.

178. Another group of governors is best exemplified by the "differential" governor of the late Sir W. Siemens[3] (Fig. 106). A spindle *a* driven by the engine drives a piece *b* (whose rotation is resisted by a friction brake) through the dynamometer coupling *c*, consisting of a nest of bevel-wheels and a loaded lever *d*. So long as the speed remains constant the rate at which work is done on the brake is constant and the lever *d* is steady. If the speed accelerates, more power has to be communicated to *b*, partly to overcome the inertia and partly to meet the increased resistance of the brake, and the lever *d* is displaced. The lever *d* works the throttle-valve or other regulator, either directly or by a steam relay. The governor is isochronous when the force employed to hold *d* in position does not vary; if the force increases when *d* is displaced, the governor is stable. A governor of this class may properly be called a dynamometric governor, since it regulates by endeavoring to keep constant the rate at which energy is transmitted to the piece *b*. In one form of Siemens's governor the friction-brake is replaced by a sort of centrifugal pump, consisting of a paraboloidal cup, open at the top and bottom, whose rotation causes a fluid to rise in it and escape over the rim when the speed is sufficiently great. Any increase in the cup's speed augments largely the power required to turn it, and consequently affects the position of the piece which corresponds to *d*[4]. Siemens's governor is not itself used to any important extent, but the principle it embodies finds application in a number of other forms.

179. The "velometer" or marine-engine regulator of Messrs. Durham and Churchill[5] is a governor of the same type. In it the rotation of a piece corresponding to *b* is resisted by means of a fan revolving in a case containing a fluid, and the coupling piece which is the mechanical equivalent of *d* in Fig. 106 acts on the throttle-valve, not directly but through a steam relay. In Silver's marine governor[6] the only friction-brake that is provided to resist the rotation of the piece which corresponds to *b* is a set of air-vanes. The inertia is, however, very great, and any acceleration of the engine's speed consequently displaces the dynamometer coupling, and so acts on the regulator in its effort to increase the speed of *b*.

Another example of the differential type is the Allen[7] governor, which has a fan directly geared to the engine, revolving in a case containing a fluid. The case is also free to turn, except that it is held back by a weight or spring and is connected to the regulator. So long as the speed of the fan is constant, the moment required to keep the case from turning does not vary, and consequently the position of the regulator remains unchanged. When the fan turns faster the moment increases, and the case has to follow it (acting on the regulator) until the spring which holds the case from turning is sufficiently extended, or the weight raised. The term "dynamometric governor" is equally applicable to this form; the power required to drive the fan is regulated by an absorption-dynamometer in the case instead of by a transmission-dynamometer between the engine and the fan. In Napier's governor the case is fixed, and the reaction takes place between one turbine-fan which revolves with the engine and another close to it which is held from turning by a spring and is connected with the regulator.

Pump governors.

180. Pump governors form another group closely related to the differential or dynamometric type. An engine may have its speed regulated by working a small pump which supplies a chamber from which water is allowed to escape by an orifice of constant size. When the engine quickens its speed water is pumped in faster than it can escape, and the accumulation of water in the chamber may be made to act on the regulator through a piston controlled by a spring or in other ways. This device has an obvious analogy to the cataract of the Cornish pumping-engine (§ 163), which has, however, the somewhat different purpose of introducing a regulated pause at the end of each stroke. The "differential valve-gear" invented by Mr. H. Davey, and successfully applied by him to modern pumping-engines, combines the functions of the Cornish cataract with that of a hydraulic governor for regulating the expansion.[8] In this gear, which is shown diagramatically in Fig. 107, the valve-rod of the engine (*a*) receives its motion from the lever *b*, one end of which (*c*) copies, on a reduced scale, the motion of the engine piston, while the other (*d*), which forms (so to speak) the fulcrum, has its position regulated by attachment to a subsidiary piston-rod, which is driven by steam in a cylinder *e*, and is forced to travel uniformly by a cataract *f*. The point of cut-off is determined by the rate at which the main piston overtakes the cataract piston, and consequently comes early with light loads and late with heavy loads.

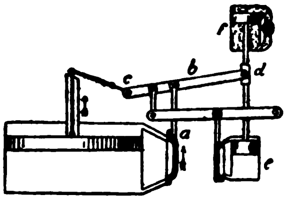

Fig. 107.—Davey's Differential Valve-Gear.

Government of marine engines.

181. The government of marine engines is peculiarly difficult on account of the sudden and violent fluctuations of load to which they are subjected by the alternate uncovering and submersion of the screw in a heavy sea. However rapidly the governor responds to increase of speed by closing the throttle-valve, an excess of work is still done by the steam in the valve-chest and in the high-pressure cylinder. To check the racing which results from this, it has been proposed to supplement the control which the throttle-valve on the steam-pipe exercises by throttling the exhaust or by spoiling the vacuum. Probably a better plan is that of Messrs. Jenkins and Lee, who give supplementary regulation by causing the governor to open a shunt-valve which connects the top and bottom of the low-pressure cylinder, thus allowing a portion of the steam in it to pass the piston without doing work. In Dunlop's pneumatic governor[9] an attempt is made to anticipate the racing of the screw by causing the regulator to be acted on by the changes of pressure on a diaphragm which is connected by an air-pipe with an open vessel fixed under the stern of the ship. A plan has recently been introduced by Mr. W. B. Thompson to prevent the racing of marine engines by working the valves from a lay shaft which is driven at a uniform speed by an entirely independent engine. So long as this lay shaft is not driven too fast the main engine is obliged to follow it; if the lay shaft is driven faster than the main engine can follow the main engine pauses so as to miss a stroke, and then goes on. Reversing the motion of the lay shaft reverses the main engine.

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[1] See a paper by Mr. J. MacFarlane Gray, *Proc. Inst. Mech. Eng.*, 1867.

[2] Willans, *Min. Proc. Inst. C.E.*, vol. lxxxi. p. 166.

[3] *Proc. Inst. Mech. Eng.*, 1853.

[4] *Proc. Inst. Mech. Eng.*, 1866; or *Phil. Trans.*, 1866.

[5] *Proc. Inst. Mech. Eng.*, 1879.

[6] *Brit. Ass. Rep.*, 1859, p. 128.

[7] *Proc. Inst. Mech. Eng.* 1873.

[8] *Proc. Inst. Mech. Eng.*, 1874.

[9] *Ibid.*, 1879.

Moscrop recorder.

182. In connection with governors mention may be made of an apparatus introduced by Mr. Moscrop to give a continuous record of fluctuations in the speed of engines.[1] It resembles a small centrifugal governor, but the displacement of the balls actuates, not a regulator, but a pencil which moves transversely on a ribbon of paper that is moved continuously by clockwork. The recorder responds so rapidly to changes of speed as to show not only the comparatively slow changes which occur from stroke to stroke, but also those short-period fluctuations between a maximum and minimum, within the limits of each single stroke, which will be discussed in the next chapter.

X. The Work on the Crank-Shaft.

Use of fly-wheel.

183. Besides those variations of speed which occur from stroke to stroke, which it is the business of the governor to check, there are variations within each single stroke over which the governor has of course no control. These are due to the varying rate at which work is done on the crank-shaft during its revolution. To limit them is the function of the fly-wheel, which acts by forming a reservoir of energy to be drawn upon during those parts of the revolution in which the work done on the shaft is less than the work done by the shaft, and to take up the surplus in those parts of the revolution in which the work done on the shaft is greater than the work done by it. This alternate storing and restoring of energy is accomplished by slight fluctuations of speed whose range depends on the ratio which the alternate excess and defect of energy bears to the whole stock the fly-wheel holds in virtue of its motion. The effect of the fly-wheel may be studied by drawing a diagram of crank-effort, which shows the work done on the crank in the same way that the indicator diagram shows the work done on the piston. The same diagram serves another useful purpose in determining the twisting and bending stress in the crank.

Diagram of crank-effort.

184. The diagram of crank-effort is best drawn by representing, in rectangular co-ordinates, the relation between the moment which the connecting-rod exerts to turn the crank and the angle turned through by the crank. When the angle is expressed in circular measure, the area of the diagram is the work done on the crank.

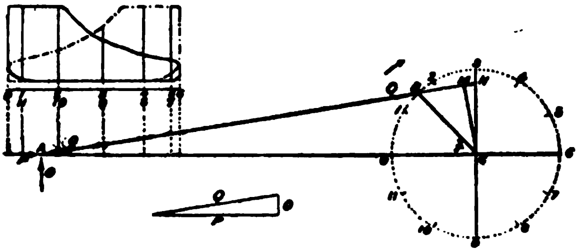

FIG. 108.

Neglecting friction, and supposing in the first place that the engine runs so slowly that the forces required for the acceleration of the moving masses are negligibly small, the moment of crank-effort is found by resolving the thrust P of the piston-rod into a component Q along the connecting-rod and a component O normal to the surface of the guide (Fig. 108). The moment of crank-effort is

$$Q\,.\,CM = P\,.\,CN = P\,r\sin\alpha\left(1+\frac{r\cos\alpha}{\sqrt{l^2-r^2\sin^2\alpha}}\right)$$

where CN is drawn perpendicular to the centre line or travel of the piston, r is the crank, l the connecting-rod, and α the angle ACB which the crank makes with the centre line. A graphic determination of CN is the most convenient in practice, unless the connecting-rod is so long that its obliquity is negligible, when the second term in the above expression vanishes. Fig. 109 shows the diagram of crank-effort determined in this way for an engine whose connecting-rod is 3½ times the length of its crank, and in which steam is cut off at half-stroke. The thrust P is determined from the indicator diagrams of Fig. 108 by taking the excess of the forward pressure on one side of the piston over the back pressure on the other side, and multiplying this effective pressure by the area of the piston. The area of the diagram of crank-effort is the work done per revolution.

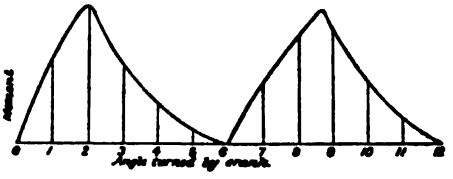

FIG. 109.—Diagram of Crank-Effort.

Effect of friction.

185. The friction of the piston in the cylinder and the piston-rod in the stuffing-box is easily allowed for, when it is known, by making a suitable deduction from P. Friction at the guides, at the crosshead, and at the crank-pin has the effect of making the stress at each of these places be inclined to the rubbing surfaces at an angle ϕ, the angle of repose, whose tangent is the coefficient of friction. Hence O, instead of being normal to the guide, is inclined at the angle ϕ in the direction which resists the piston's motion (Fig. 110); and the thrust along the connecting-rod, instead of passing through the centre of each pin, is displaced far enough to make an angle ϕ with the radius at the point where it meets the pin's surface. To satisfy this condition let a "friction-circle" be drawn about the centre of each pin, with radius equal to $a\sin\phi$, where a is the actual radius of the pin. Any line drawn tangent to this circle will make the angle ϕ with the radius of the pin at the surface of the pin. The thrust of the connecting-rod must be tangent to both circles; it is drawn as in Fig. 110, so that it resists the rotation of the pins relatively to the rod. The direction of rotation of the pins is shown by curved arrows in the figure, where the friction-circles are drawn to a greatly exaggerated scale. Finally, P (after allowing for the friction of piston-packing and stuffing-box) is resolved into O and Q, and Q.CM, the moment of Q on the shaft, is determined. This gives a diagram of crank-effort, correct so far as friction affects it, whose area is no longer equal to that of the indicator diagram. The difference, however, does not represent the whole work lost through friction of the mechanism, since the friction of the shaft itself, and of those parts of the engine which it drives, has still to be allowed for if the frictional efficiency of the engine as a whole is in question.

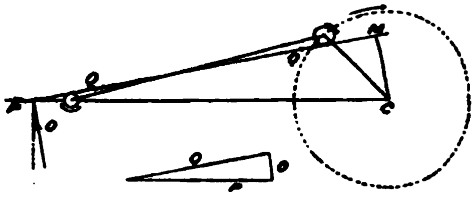

FIG. 110.

Effect of inertia.

186. The diagram of crank-effort is further modified when we take account of the inertia of the piston and connecting-rod. For the purpose of investigating the effects of inertia, we may assume that the crank is revolving at a sensibly uniform rate of n turns per second. Let M be the mass of the piston, piston-rod, and crosshead in pounds, and a its acceleration at any instant in feet per second. The force required to accelerate it is Ma/g, in pounds-weight, and this is to be deducted in estimating the effective value of P. The effect is to reduce P during the first part of the stroke and to increase it towards the end, thereby compensating to some extent for the variation which P undergoes in consequence of an early cut off. If the connecting-rod is so long that its obliquity may be neglected the piston has simple harmonic motion, and

$$a = -4\pi^2n^2r\cos\alpha = -4\pi^2n^2x,$$

where x is the distance of the piston from its middle position. More generally, whatever ratio the length l of the connecting-rod bears to that of the crank r,

$$a = -4\pi^2n^2r\left(\cos\alpha+\frac{rl^2\cos 2\alpha+r^3\sin^4\alpha}{(l^2-r^2\sin^2\alpha)^{\frac{3}{2}}}\right)$$

The effect is to make, on the diagram of P, a correction of the character shown in Fig. 111, where the broken line cd refers to the case of an indefinitely long connecting-rod and the full line ab to the case of a connecting-rod 3½ times the length of the crank. In a vertical engine the weight of the piston and piston-rod is to be added to or subtracted from P.

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[1] *Proc. Inst. Mech. Eng.*, 1884.

To allow for the inertia of the connecting-rod is a matter of somewhat greater difficulty. Its motion may conveniently be analyzed as consisting of translation with the velocity of the crosshead, combined with rotation about the crosshead as centre. Hence the force required for its acceleration is the resultant of three components—F_1, the force required for the linear acceleration a (which is the same as that of the piston); F_2, the force required to cause angular acceleration about the crosshead; and F_3, the force towards the centre of rotation, which depends on the angular velocity, and is equal and opposite to the so-called centrifugal force. Let θ be the angle BAC (Fig. 112), $\dot\theta$ the angular velocity of the rod about A, and $\ddot\theta$ its angular acceleration, and let M′ be the mass of the rod. Then

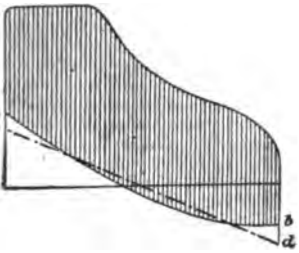

FIG. 111.

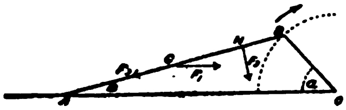

FIG. 112.

$$F_1 = M'a/g,$$

and acts through the centre of gravity G, parallel to AC;

$$F_2 = M'.\,AG.\,\ddot\theta/g,$$

and acts at right angles to the rod through the centre of percussion H;

$$F_3 = M'.\,AG.\,\dot\theta^2/g,$$

and acts along the rod towards A. Also,

$$\dot\theta = \frac{2\pi nr\cos\alpha}{\sqrt{l^2 - r^2\sin^2\alpha}};$$

and

$$\ddot\theta = \frac{-4\pi^2 n^2 r\sin\alpha(l^2 - r^2)}{(l^2 - r^2\sin^2\alpha)^{\frac{3}{2}}}.$$

The moments of these forces about C are next to be found, and to be deducted from the moment of the thrust in the connecting-rod (and if the weight of the rod is to be considered, its moment about C is to be added) in finding the resultant moment of crank-effort.

187. If, however, the friction at the crosshead and crank-pin is to be taken account of, the whole group of forces acting on the rod must be considered as follows. Compound forces equal and opposite F_1, F_2, and F_3 into a single force R (Fig. 113), which may be called the resultant resistance to acceleration of the connecting-rod. If the weight of the rod is to be considered let it also be taken as a component in reckoning R. Then the rod may in any position be regarded as in equilibrium under the action of the forces Q, R, and S, where Q and S are the forces exerted on it by the crosshead and crank-pin respectively. These three forces meet in a point p in R, which is to be found by trial, the condition being that in the diagram of forces, Fig. 114, after the triangle POQ has been drawn, and the force R set out, the force-line S shall be parallel to a line drawn from p tangent to the friction-circle of the crank-pin, as in Fig. 113. When this condition has been satisfied by trial, the value of S, which is the thrust on the crank-pin, is determined, and S . CM is the moment of crank-effort. This method is due to the late Prof. Fleeming Jenkin, who has applied it with great generality to the determination of the frictional efficiency of machinery in two important papers,[1] the second of which deals in detail with the dynamics of the steam-engine. Fig. 115, taken from that paper, shows the diagram of crank-effort in a horizontal direct-acting engine,—the full line with friction, and the dotted line without friction,—the inertia of the piston and connecting-rod being taken account of, as well as the weight of the latter. It exhibits well the influence which the inertia of the reciprocating parts has in equalizing the crank-effort in the case of an early cut-off. The cut-off is supposed to occur pretty sharply at about one-sixth of the stroke. The engine considered is of practical proportions, and makes four turns per second; and the initial steam pressure is 50 lb per square inch. It appears from the diagram that, with a slightly higher speed, or with heavier rods, a better balance of crank-effort might be secured, especially as regards the stroke towards the crank, which comes first in the diagram; on the other hand, by unduly increasing the mass of the reciprocating pieces or their speed the inequality due to expansion would be over-corrected and a new inequality would come in.

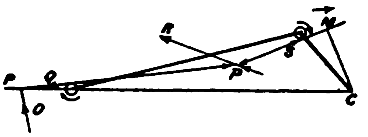

FIG. 113.

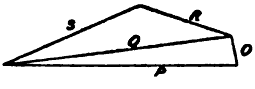

FIG. 114.

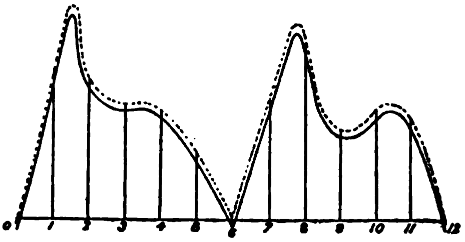

FIG. 115.

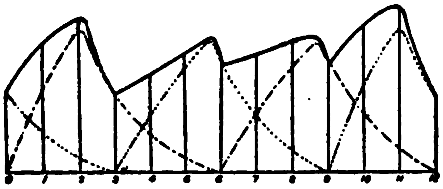

FIG. 116.—Crank-Effort Diagram for Two Cranks.

Combined diagrams.

188. When two or more cranks act on the same shaft, the joint moment of crank-effort is found by combining the diagrams for the separate cranks, in the manner illustrated by Fig. 116, which refers to the case of two cranks at right angles.

Circular diagram.

Another graphic method of exhibiting the variations of moment exerted on the crank-shaft during a revolution is to draw a circular diagram of crank-effort, in which lines proportional to the moment are set off radially from a circular line which represents the zero of moment. An example of this plan is given in Fig. 117, which shows the resultant moment determined by Mr. A. C. Kirk for one of his triple-expansion engines with three cranks set at 120° from each other. Curves are drawn for various speeds, giving in each case the resultant moment due to the steam pressure (as determined from actual indicator diagrams) combined with the moments due to the inertia of the reciprocating parts. The line marked 0 is the steam line without inertia—or, in other words, the curve corresponding to an indefinitely slow speed. The other curves refer to the number of revolutions per minute marked on them.

Fluctuations of speed.

189. To determine the fluctuations of speed during a revolution, the resultant diagram of work done *on* the crank-shaft is to be compared with a similar diagram drawn to show the work done *by* the shaft in overcoming its own friction and in overcoming the resistance of the mechanism

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[1] *Trans. Roy. Soc., Edin.*, vol. xxviii. p. 1 and p. 703.

which it drives. In general the resistance may be taken as constant, and the diagram of effort exerted by the crank-shaft is then a straight line, as EFGHIJKL in Fig. 118. At F, G, H, I, J, and K the rate at which work is being done on and by the shaft is the same; hence at these points the fly-wheel is neither gaining nor losing speed. The shaded area above FG is an excess of work done on the crank, and raises the speed of the fly-wheel from a minimum at F to a maximum at G. From G to H the fly-wheel supplies the defect of energy shown by the shaded area below GH, by which the demand for work exceeds the supply; its speed again reaches a minimum at H, and again a maximum at I. The excesses and defects balance in each revolution if the engine is making a constant number of turns per second. In what follows it is assumed that they are only a small fraction of the whole energy held by the fly-wheel.

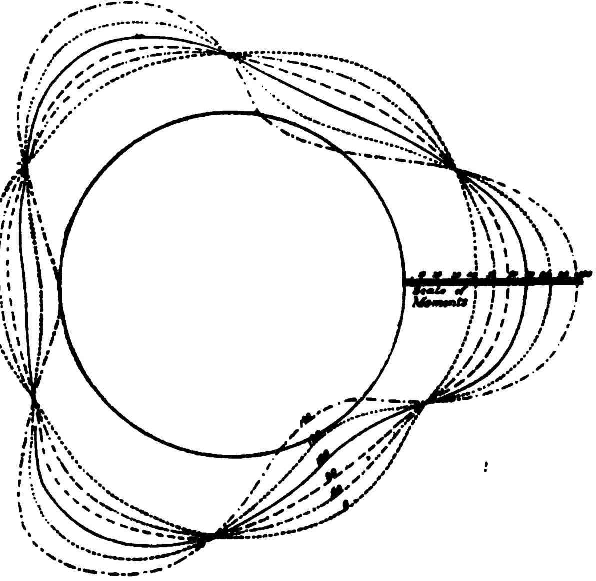

FIG. 117.—Circular Diagram of Crank-Effort for a Three-Cylinder Engine.

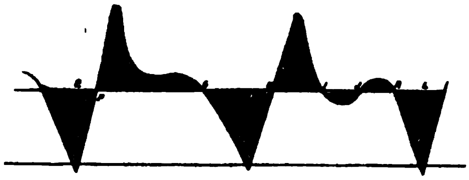

FIG. 118.

Function of fly-wheel.

Let ΔE be the greatest single amount of energy which the fly-wheel has to give out or absorb, as determined by measuring the shaded areas of the diagram; and let ω_1 and ω_2 be the maximum and minimum values of the wheel's angular velocity, which occur at the extremes of the period during which it is storing or supplying the energy ΔE. The mean angular velocity of the wheel ω_0 will be sensibly equal to $\frac{1}{2}(\omega_1 + \omega_2)$ if the range through which the speed varies is moderate. Let E_0 be the energy of the fly-wheel at this mean speed. Then

$$E_0 = \tfrac{1}{2}I\omega_0^2,$$

where I is the moment of inertia of the fly-wheel.

$$\Delta E = \frac{I(\omega_1^2 - \omega_2^2)}{2} = I\omega_0(\omega_1 - \omega_2) = 2E_0 \cdot \frac{(\omega_1 - \omega_2)}{\omega_0}.$$

The quantity $\frac{\omega_1 - \omega_2}{\omega_0}$, which we may write q, is the ratio of the extreme range of speed to the mean speed, and measures the degree of unsteadiness which the fly-wheel leaves uncorrected. If the problem be to design a fly-wheel which will keep q down to an assigned limit, the energy of the wheel must be such that

$$E_0 = \frac{\Delta E}{2q}.$$

The Moscrop recorder,, alluded to in § 182, exhibits the degree of unsteadiness during a single revolution by the width of the line which it draws. On the other hand, any bending of the line implies the quite independent characteristic of unsteadiness from one revolution to another. The former is due to insufficient fly-wheel energy, the latter to imperfect governing.

190. An interesting consequence of the periodic alternations in crank-effort which occur in each revolution has been pointed out by Mr. M. Longridge.[1] The fly-wheel receives its alternate acceleration and retardation through changes of the torsional stress in the shaft. If these occur at intervals nearly equal to the period of free torsional vibration which the fly-wheel possesses in virtue of the torsional elasticity of the shaft between it and the crank, strains of great amplitude will arise; and Mr. Longridge has suggested that this may account for the observed fact that engine-shafts have been ruptured when running so that the fluctuations of crank-effort occurred with one particular frequency, although the greatest effort was itself much less than the shaft would safely bear.

XI. EXAMPLES OF STEAM-ENGINES.

STATIONARY ENGINES.

Descriptive terms.

191. In classifying engines with regard to their general arrangement of parts and mode of working, account has to be taken of a considerable number of independent characteristics. We have, first, a general division into *condensing* and *non-condensing engines*, with a subdivision of the condensing class into those which act by surface condensation and those which use injection. Next there is the division into *compound* and *non-compound*, with a further classification of the former as double-, triple-, or quadruple-expansion engines. Again, engines may be classed as *single* or *double-acting*, according as the steam acts on one or alternately on both sides of the piston. Again, a few engines—such as steam-hammers and certain kinds of steam-pumps—are *non-rotative*, that is to say, the reciprocating motion of the piston does work simply on a reciprocating piece; but generally an engine does work on a continuously revolving shaft, and is termed *rotative*. In most cases the crank-pin of the revolving shaft is connected directly with the piston-rod by a connecting-rod, and the engine is then said to be *direct acting*; in other cases, of which the ordinary beam-engine is the most important example, a lever is interposed between the piston and the connecting-rod. The same distinction applies to non-rotative pumping engines, in some of which the piston acts directly on the pump-rod, while in others it acts through a beam. The position of the cylinder is another element of classification, giving *horizontal*, *vertical*, and *inclined cylinder* engines. Many vertical engines are further distinguished as belonging to the *inverted cylinder* class; that is to say, the cylinder is above the connecting-rod and crank. In *oscillating cylinder engines* the connecting-rod is dispensed with; the piston-rod works on the crank-pin, and the cylinder oscillates on trunnions to allow the piston-rod to follow the crank-pin round its circular path. In *trunk engines* the piston-rod is dispensed with; the connecting-rod extends as far as the piston, to which it is jointed, and a trunk or tubular extension of the piston, through the cylinder cover, gives room for the rod to oscillate. In *rotary* engines there is no piston in the ordinary sense; the steam does work on a revolving piece, and the necessity is thus avoided of afterwards converting reciprocating into rotary motion.

192. In the single-acting atmospheric engine of Newcomen the beam was a necessary feature; the use of water-packing for the piston required that the piston should move down in the working stroke, and a beam was needed to let the counterpoise pull the piston up. Watt's improvements made the beam no longer necessary; and in one of the forms he designed it was discarded—namely, in the form of pumping engine known

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[1] *Proc. Inst. Mech. Eng.*, May, 1884, p. 162.

as the Bull engine, in which a vertical inverted cylinder stands over and acts directly on the pump-rod. But the beam type was generally retained by Watt, and for many years it remained a favorite with builders of engines of the larger class. The beam formed a convenient driver for pump-rods and valve-rods; and the parallel motion invented by Watt as a means of guiding the piston-rod, which could easily be applied to a beam-engine, was, in the early days of engine-building, an easier thing to construct than the plane surfaces which are the natural guides of the piston-rod in a direct-acting engine. In modern practice the direct-acting type has to a very great extent displaced the beam type. For mill-driving and the general purposes of a rotative engine the beam type is now rarely chosen. In pumping engines it is more common, but even there the tendency is to use direct-acting forms.

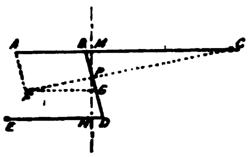

FIG. 119.—Watt's Parallel Motion.

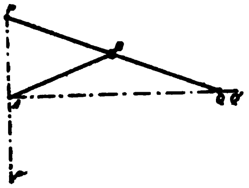

FIG. 120.

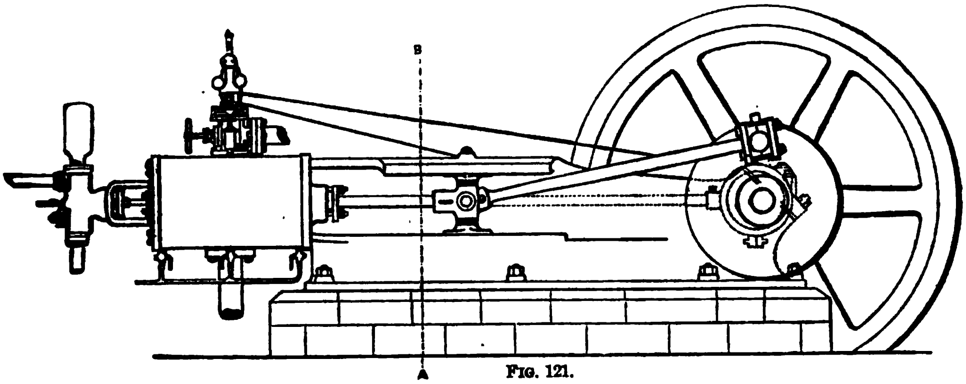

FIG. 121.

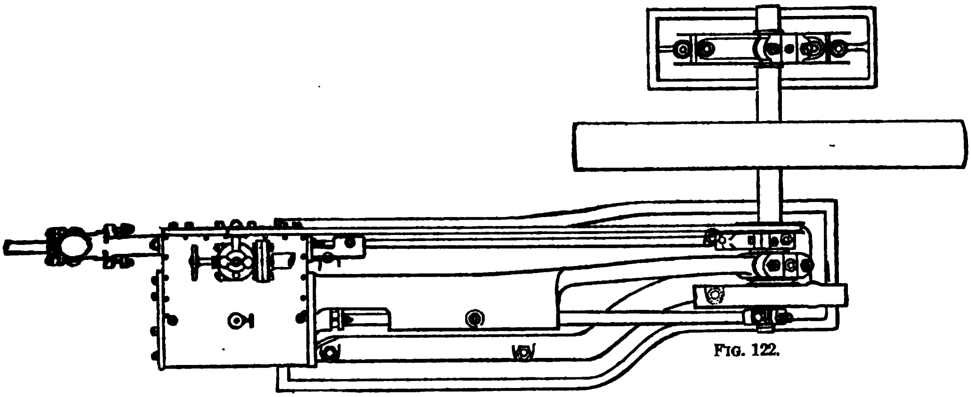

FIG. 122.

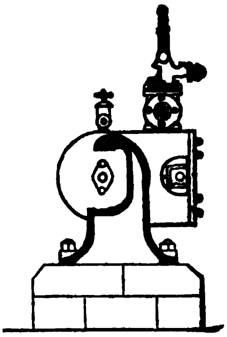

FIG. 123.

FIG. 121.—Small Horizontal Direct-Acting Steam-Engine: Side Elevation. FIG. 122.—Plan. FIG. 123.—Section on AB in Fig. 121.

Parallel motion in beam-engines.

193. The only distinctive feature of beam-engines requiring special notice here is the "parallel motion," an ordinary form of which is shown diagrammatically in Fig. 119. There MN is the path in which the piston-rod head, or crosshead, as it is often called, is to be guided. ABC is the middle line of half the beam, C being the fixed centre about which the beam oscillates. A link BD connects a point in the beam with a radius link ED, which oscillates about a fixed centre at E. A point P in BD, taken so that BP : DP:: EN : CM, moves in a path which coincides very closely with the straight line MPN. Any other point F in the line CP or CP produced is made to copy this motion by means of the links AF and FG, parallel to BD and AC. In the ordinary application of the parallel motion a point such as F is the point of attachment of the piston-rod, and P is used to drive a pump-rod. Other points in the line CP produced are occasionally made use of, by adding other links parallel to AC and BD.[1]

Watt's linkage gives no more than an approximation to straight-line motion, but in a well-designed example the amount of deviation need not exceed one four-thousandth of the length of stroke. It was for long believed that the production of an exact straight-line motion by pure linkage was impossible, until the problem was solved by the invention of the Peaucellier cell.[2] The Peaucellier linkage has not been applied to the steam-engine, except in isolated cases.

Scott-Russell's parallel motion.

194. Another "parallel motion" which has been used in steam-engines is shown in Fig. 120. AB is a link pivoted on a fixed centre at A, and connected to the middle of another link PQ, which is twice the length of AB. Q is guided to move in a straight line in the direction of AQ. P then moves in an exact straight line through A. This is not a pure linkage, since Q slides in a fixed guide, but the distance through which Q has to be guided is small compared with the stroke of P. If Q is guided to move in the arc of a circle of large radius, by using a radius rod from a fixed centre above or below it, the guiding surfaces at Q are avoided, but the path of P is then only very nearly straight. An example of the linkage in this form, with the further modification

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[1] The kinematics of the parallel motion are discussed in Rankine's *Machinery and Mill Work*, p. 275, and rules are given for the proportions and positions of the parts.

[2] See Kempe's *How to Draw a Straight Line* ("Nature Series"), 1877.

that A is shifted out, and B is brought nearer to P, occurs in the pumping engine of Fig. 130 below.

In by far the greater number of modern steam-engines the crosshead is guided by a block sliding on planed surfaces. In many beam-engines, even, this plan of guiding the piston has taken the place of the parallel motion.

Horizontal direct-acting engines.

195. No type of steam-engine is so common as the horizontal direct-acting. A small engine of this type, made by Messrs. Tangye, and rated as a 10-horse-power engine, is illustrated in Figs. 121 to 124. It furnishes a good example of a very numerous class, and serves to illustrate the principal parts of a complete engine. Fig. 121 is a side elevation, Fig. 122 a plan, Fig. 123 a transverse section through the bedplate in front of the cylinder, on the line AB; and Fig. 124 is a horizontal section through the cylinder, valve-chest, valve, stuffing-boxes, piston, and crosshead. The bedplate is a single hollow casting, with two surfaces planed on it to serve as guides (see Fig. 123). At one end the bedplate forms a pillow-block for the shaft, which has another main bearing independently supported beyond the fly-wheel. At the other end the bedplate is shaped so as to form the cylinder cover; the cylinder is bolted to this and overhangs the bed.

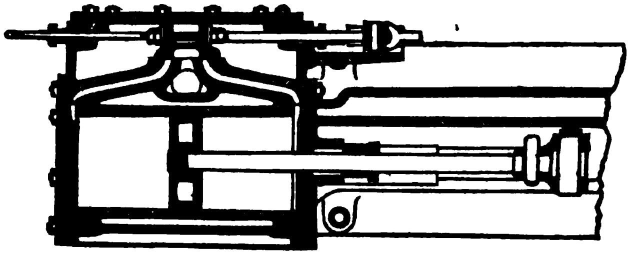

FIG. 124.—Horizontal Section through Cylinder and Valve-Chest.

Details.

The cylinder (of 10 inches diameter and 20 inches stroke) consists of an internal "liner" of cast-iron, exactly bored, and fitted within an external cylindrical casting, of which the ports and sides of the valve-chest form part. The space between the liner and the external cylinder serves as a steam-jacket. The use of a separate liner within the main cylinder is now general in large engines. In the front cylinder cover there is a stuffing-box through which the piston-rod passes. The stuffing-box is kept steam-tight by a soft packing which is pressed in by a gland. In some instances the packing consists of metallic rings. The cylinder cover and gland are lined with a brass ring in the hole through which the piston-rod passes. The valve-rod is brought out of the valve-chest in the same way. The piston is a hollow casting into which the piston-rod is screwed and riveted over. It is packed by two split rings of cast-iron, which are sprung into recesses turned in the circumference of the piston. This mode of packing is used in locomotives and small engines. For large pistons the usual plan is to employ wider split rings, called floating rings, pressed against the sides of the cylinder, not by their own elasticity, but by separate springs behind them in the body of the piston; they are held in place by a movable flange called a junk-ring on one face of the piston. One example of the packing of a large piston is shown in Fig. 134. The crosshead consists of a steel centre piece with a round boss, in which the piston-rod is secured by a cotter, and a forked front, where the end of the connecting-rod works on a pin. A pair of pins at top and bottom carry the steel shoes or sliding-blocks, whose distance from the centre is adjustable by nuts to take up wear. There is no crank; the connecting-rod works on a pin fixed in a disk on the end of the shaft in front of the main bearing. The valve-rod, which is worked by an eccentric just behind the bearing is extended through the end of the valve-chest, and forms the plunger of a feed-pump which is bolted to the end of the chest. Frequently the feed-pump is fixed at any convenient part of the bedplate, and is driven by a separate eccentric, and in some cases its plunger is connected directly to the crosshead. In the main bearing the shaft turns in gun-metal or phosphor-bronze blocks called brasses. In heavy engines these are generally lined with Babbit's anti-friction metal or other soft alloy, and in many modern engines the brasses are entirely dispensed with, a lining of Babbit's metal being let into the cast-iron surface of the bearing. When the brasses are in two pieces, the plane of division between them is chosen to be that in which the wear is likely to be least. A more satisfactory adjustment is possible when the brasses are in three or more pieces.

Condenser and air-pump.

196. When a condenser is used with a small horizontal engine it is usually placed behind the cylinder; and the air-pump, which is within the condenser, is a horizontal plunger or piston-pump worked by a "tail-rod"—that is, a continuation of the piston-rod past the piston and through the back cover of the cylinder. Figs. 125 and 126 show in section one of Messrs. Tangye's small condensers fitted with a double-acting air-pump to be driven by a tail-rod. The condenser proper is the chamber A, and into it the injection-water streams continuously through perforations in the pipe B, which has a cock outside to regulate the supply. The pump draws condensed water down to the lower part of the vessel at either end alternately through the valves C, and forces it up thence through the valves D to a chamber E, from which the delivery-pipe leads out. The pump is a gun-metal piston working in a cylinder fitted with a gun-metal liner. The valves are flat india-rubber rings held down in the centre by a spring, which allows them to open by rising bodily, as well as by bending.

High-speed horizontal engines.

197. The engine of Figs. 121–4 makes 85 revolutions per minute, and its mean piston speed is consequently about 280 feet per minute. In some special forms of small horizontal engine the design is adapted to a much more rapid reciprocation of the moving masses, and the piston speed is raised to a value seldom exceeded in the largest land engines, although still higher values are now common in marine practice. Experience shows that the weight of engines of any one type varies roughly as the piston area. Their power depends on the product of piston area, piston speed, and pressure; and hence, so long as the pressures are similar, the ratio of power to weight is nearly proportional to piston speed. Cases present themselves in which it is desirable to make this ratio as great as possible; and, apart from this, an engine making a large number of revolutions per minute is a convenient motor for certain high-speed machines.

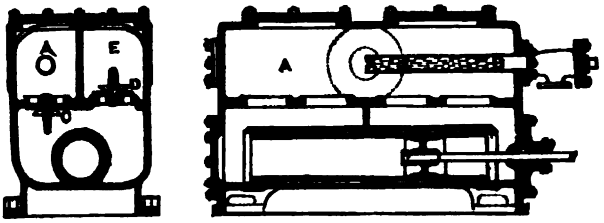

FIG. 125. FIG. 126.

Condenser and Air-Pump.

Armington and Sims engine.

A good example of a small horizontal engine, specially designed by the symmetry and balance of its parts, by largeness of the bearing surfaces, and by very perfect lubrication, to stand the strains which are caused by high speed, is the Armington & Sims engine, made in America by the patentees and in England by Messrs. Greenwood & Batley. The bedplate is symmetrical about the line of motion of the crosshead; it supplies two very long main bearings for the shaft, at each end of which there is an overhung fly-wheel. The bearings have an adjustable side-block to take up wear. They are formed entirely of white-metal, cast on to the cast-iron pillow-blocks. In the middle are two disks, forming crank-cheeks, which are weighted opposite the crank-pin, so that they balance the pin and that part of the connecting-rod which may be treated as having its mass applied there. The crank-pin and the crosshead-pin are wide enough to give a large bearing area. The crosshead-block is a hollow bronze casting, giving an exceptionally large surface of contact with the guides. The valve is a piston-valve of the Trick type, which works sufficiently tight without packing. The valve-rod and eccentric-rod are connected through a block with slides on a fixed guide. The governor, which has been already illustrated in Fig. 100, is contained within one of the fly-wheels. An engine of this type, with a cylinder 12 inches in diameter and a stroke of 12 inches, makes 275 revolutions per minute, has a piston speed of 550 feet per minute, and indicates about 80 horse-power. Other good examples of high speed combined with double action are furnished by the Porter-Allen engine[1] and by the very light engines which Mr. Thorneycroft and others have introduced for driving fans to supply air to the closed stoke-holes of torpedo-boats. In these a speed of 1000 revolutions per minute is made possible by the use of light reciprocating parts and large bearing surfaces.

Large horizontal Corliss engine.

198. Fig. 127 shows a large non-compound horizontal Corliss engine for mill-driving, by Messrs. Hick, Hargreaves & Co. The cylinder is 34 inches in diameter, the stroke 8 feet, and the speed 45 revolutions per minute, giving a mean piston speed of 720 feet per minute. The cylinder is steam-jacketed round the barrel in the space between the liner and the outer cylinder, and also at the ends, which are cast hollow for this purpose. In large horizontal engines the weight of the piston tends to cause excessive wear on the lower side of the cylinder. In the example shown a part of the weight is borne by a tail-rod, ending in a block, which slides on a fixed guide behind the cylinder. To further diminish wear the piston is sometimes made much wider from front to back than the one shown here; and the device is sometimes resorted to of giving the piston-rod "camber"—that is to say, an upward curvature in the middle portion, which the weight of the piston reduces to straightness. Fig. 127 illustrates a common method of attaching the air-pump and condenser in large horizontal engines. The condenser is placed in a well in front of the cylinder, and the air-pump, which is a vertical bucket-pump, is worked by a bell-crank lever, connected with the crosshead by a link. The fly-wheel of this engine is grooved for rope-gearing; it is cast in segments, which are bolted to one another and to the spokes, and the spokes are secured by cotters in tapered sockets in the nave. It is large and heavy, to suit the inequality of driving effort which is caused by the use of a single cylinder and a very early cut-off in engines of this class. To facilitate starting and valve-setting, mill engines are often provided with an auxiliary called a "barring" engine. The barring engine turns a toothed pinion, which gears into a toothed rim in the fly-wheel, and is contrived to fall automatically out of gear as soon as the main engine starts.

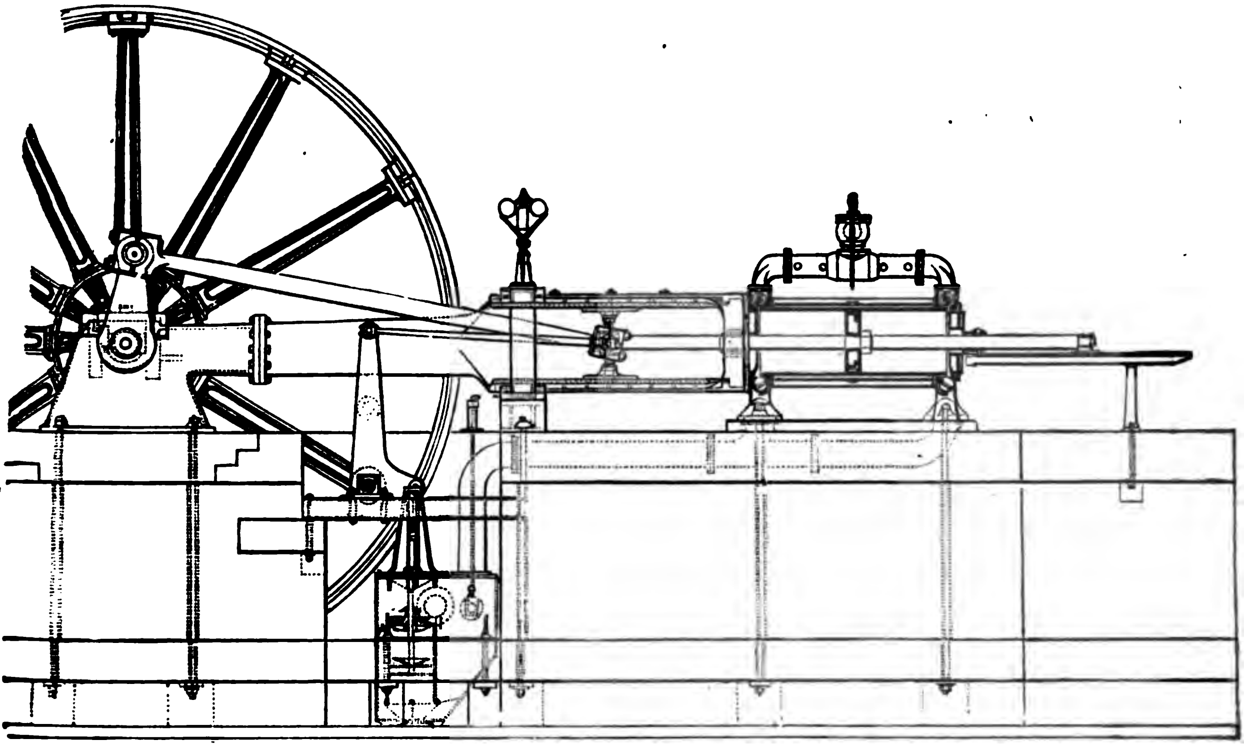

Fig. 127.—Horizontal Corliss Condensing Engine.

Coupled engines.

199. When uniformity of driving effort or the absence of dead-points is specially important, two independent cylinders are often coupled to the same shaft by cranks at right angles to each other, an arrangement which allows the engine to be started readily from any position. The ordinary locomotive is an example of this form. Among fixed engines of the larger kind, *winding engines*, in which ease of starting, stopping, and reversing is essential, are very generally made by coupling a pair of horizontal cylinders, with cranks at right angles to each other, on opposite sides of the winding-drum, with the link-motion as the means of operating the valves.

Compound horizontal engines.

200. Non-compound engines of so large a size as that of Fig. 127 are comparatively uncommon. Horizontal engines of the larger class are generally compounded either (1) by having a high and a low pressure cylinder side by side, working on two cranks at exactly or nearly right angles to each other, or (2) by placing one cylinder behind the other, with the axes of both in the same straight line. The latter is called the *tandem* arrangement. In it one piston-rod is generally common to both cylinders; occasionally, however, the piston-rods are distinct, and are connected to one another by a framing of parallel bars outside of the cylinders. Another construction, rarely followed, is to have parallel cylinders with both piston-rods acting on one crank by being joined to opposite ends of one long crosshead. In some recent compound engines the large cylinder is horizontal, and the other lies above it in an inclined position, with its connecting-rod working on the same crank-pin.

In tandem engines, since the pistons move together, there is no need to provide a receiver between the cylinders. It is practicable to follow the "Woolf" plan of allowing the steam to expand directly from the small into the large cylinder; and in many instances this is done. In point of fact, however, the connecting-pipe and steam-chest form an intermediate receiver of considerable size, which will cause loss by "drop" (§ 113) unless steam be cut off in the large cylinder before the end of the stroke. Hence it is more usual to work with a moderately early cut-off in the low-pressure cylinder than to use the "Woolf" plan of admitting steam to it throughout the whole stroke. Unless it is desired to make the cut-off occur before half-stroke, a common slide-valve will serve to distribute steam to the large cylinder. For an earlier cut-off than this a separate expansion-valve is required on the low-pressure cylinder, to supplement the slide-valve; and in any case, by providing a separate expansion-valve, the point of cut-off is made subject to easy control, and may be adjusted so as to avoid drop or to divide the work as may be desired between the two cylinders.[1] For this reason it is not unusual to find an expansion-valve, as well as a common slide-valve, on the low-pressure cylinder even of tandem engines. In many cases, however, the common slide-valve only is used. On the high-pressure cylinder of compound engines, the cut-off is usually effected either by an expansion slide-valve or by some form of Corliss or other trip-gear.

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[1] *Proc. Inst. Mech. Eng.*, 1868.

For mill engines the compound tandem and compound coupled types are now the most usual, and the high-pressure cylinder is very generally fitted with Corliss gear. In the compound coupled arrangement the cylinders are on separate bedplates, and the fly-wheel is between the cranks.

Direct-acting vertical cylinder engines.

201. The general arrangement of vertical engines differs little from that of horizontal engines. The cylinder is usually supported above the shaft by a cast-iron frame resembling an inverted A, whose sides are kept parallel for a part of their length to serve as guides for the crosshead. Sometimes one side of the frame only is used, and the engine is stiffened by a wrought-iron column between the cylinder and the base on the other side. *Wall-engines* are a vertical form with a flat frame or bedplate, which is made to be bolted against a wall; in these the shaft is generally at the top. Vertical engines are compounded, like horizontal engines, either by coupling parallel cylinders to cranks at right angles (as in the ordinary marine form which will be illustrated later, § 218), or, tandem fashion, by placing the high-pressure cylinder above the other. In vertical condensing engines the condenser is situated at the base, and the air-pump, which has a vertical stroke, is generally worked by a lever connected by a short link to the crosshead. In some cases the pump is horizontal, and is worked by a crank on the main shaft.

High-speed single-acting engines.

202. Engines making 400 to 1600 revolutions per minute have been extensively applied, in recent years, to the driving of dynamos and other high-speed machines. These are for the most part single-acting; steam is admitted to the back of the piston only, and the connecting-rod is in compression throughout the whole revolution. Besides simplifying the valves, this has the important advantage that alternation of strain at the joints may be entirely avoided, with the knocking and wear of the brasses which it is apt to cause. To secure, however, that the connecting-rod shall always push, there must be much cushioning during the back or exhaust stroke. From a point near the middle of the back stroke to the end the piston is being retarded; and, as this must not be done by the rod (which would thereby be required to pull), cushioning must begin there, and the work spent upon the cushion must at every stage be at least as great as the loss of energy on the part of the piston and rod. In some single-acting engines this cushioning is done by compressing a portion of the exhaust steam; in others the rod is kept in compression by help of a supplementary piston, on which steam from the boiler presses; in Mr. Willans's engine the cushioning is done by compressing air.

Brotherhood engine.

203. A very successful example of the multiple-cylinder single-acting high-speed type is the three-cylinder engine introduced by Mr. Brotherhood in 1873, the most recent form of which is shown in Figs. 128 and 129. Fig. 128 is a longitudinal and Fig. 129 a transverse section. Three cylinders, set at 120° apart, project from a closed casing, the central portion of which forms the exhaust. The pistons are of the trunk type—that is to say, there is a joint in the piston itself which allows the piston-rod to oscillate, and so makes a separate connecting-rod unnecessary. The three rods work on a single crank-pin, which is counterbalanced by masses fixed to the crank cheeks on the other side of the shaft. Steam is admitted to the back of the pistons only. It passes first through a throttle-valve, which is controlled by a centrifugal spring-governor (Fig. 128), and is then distributed to the cylinders by three piston-valves A, worked by an eccentric, the sheave of which is made hollow so as to overhang one of the main bearings (Fig. 128). Release takes place by the piston itself uncovering exhaust ports in the circumference of the cylinder, and the rocking motion of the piston rod is taken advantage of to open a supplementary exhaust port (B, Fig. 129), which remains open during a sufficient portion of the back stroke. The flexible coupling C shown in Fig. 128, in which the twisting moment of the shaft is transmitted through disks of leather, prevents straining of the shaft and bearings through any want of alignment between the shaft of the engine and that of the mechanism it drives. Besides its use as a steam-engine, Mr. Brotherhood's pattern has been extensively applied in driving torpedoes by means of compressed air. As a steam-engine it is compounded by placing a high-pressure cylinder outside of and tandem with each low-pressure cylinder.

204. In other engines of this type a pair of cylinders, or a high and a low pressure cylinder, are set vertically side by side, to work on cranks opposite each other. The cranks and connecting-rods are completely enclosed, and are lubricated by dipping into a mixture of oil and water with which the lower part of the casing is filled. In the Westinghouse engine, where there are two vertical cylinders to which steam is admitted by a piston-valve, the crank-shaft is situated half a crank's length out of the line of stroke, to reduce the effects of the connecting-rod's obliquity during the working stroke.[2] In Mr. Willans's latest form of engine the high and low pressure cylinders are tandem, and the space between the piston forms an intermediate receiver. The piston-rod is hollow, and has a piston-valve in it which controls the admission of steam to the high-pressure cylinder and its transfer to the low-pressure cylinder. The piston-valve within the rod takes its differential motion from an eccentric on the crank-pin. The crosshead is itself a piston working in a cylindrical guide, in which it compresses air as it rises during the back stroke in order to cushion the reciprocating parts.[3]

Pumping engines.

205. In engines for pumping or for blowing air it is not essential to drive a revolving shaft, and in many forms the reciprocating motion of the steam-piston is applied directly or through a beam to produce the reciprocating motion of the pump-piston or plunger. On the other hand, pumping engines are frequently made rotative for the sake of adding a fly-wheel. When the level of the suction water is sufficiently high, horizontal engines, with the pump behind the cylinder and in line with it, are generally preferred; in other cases a beam-engine or vertical direct-acting engine is more common. Horizontal engines are, however, employed to

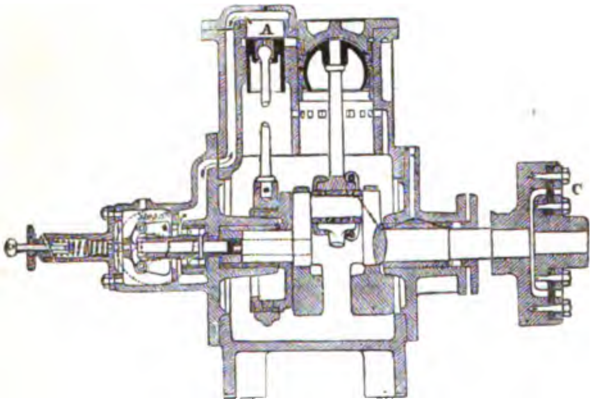

FIG. 128.—Brotherhood's Three-Cylinder Engine: longitudinal section.

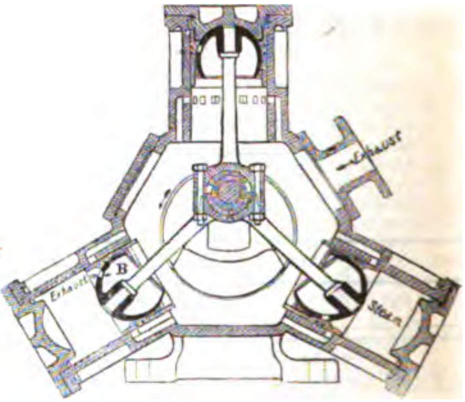

FIG. 129.—Brotherhood's Three-Cylinder Engine: transverse section.

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[1] Or, alternatively, the adjustment may be made so that the steam undergoes equal changes of temperature in both cylinders.

[2] See *Engineering*, August 18, 1886.

[3] See "Discussion on High Speed Motors," *Min. Proc. Inst. C.E.*, Nov. 1885.

pump water from any depth by using triangular rocking frames, which serve as bell-crank levers between the horizontal piston and vertical pump-rods.[1]

Fig. 130 shows a compound inverted vertical pumping engine of the non-rotative class, by Messrs. Hathorn, Davey & Co. Steam is distributed through lift valves, and the engine is governed by the differential gear illustrated in Fig. 107, in conjunction with a cataract, which makes the piston pause at the end of each stroke. The pistons are in line with two pump-rods, and are coupled by an inverted beam which gives guidance to the crossheads by means of an approximate straight-line motion, which is a modification of that of Fig. 120. Surface condensers are frequently used with pumping engines, the water which the engine pumps serving as circulating water.

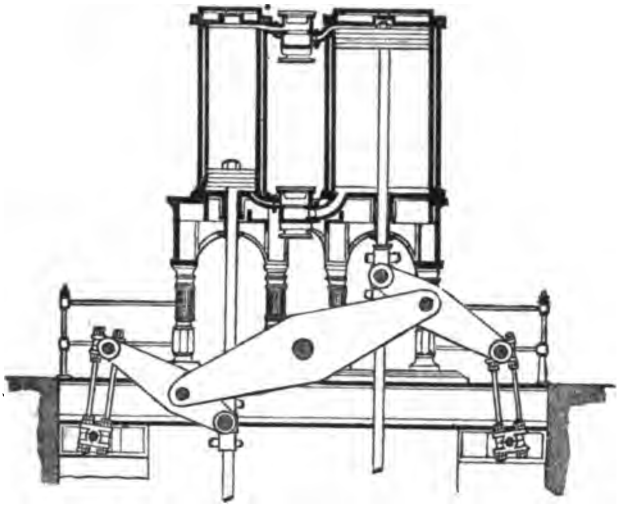

FIG. 130.—Vertical Non-Rotative Pumping Engine.

Direct-acting steam-pumps. 206. In a very numerous class of direct-acting steam-pumps, the steam-piston and the pump-piston or plunger are on the same piston-rod. In some of these a rotative element is introduced, partly to secure uniformity of motion, and partly for convenience of working the valves; a connecting-rod is taken from some point in the piston-rod to a crank-shaft which carries a fly-wheel; or a slotted crosshead fixed to the rod gives rotary motion to a crank-pin gearing into the slot, the line of the slot being perpendicular to that of the stroke. Many other steam-pumps are strictly non-rotative. In some the valve is worked by tappets from the piston-rod. In the Blake steam-pump a tappet worked by the piston as it reaches each end of its stroke throws over an auxiliary steam-valve, which admits steam to one or other side of an auxiliary piston carrying the main slide-valve. In Cameron & Floyd's form one of a pair of tappet-valves at the ends of the cylinder is opened by the piston as it reaches the end of the stroke, and puts one or other side of an auxiliary piston, which carries the slide-valve, into communication with the exhaust, so that it is thrown over. In the Worthington engine—a design which has had much success in America, and is now being introduced in England by Messrs. Simpson—two steam cylinders are placed side by side, each working its own pump-piston. The piston-rod of each is connected by a short link to a swinging bar, which actuates the slide-valve of the other steam-cylinder. In this way one piston begins its stroke when the motion of the other is about to cease, and a smooth and continuous action is secured.

Worthington engines. 207. The Worthington engine has been extensively applied, on a large scale, to raise water for the supply of towns and to force oil through "pipe-lines" in the United States. In the larger sizes it is made compound, each high-pressure cylinder having a low-pressure cylinder tandem with it on the same rod. Owing to the lightness of the reciprocating masses, and their comparatively slow acceleration, their inertia does not compensate, to any great extent, for the inequality of pressure on the pump-piston that would be caused by an early cut-off in the steam cylinder (see ? 186). To meet this difficulty, and make high expansion practicable, an ingenious addition has recently been made to the engine.[2] A crosshead A (Fig. 131) fixed to each of the piston-rods is connected to the piston-rods of a pair of oscillating cylinders B, B, which contain water and communicate with a reservoir full of air compressed to a pressure of about 300 ℔ per square inch. When the stroke (which takes place in the direction of the arrow) begins the pistons are at first forced in, and work is at first done by the main piston-rod, through the compensating cylinders B, B, on the compressed air in the reservoir. This continues until the crosshead has advanced so that the cylinders stand at right angles to the line of stroke. Then for the remainder of the stroke the compensating cylinders assist in driving the main piston, and the compressed air gives out the energy which it stored in the earlier portion. The volume of the air reservoir is so much greater than the volume of the cylinders B, B that the air pressure remains nearly constant throughout the stroke. Any leakage from the cylinder or reservoir is made good by a small pump which the engine drives. One advantage which this method of equalizing the effort of a steam-engine piston has (as compared with making use of the inertia of the reciprocating masses) is that the effort, when adjusted to be uniform at one speed, remains uniform although the speed be changed, provided the inertia of the reciprocating parts be small. In the Worthington "high-duty" engine, where this plan is in use, the high and low pressure cylinders are each provided with a separate expansion-valve of the rocking-cylinder type, as well as a slide-valve; the cut-off is early, and the efficiency is as high as in other pumping engines of the best class.

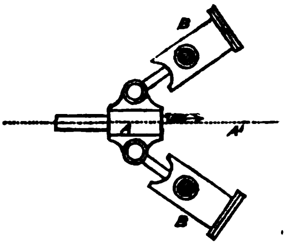

FIG. 131.

The pulsometer. 208. Mr. Hall's "pulsometer" is a peculiar pumping engine without cylinder or piston, which may be regarded as the modern representative of the engine of Savery (? 6). The sectional view, Fig. 132, shows its principal parts. There are two chambers A, A′, narrowing towards the top, where the steam-pipe B enters. A ball-valve C allows steam to pass into one of the chambers and closes the other. Steam entering (say) the right-hand chamber forces water out of it past the clack-valve V into a delivery passage D, which is connected with an air-vessel. When the water-level in A sinks so far that steam begins to blow through the delivery-passage, the water and steam are disturbed and so brought into intimate contact, the steam in A is condensed, and a partial vacuum is formed. This causes the ball-valve C to rock over and close the top of A, while water rises from the suction-pipe E to fill that chamber. At the same time steam begins to enter the other chamber A′, discharging water from it, and the same series

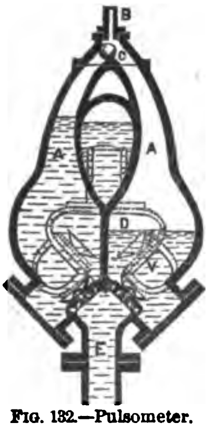

FIG. 132.—Pulsometer.

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[1] For an account of beam and other forms of rotative pumping engines, see a paper by Mr. Rich, and remarks by Mr. J. G. Mair, in *Min. Proc. Inst. C. E.*, April, 1884.

[2] *Min. Proc. Inst. C.E.*, 1886, part iv.; *Engineering*, August 20, 1886.

of actions is repeated in either chamber alternately. While the water is being driven out there is comparatively little condensation of steam, partly because the shape of the vessel does not promote the formation of eddies, and partly because there is a cushion of air between the steam and the water. Near the top of each chamber is a small air-valve opening inwards, which allows a little air to enter each time a vacuum is formed. When any steam is condensed, the air mixed with it remains on the cold surface and forms a non-conducting layer. The pulsometer is, of course, far from efficient as a thermodynamic engine, but its suitability for situations where other steam-pumps cannot be used, and the extreme simplicity of its working parts, make it valuable in certain cases.

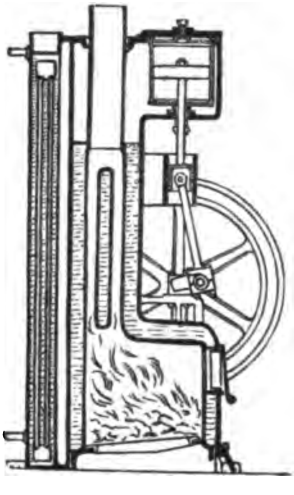

FIG. 133.—Davey Motor.

Davey's safety motor.

209. We have seen that the tendency of modern steam practice is towards higher pressures, and that this means a gain both in efficiency and in power for a given weight of engine. High pressure, or indeed any pressure materially above that of the atmosphere, is out of the question when engine and boiler are to work without the regular presence of an attendant. Mr. Davey has recently introduced a domestic motor which deserves notice from the fact that it employs steam at atmospheric pressure. One form of this successful little engine is shown in Fig. 133. The boiler—which serves as the frame of the engine—is of cast-iron, and is fitted with a cast-iron internal fire-box, with a vertical flue which is traversed by a water-bridge. The cylinder, which is enclosed within the upper part of the boiler, and the piston are of gun-metal, and work without lubrication. Steam is admitted by an ordinary slide-valve, also of gun-metal, worked by an eccentric in the usual way. The condenser stands behind the boiler; it consists of a number of upright tubes in a box, through which a current of cold water circulates from a supply-pipe at the bottom to an overflow-pipe at the top. In larger sizes of the motor the cylinder stands on a distinct frame, and the boiler has a hopper fire-box, which will take a charge of coke sufficient to drive the engine for several hours without attention. About 6 or 7 ℔ of coke are burned per horse-power per hour.

Rotary engines.

210. From the earliest days of the rotative engine attempts have been made to avoid the intermittent reciprocating motion which an ordinary piston-engine first produces and then converts into motion of rotation. Murdoch, the contemporary of Watt, proposed an engine consisting of a pair of spur-wheels gearing with one another in a chamber through which steam passed by being carried round the outer sides of the wheels in the spaces between successive teeth.[1]

In a more modern wheel-engine (Dudgeon's) the steam was admitted by ports in side-plates into the clearance space behind teeth in gear with one another, just after they had passed the line of centres. From that point to the end of the arc of contact the clearance space increased in volume; and it was therefore possible, by stopping the admission of steam at an intermediate point, to work expansively. The difficulty of maintaining steam-tight connection between the teeth and the side-plates on which the faces of the wheels slide is obvious; and the same difficulty has prevented the success of many other forms of rotary engine. These have been devised in immense variety, in many cases, it would seem, with the idea that a distinct mechanical advantage was to be secured by avoiding the reciprocating motion of a piston.[2] In point of fact, however, very few forms entirely escape having pieces with reciprocating motion. In all rotary engines, with the exception of steam turbines,—where work is done by the kinetic impulse of steam,—there are steam chambers which alternately expand and contract in volume, and this action usually takes place through a more or less veiled reciprocation of working parts. So long as engines work at a moderate speed there is little advantage in avoiding reciprocation; the alternate starting and stopping of piston and piston-rod do not effect materially the frictional efficiency, throw no deleterious strain on the joints, and need not disturb the equilibrium of the machine as a whole. The case is different when very high speeds are concerned; it is then desirable as far as possible to limit the amount of reciprocating motion and to reduce the masses that partake in it.

Tower's spherical engine.

211. A recent interesting and successful example of the rotary type is the spherical engine of Mr. Beauchamp Tower,[3] which, like several of its predecessors,[4] is based on the kinematic relations of the moving pieces in a Hooke's joint. Imagine a Hooke's joint, uniting two shafts set obliquely to one another, to be made up of a central disk to which the two shafts are hinged by semicircular plates, each plate working in a hinge which forms a diameter of the central disk, the two hinges being on opposite sides of the disk and and at right angles to one another. Further, let the disk and the hinged pieces be enclosed in a spherical chamber through whose walls the shafts project. As the shafts revolve each of the four spaces bounded by the disk, a hinged piece, and the chamber wall will suffer a periodic increase and diminution of volume, between limits which depend on the angle at which the shafts are set. In Mr. Tower's engine this arrangement is modified by using spherical sectors, each a quarter sphere, in place of semicircular plates, for the pieces in which the shafts terminate. The shafts are set at 135°. Each of the four enclosed cavities then alters in volume from zero to a quarter sphere, back to zero, again to a quarter sphere, and again back to zero, in a complete revolution of the shafts. In practice the central disk is a plate of finite thickness, whose edge is kept steam-tight in the enclosing chamber by spring-packing, and the sectors are reduced to an extent corresponding to the thickness of the central disk. One shaft is a dummy and runs free, the other is the driving-shaft. Steam is admitted and exhausted by ports in the spherical sectors, whose backs serve as revolving slide-valves. It is admitted to each cavity during the first part of each periodical increase of the cavity's volume. It is then cut off and allowed to expand as the cavity further enlarges, and is exhausted as the cavity contracts. If the working shaft, to which the driven mechanism serves as a fly-wheel, revolves uniformly, the dummy shaft is alternately accelerated and retarded. Apart from this, the only reciprocating motion is the small amount of oscillation which the comparatively light central disk undergoes.

Another rotary engine of the Hooke's-joint family is Mr. Fielding's,[5] in which a gimbal-ring and four curved pistons take the place of the disk. Two curved pistons are fixed on each side of the gimbal-ring, and as the shafts revolve these work in a corresponding pair of cavities, which may be called curved cylinders, fixed to each shaft.

Steam turbines.

212. Attempts have been made from time to time to devise steam engines of the turbine class, where rotation of a wheel is produced either by reaction from a jet of escaping steam or by impact of a jet upon revolving blades. A revolving piece which is to extract even a respectable fraction of the kinetic energy of a steam jet must move with excessive velocity. In Mr. C. A. Parson's steam-turbine this difficulty is overcome and a moderate degree of efficiency is secured by using a series of central-flow turbine wheels, in the form of perforated disks, all on one shaft, with fixed disks between which are perforated to serve as guide-blades. Steam passes from end to end of this series, giving up a small portion of its energy to each, but retaining little at the end.

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[1] See Farey's *Treatise on the Steam-Engine*, p. 676.

[2] A large number of proposed rotary engines are described, and their kinematic relations to one another are discussed, in Reuleaux's *Kinematics of Machinery*, translated by Prof. Kennedy.

[3] *Proc. Inst. Mech. Eng.*, March, 1885.

[4] One of these, the disk-engine of Bishop, was used for a time in the printing office of *The Times*, but was discarded in 1857.

[5] *Min. Proc. Inst. C. E.*, November, 1885.

XII. Marine Engines.

Types of marine engines.

213. The early steamers were fitted with paddle-wheels, and the engines used to drive them were for the most part modified beam-engines. Bell's "Comet" (§ 21) was driven by a species of inverted beam-engine, and another form of inverted beam, known as the side-lever engine, was for long a favorite with marine engineers. In the side-lever engine the cylinder was vertical, and the piston-rod projected through the top. From a crosshead on the rod a pair of links, one on each side of the cylinder, led down to the ends of a pair of horizontal beams or levers below, which oscillated about a fixed gudgeon at or near the middle of their length. The two levers were joined at their other ends by a crosstail, from which a connecting-rod was taken to the crank above. The side-lever engine is now obsolete.

Side-lever engines.

Beam engines.

In American practice, engines of the beam type, with a braced-beam supported on A frames above the deck, are still common in river steamers and coasters.

Steeple engines.

214. An old form of direct-acting paddle-engine was the steeple-engine, in which the cylinder was set vertically below the crank. Two piston-rods projected through the top of the cylinder, one on each side of the shaft and of the crank. They were united by a crosshead sliding in vertical guides, and from this a return-connecting-rod led to the crank.

Oscillating engines.

Diagonal engines.

215. Modern paddle-wheel engines are usually of one of the following types. (1.) In *oscillating cylinder engines* the cylinders are set under the crank-shaft, and the piston-rods are directly connected to the cranks. The cylinders are supported on trunnions which give them the necessary freedom of oscillation to follow the movement of the crank. Steam is admitted through the trunnions to slide-valves on the sides of the cylinders. In some instances the mean position of the cylinders is inclined instead of vertical; and oscillating engines have been arranged with one cylinder before and another behind the shaft, both pistons working on one crank. The oscillating cylinder type is best adapted for what would now be considered comparatively low pressures of steam. (2.) *Diagonal engines* are direct-acting engines of the ordinary connecting-rod type, with the cylinders fixed on an inclined bed and the guides sloping up towards the shaft.

Trunk engines.

216. When the screw-propellor began to take the place of paddle-wheels in ocean-steamers, the increased speed which it required was at first supplied by using spur-wheel gearing in conjunction with one of the forms of engines then usual in paddle steamers. After a time types of engine better suited to the screw were introduced, and were driven fast enough to be connected directly to the screw-shaft. The smallness of the horizontal space on either side of the shaft formed an obstacle to the use of horizontal engines, but this difficulty was overcome in several ways. In Penn's trunk-engine, still used in the navy, the engine is shortened by attaching the connecting-rod directly to the piston, and using a hollow piston-rod, called a trunk, large enough to allow the connecting-rod to oscillate inside it. The trunk extends through both ends of the cylinder and forms a guide for the piston. It has the drawback of requiring very large stuffing-boxes, of wasting cylinder space, and of presenting a large surface of metal to alternate heating by steam and cooling by contact with the atmosphere. The use of high-pressure steam is likely to make the trunk-engine obsolete.

Return-connecting-rod engines.

217. The return-connecting-rod engine is another horizontal form much used in the navy. It is a steeple-engine placed horizontally, with two, and in some cases four, piston-rods in each cylinder. The piston-rods pass clear of the shaft and the crank, and are joined beyond it in a guided crosshead, from which a connecting-rod returns.

Horizontal direct-acting engines.

Ordinary horizontal direct-acting engines with a short stroke and a short connecting-rod are also common in war-ships, where the horizontal is frequently preferred to the vertical type of engine for the sake of keeping the machinery below the water-line. In horizontal marine engines the air-pump and condenser are generally placed on the opposite side of the shaft from the cylinder, which balances the weight and allows the air-pump to be driven direct.

Inverted vertical engines.

218. In merchant ocean-steamers one general type of engine is universal, and the same type is now to an increasing extent adopted in naval practice. This is the inverted vertical direct-acting engine, generally with two or more cylinders placed side by side directly over the shaft. In exceptional cases a single cylinder has been used, with a fly-wheel on the shaft. Two, three, and four cylinders are common.

Example.

The most usual form of existing marine engine is the two-cylinder compound arrangement, with cranks at right angles, or nearly at right angles, of which Figs. 135, 136, 137 (pp. 544–46) show a characteristic example (the engines of the s. s. "Tartar," by Messrs. John and James Thomson, Glasgow).

Fig. 135 is an end elevation, Fig. 136 a longitudinal section through the centre of the engines, and Fig. 137 a thwartship-section through the condenser and air-pump. The cylinders are 50 and 94 inches in diameter, and the stroke is 5 feet. Both cylinders are fitted with liners, and are steam-jacketed. Double-ported slide-valves are used on both, and the high-pressure valve has a relief-ring. The crosshead guides are fitted on the side on which the crosshead bears when the engines are going ahead, with a hollow box behind the guiding surface, and cold water is kept circulating in this to prevent the guides from heating. The crank-shaft is of Vicker's steel, 17½ inches in diameter.

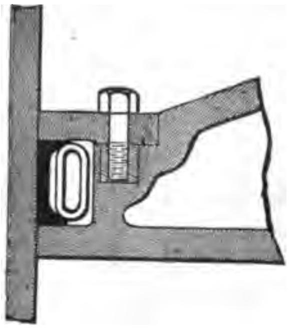

Fig. 134.—Piston Packing.

The condenser is in the place it usually has in engines of this type,—in the lower part of the back frame, with its tubes running horizontally from end to end of the engine. There are 1400 tubes, of 1 inch diameter and 1¼ inch pitch. The air-pumps are of the single-acting bucket kind, and are driven by a lever from the crosshead. Centrifugal circulating pumps are used, driven by a pair of independent small vertical engines. The link-motion is worked by steam starting and reversing gear, which appears on the left side of the engine in Fig. 135. These engines work with a boiler pressure of 90 lb, and indicate 3560 horse-power. Fig. 134 shows, on a larger scale, the piston packing, which consists of a pair of floating rings, pressed out by a spiral spring behind them.

Tandem vertical engines.

219. Two other arrangements of double compound (as distinguished from triple-expansion) marine engines of the inverted vertical type require notice. One is the tandem arrangement, largely adopted in the steamers of the "White Star" line. In these each crank is operated by an independent pair of compound cylinders, the high-pressure cylinder being on top of the low-pressure cylinder, with one piston-rod

common to both. The valves of both are worked by a single pair of eccentrics with a link-motion; the valve-rod of the low-pressure cylinder extends through the top of its valve-chest, and is joined either directly or by a short lever with the valve-rod of the high-pressure cylinder. Generally two pairs of tandem cylinders are placed side by side, one pair abaft the other, to work on cranks at right angles. In exceptionally large engines three pairs have been used, working on cranks 120° apart,[1] an arrangement greatly superior to that of two cranks in uniformity of effort on the shaft. To facilitate removing the pistons from the cylinders, the large cylinder has in some cases been set above the other.

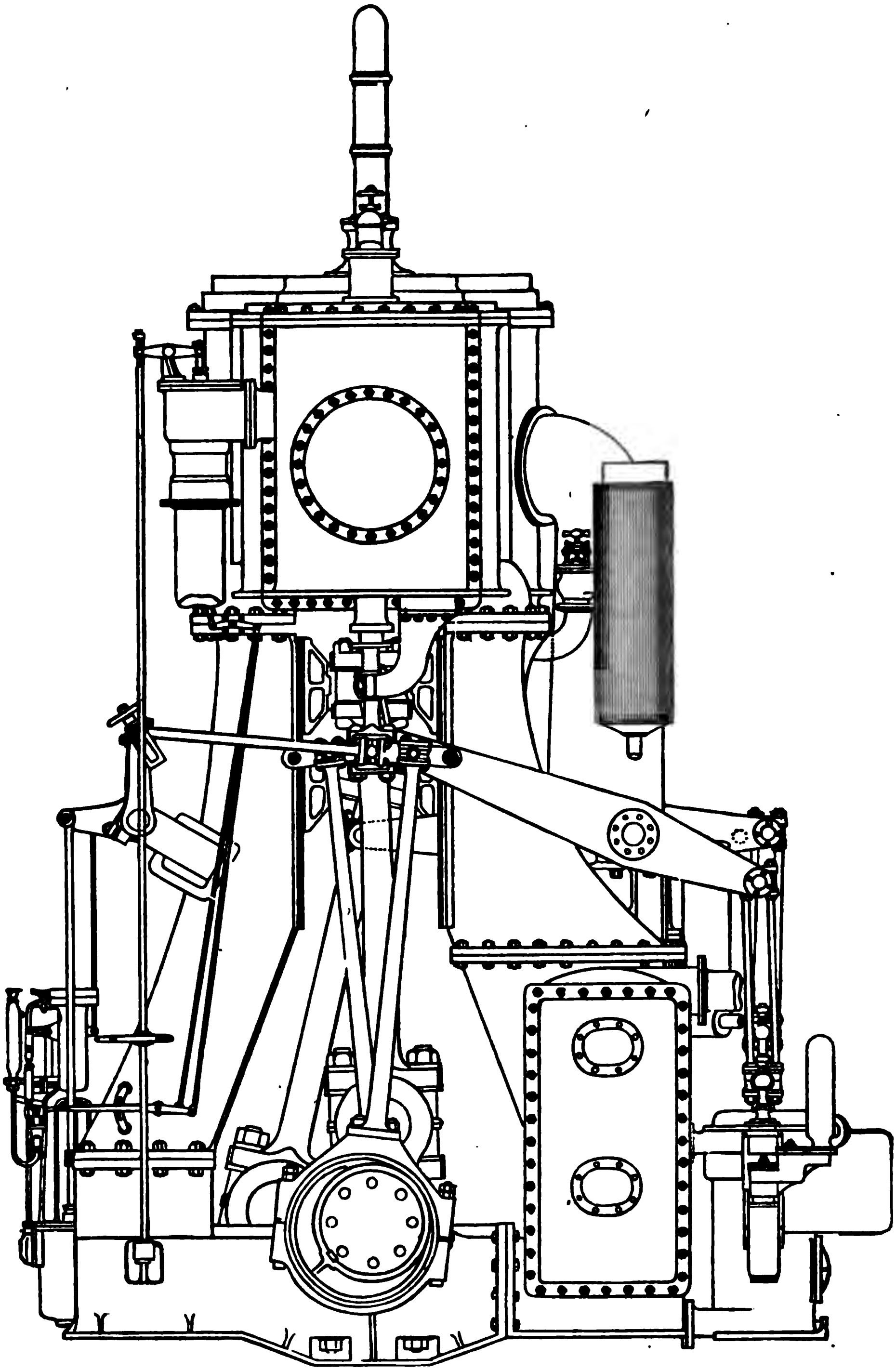

FIG. 185.—End Elevation of Marine Engine.

220. The other arrangement of double compound marine engine has three cylinders set in line fore and aft. The middle one is the high-pressure cylinder; the other two receive steam from it, and form together the equivalent of one large low-pressure cylinder. The three work on cranks at 120° apart. Besides securing the advantage in uniformity of effort which three cranks have over two, this

Three-cylinder arrangement.

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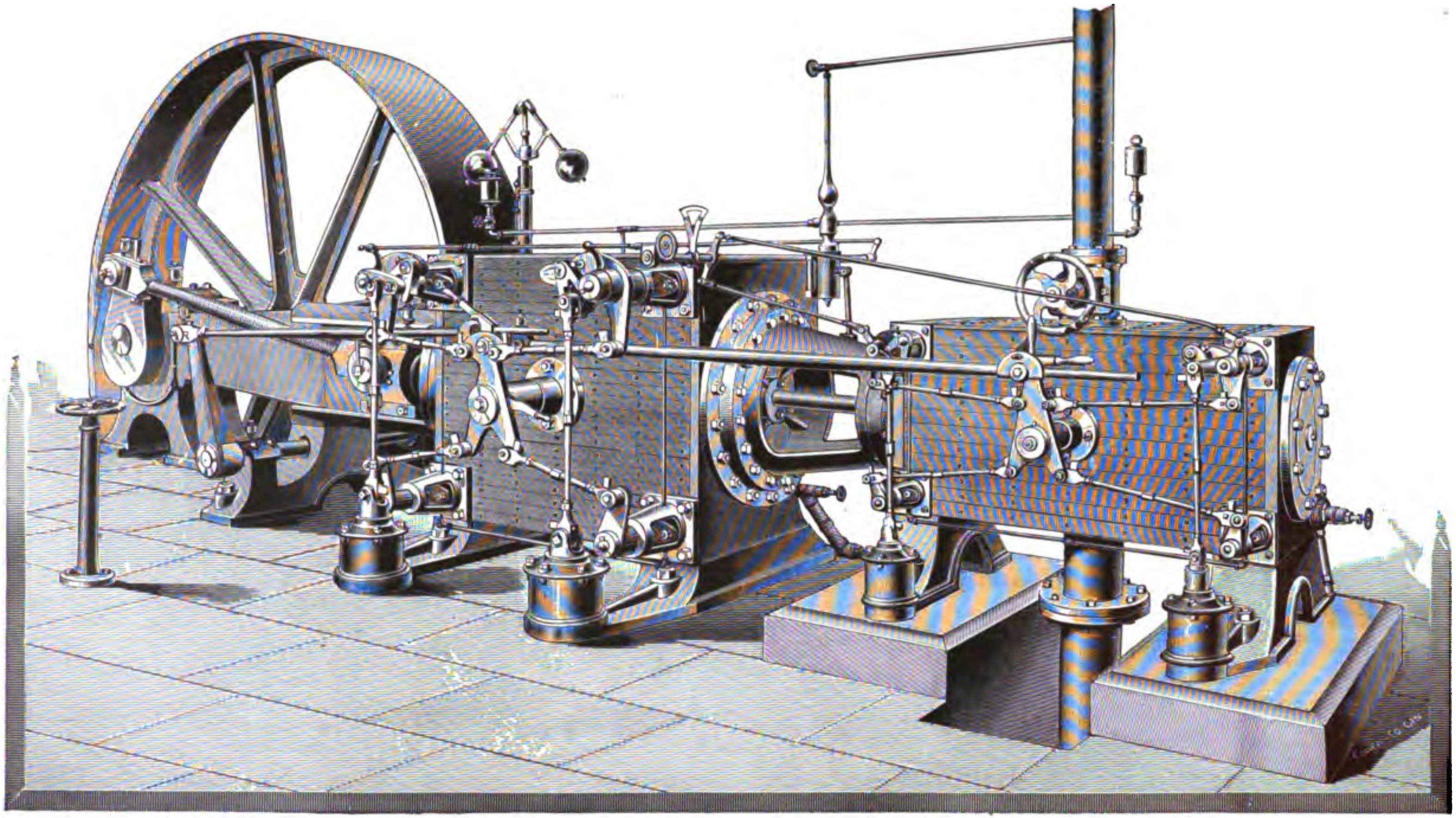
[1] See description of the engines of the "City of Rome," with three 46-inch and three 86-inch cylinders with a stroke of 6 feet, working up to 11,890 I. H. P., *Proc. Inst. Mech. Eng.*, 1880.



COMPOUND CONDENSING ENGINE

form avoids the use, in very powerful engines, of a low-pressure cylinder of excessive size. On the other hand, the three-cylinder form takes up more space, and has a larger number of working parts. In the most powerful engines that have yet been constructed this three-cylinder arrangement is followed. The "Umbria" and "Etruria" have a 71-inch high-pressure cylinder between two 105-inch low-pressure cylinders, with a stroke of 6 feet. These engines, which were built just before the introduction of triple expansion, are supplied with steam at a pressure of 110 ℔ by gauge, and indicate 14,300 horse-power.

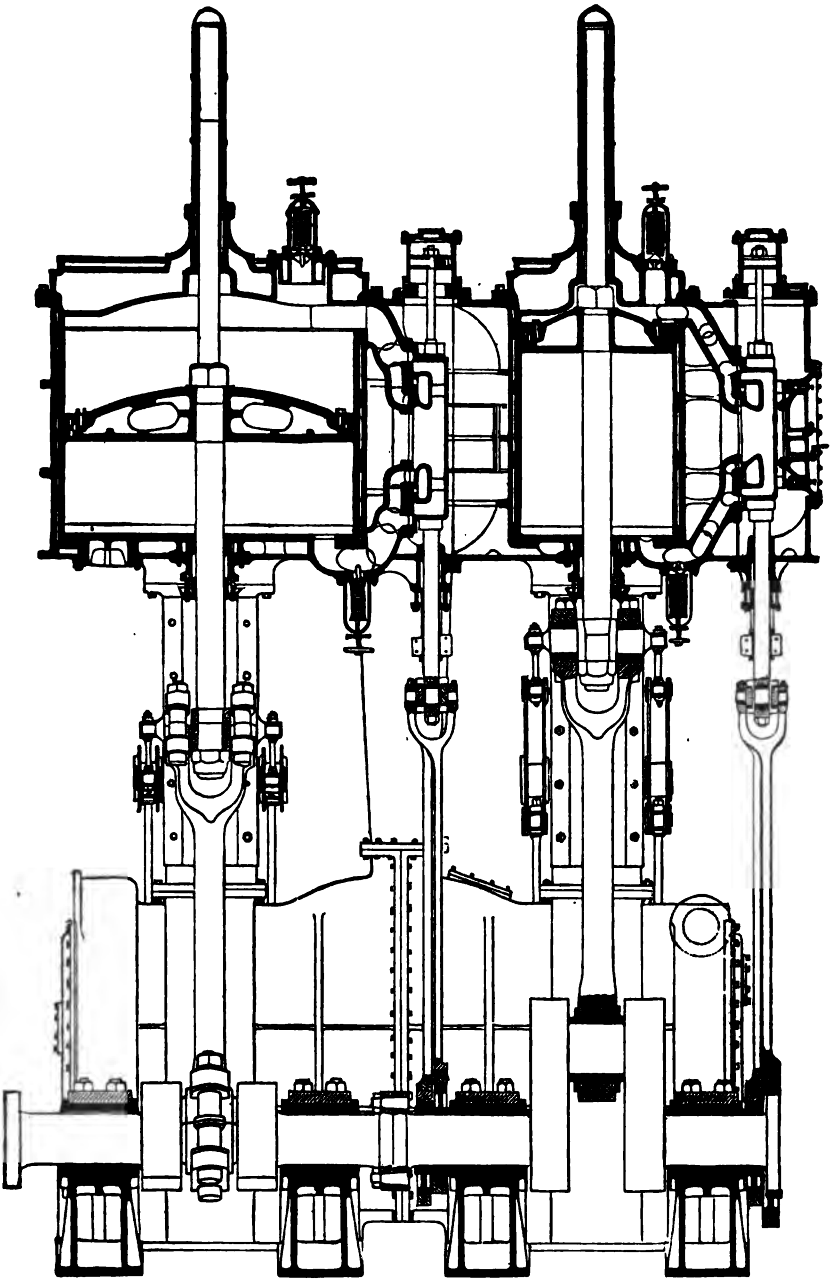


FIG. 136.—Longitudinal Section of Marine Engine.

In this and in the ordinary two-cylinder form of marine engine, the low-pressure valve-chest and the casing of the engine between the cylinders form an intermediate receiver for the steam.

Triple expansion engines.

221. During the last two or three years a great advance has taken place in marine engineering by the general introduction of triple-expansion engines and by an increase in steam pressure which the system of triple expansion makes practicable. In 1874 the steamer "Propontis" was fitted with a set of three-crank triple-expansion engines, designed by Mr. A. C. Kirk. The experiment was prevented from being fully successful by the failure of the boilers, which were of a special type. Another experiment with triple engines in the yacht "Isa" in 1877 prepared the way for their application to regular ocean service. In 1882 the steamship "Aberdeen," with triple engines, designed by Mr. Kirk, to work with steam of 125 ℔ pressure, supplied from double-ended steel boilers of the ordinary marine type, demonstrated the advantage and safety of the system. Since then its use has become general in new steamers, and in many cases the older double engines are being removed to give place to engines of the triple-expansion type, with the effect of reducing the consumption of coal by about 25 per cent.[1]

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[1] The rapid progress of the system of triple expansion may be judged from the fact mentioned by Mr. W. Parker of Lloyds in a recent paper (*Engineering*, July 30, 1886), that out of 199 engines then being built for merchant steamers, 128 sets were of the triple-expansion type. For war ships also triple engines are being built of sizes up to 18,000 horse-power. For a discussion of several important points in the design of triple-expansion engines, see a paper by R. Wyllie, *Proc. Inst. Mech. Eng.*, Oct., 1886.

222. In the most common arrangement of triple-expansion engines three cylinders are ranged in line, fore and aft, working on cranks at 120° apart. Piston-valves are generally preferred, and these are not uncommonly worked by some form of radial valve-gear instead of the ordinary link-motion. An advantage of this is that the space which would be taken up by eccentrics upon the shaft is saved, and longer main bearings are in consequence possible, without spreading the engines in the fore-and-aft direction. An objectionable feature of the three-cylinder triple engine is its length; on the other hand, the high speed and high pressure which are features of modern practice make long bearings indispensable.

Quadruple-expansion engines.

223. To avoid the length of the three-crank engine, Mr. Brock and others have made engines of the triple-expansion type with two cranks, by putting the high and the intermediate pressure cylinders above and tandem with two low-pressure cylinders. Mr. Brock has also built four-cylinder *quadruple*-expansion engines of a similar form (with two cranks), and estimates that they show an economy in coal consumption of 5 per cent. as compared with triple-expansion engines working with the same pressure of steam.

224. Steam-jackets are retained by some but not by all builders; where they are employed the boiler steam is usually reduced in pressure before admission to the intermediate and low-pressure cylinder jackets and to the receiver-jackets. The feed-water is frequently heated to about 200° F. by Weir's plan of condensing in it, by common injection, a quantity of steam taken from the second receiver; this has the advantage of freeing it of air, and of preventing local chilling in the boiler. In present-day practice the boiler pressure, for a triple-expansion engine, ranges from 120 to 170 ℔ per square inch (by gauge), and it does not appear that any material increase of this is possible without a complete departure from the present type of marine boiler. On the other hand, without a material increase of pressure there is little advantage in quadruple expansion.

Surface condensers.

225. Surface condensation was introduced in marine engines by S. Hall in 1831, but was not brought into general use until much later. Previous to this it had been necessary, in order to avoid the accumulation of too dense brine in the boiler, to blow off a portion of the brine at short intervals and replace it by sea water, a process which of course involved much waste of heat. By the use of surface condensers it became possible to use the same portion of water over and over again. The very freedom of the condensed water from dissolved mineral substances was for a time an obstacle to the adoption of surface condensers, for it was found that the boiler, no longer protected by a deposit of scale, became rapidly corroded through the action of acids formed by the decomposition of the lubricating oil. This objection was overcome by introducing a sufficient amount of salt water to allow some scale to form, and the use of surface condensers soon became universal on steamers plying in sea water. The marine condenser consists of a multitude of tubes, generally of brass, about ¾ of an inch in diameter. Through these cold sea-water is made to circulate, while the steam is brought into contact with their outside surfaces. In some cases, especially in Admiralty practice, cold water circulates outside the tubes and the steam passes inside.

Marine engine pumps.

226. The ordinary marine engine has four pumps: the air-pump, which is made large enough to serve in case injection instead of surface-condensation should at any time be resorted to; the feed-pump; the circulating pump, which maintains a current of sea-water through the tubes of the condenser; and the bilge-pump, which discharges any water accumulated by leakage or otherwise in the bilge of the ship. The pumps are so arranged that in the event of a serious leak the circulating-pump can also draw its supply from the bilge. In most engines, especially those of less recent construction, the four pumps are placed behind the condenser, and are worked by a single crosshead driven by a lever, the other end of which is connected by a short link with one of the crossheads of the engine. It is now becoming common to use a small engine, distinct from the main engine, to drive the feed-pump, and to supply circulating water by a centrifugal pump also driven by a separate engine.

Relation of coal burnt to power.

227. In the improvement of the marine engine two points are noteworthy,—reduction in the rate of consumption of coal per horse-power, and reduction in the weight of the machine (comprising the engine proper and the boilers) per horse-power. The second consideration is in some cases of even more moment than the first, especially in war-ships. Progress has been made, in both respects, by increase of steam pressure, and, in the second respect especially, by increase of piston speed. Fifty years ago the boilers of marine engines made steam at a pressure of about 5 ℔ per square inch above that of the atmosphere. By 1860 compound engines were in use with pressures ranging from 25 to 40 ℔. In 1872 statistics collected for nineteen ocean steamers showed that the average consumption of coal was then 2.11 ℔ per H. P. per hour, the boiler-pressure 45 to 60 ℔, and the mean piston speed about 375 feet per minute.[1] These were for the most part two-cylinder compound engines of the vertical inverted type. Nine years later statistics for thirty engines of the same type showed a consumption of 1.83 ℔ of coal, a mean boiler pressure of 77½ ℔, and a mean piston speed of 467 feet per minute.[2] In recent triple-expansion engines the pressure is as high as 165 ℔; a piston speed of 700 or 800 feet per minute is not uncommon in naval engines, and in some cases it has risen to over 1000 feet per minute.[3] The economy in coal consumption brought about by the change from double-expansion engines working at (say) 80 ℔ to triple engines at 160 ℔ or more is variously estimated at from 18 to 25 per cent. Much of this is due simply to the increased range of temperature through which the working substance is carried; but it appears that the actual performance of the triple engine is better than that of the double compound in a ratio greater than that by which its ideal efficiency—as an engine using a wider range of temperature—exceeds that of the other; and this is to be ascribed to the same causes as have been already discussed in speaking of the advantage of the compound over the simple engine. Apart from its greater economy of coal, the triple engine owes some of its practical success to the mechanical superiority of three driving cranks over two.

Relation of weight to power.

228. The relation of weight of machinery to power developed, and the causes which affect this ratio, have recently been discussed by Messrs. Marshall and Weighton,[4] from whose paper the following figures are taken. Before the introduction of triple expansion and forced draught the weight of engines in the mercantile marine, including the boilers and the water in them, was 480 ℔ per I. H. P. In the navy this was reduced, chiefly by the use of lighter framing, with the object of minimizing weight, to 360 ℔. Triple-engines of the merchant type, without forced draught, are only slightly lighter than double engines; but in naval practice, where forced draught, greatly increased speed, and the use of steel for frames and working parts have combined to reduce the ratio of weight to power, a marked reduction

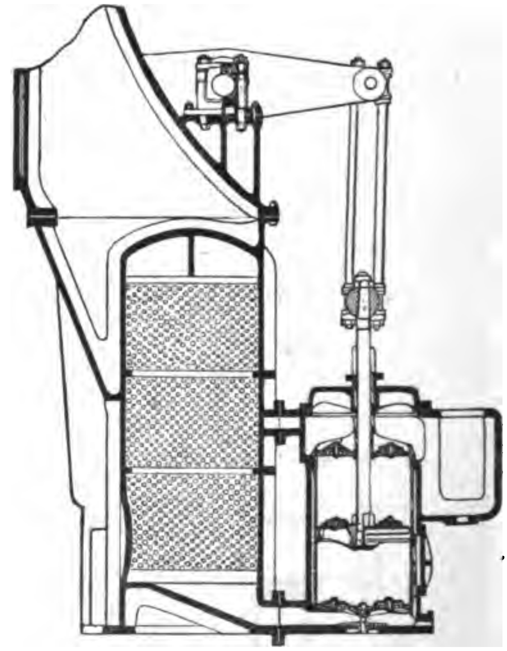

FIG. 137.—Section through Condenser and Air-Pump.

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[1] Sir F. J. Bramwell, *Proc. Inst. Mech. Eng.*, 1872.
[2] F. C. Marshall, *Proc. Inst. Mech. Eng.*, 1881.
[3] Marshall and Weighton, *Proc. North-East Coast Inst. Engineers and Shipbuilders*, 1886.
[4] *Loc. cit.*

in weight is apparent. A recent set of vertical triple engines, which with natural draught indicate 2200 H.P., and with a draught forced by pressure in the stokehole equal to 2 inches of water indicate 4000 H.P., weigh under the latter condition (along with the boilers) only 155 lb per I.H.P. In another set, in which the draught is forced by a pressure of 3 inches, and the cylinders are only 15½, 24, and 37 inches in diameter, with a stroke of 16 inches, the indicated horse-power is 4200, and the weight of engines and boilers is 136 lb per I.H.P. In these the boilers are of the locomotive type, and the mean piston speed is 1066 feet per minute. Even these light weights are surpassed in smaller engines, such as those of torpedo boats. In so far as this immense development of power from a small weight of machinery is due to high piston speed, it is secured without loss—indeed with some gain—of thermodynamic efficiency; forced draught, however, without a corresponding extension of the heating surface leads to a less efficient expenditure of fuel. With a given type of engine there is a certain ratio of expansion which gives a minimum in the ratio of weight to power; when this ratio of expansion is exceeded the engines have to be enlarged to an extent that more than counterbalances the saving in boiler weight; when a less ratio of expansion is used the boilers have to be enlarged to an extent that more than counterbalances the reduction of weight in the engine proper.[1]

XIII. LOCOMOTIVE ENGINES.

Locomotive engines. 229. The ordinary locomotive consists of a pair of direct-acting horizontal or nearly horizontal engines, fixed in a rigid frame under the front end of a boiler of the type described in § 133, and coupled to the same shaft by cranks at right angles, each with a single slide-valve worked by a link-motion, or by a form of radial gear. The engine is non-condensing, except in special cases, and the exhaust steam, delivered at the base of the funnel through a blast-pipe, serves to produce a draught of air through the furnace. In some instances a portion of the exhaust steam, amounting to about one-fifth of the whole, is diverted to heat the feed-water. In tank engines the feed-water is carried in tanks on the engine itself; in other engines it is carried behind in a tender.

Driving-wheels. 230. On the shaft are a pair of driving-wheels, whose frictional adhesion to the rails furnishes the necessary tractive force. In some engines a single pair of driving-wheels are used; in many more a greater tractive force is secured by having two equal driving-wheels on each side, connected by a coupling-rod between pins on the outside of the wheels. In goods engines a still greater proportion of the whole weight is utilized to give tractive force by coupling three and even four wheels on each side. These arrangements are distinguished by the terms "four-coupled," "six-coupled," and "eight-coupled" applied to the engines. **Inside and outside cylinder engines.** In *inside-cylinder* engines the cylinders are placed side by side within the frame of the engine, and their connecting-rods work on cranks in the driving shaft. In *outside-cylinder* engines the cylinders are spread apart far enough to lie outside the frame of the engine, and to work on crank-pins on the outsides of the driving wheels. This dispenses with the cranked axle, which is the weakest part of a locomotive engine. Owing to the frequent alternation of strain to which it is subject, a locomotive crank axle is peculiarly liable to rupture, and has to be removed after a certain amount of use.

Leading wheels. In some locomotives the leading wheels are coupled to driving wheels behind them, but it is now generally preferred to have under the front of the engine two or four smaller wheels which do not form part of the driving system. **Bogie.** These are carried in a *bogie*, that is, a small truck upon which the front end of the boiler rests by a swivel-pin or plate which allows the bogie to turn, so as to adapt itself to curves in the line, and thus obviate the grinding of tires and danger of derailment which would be caused by using a long rigid wheel-base. The bogie appears to have been of English origin;[2] it was brought into general use in America, and is now common in English as well as in American practice. Instead of a four-wheeled bogie, a single pair of leading wheels are also used, carried by a Bissel *pony* truck, which **Pony truck.** has a swing-bolster pivoted by a radius bar about a point some distance behind the axis of the wheels. This has the advantage of combining lateral with radial movement of the wheels, both being required if the wheel-base is to be properly accommodated to the curve. **Radial axle-box.** Another method of getting lateral and radial freedom is the plan used by Mr. Webb of carrying the leading axle in a box curved to the arc of a circle, and free to slide laterally for a short distance, under the control of springs, in curved guides.[3]

Valves. 231. In inside-cylinder engines the slide-valves are frequently placed back to back in a single valve-chest between the cylinders. The width of the engine within the frame leaves little room for them there, and they are reduced to the flattest possible form, in some cases with split ports, half above and half below a partition in a central horizontal plane. In some of Mr. Stroudley's engines the valves are below the cylinders, with faces sloping down towards the front, while the cylinders themselves slope slightly up. In many engines the valves work on horizontal planes above the cylinders; this position is specially suitable when Joy's or some other form of radial gear is used instead of the link-motion. Radial valve-gears have the advantage, which is of considerable moment in inside-cylinder engines, that the part of the shafts' length which would otherwise be needed for eccentrics is available to increase the width of main bearings and crank-pins, and to strengthen the crank-cheeks. Walshaert's gear is very extensively used on Continental locomotives, and Joy's has now been applied to a large number of British engines.

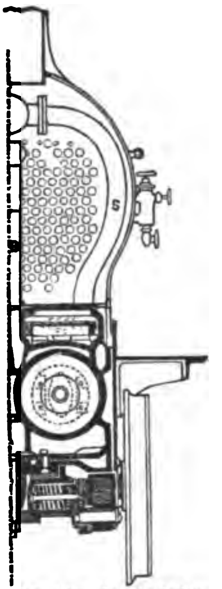

Fig. 138.—Inside-Cylinder Locomotive.

232. In a powerful locomotive of the ordinary type the cylinders are 17 to 19 inches in diameter, with a stroke of about 26 inches. The steam pressure is 130 to 175 lb. The horse-power ranges up to about 700. A passenger engine for express service has driving-wheels from 7 to 8 feet in diameter, and weighs, without the tender, about 40 tons. Of this nearly 15 tons is borne by each driving axle.[4]

Inside cylinder engine. Fig. 138 shows a half section through the smoke-box and one cylinder of an inside-cylinder engine (of the Midland Railway), and illustrates how in an engine of this type the cylinders are situated with regard to the frame, which consists of a single pair of steel plates, extending from end to end and united by other transverse plates, one of which, called the motion-plate, gives support to the guide-bars, and another holds the draw-bar. Another form of frame is built up of two longitudinal plates on each side. In the engine illustrated the valves are above the cylinders, and are worked by Joy's gear. A bogie truck appears in section below the engine. S is the steam-pipe, and B the blast-pipe, which is tapered in the fore-and-aft plane.

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[1] On the general subject of marine engines, reference should be made to Mr. A. E. Seaton's *Manual of Marine Engineering;* to Mr. R. Sennett's *Treatise on the Marine Steam Engine;* and to Mr. W. H. Maw's *Recent Practice in Marine Engineering.*

[2] *Min. Proc. Inst. C. E.*, vol. liii. 3, p. 56.

[3] *Proc. Inst. Mech. Eng.*, 1883.

[4] For account of many details in recent English practice in locomotive building, reference should be made to a valuable paper by Mr. Stroudley, and a discussion upon it (*Min. Proc. Inst. C. E.*, lxxxi.).

Outside-cylinder engine.

233. The outside-cylinder type is adopted by several British makers; in America it is almost universal. There the cylinders are in castings which are bolted together to form a saddle on which the bottom of the smoke-box sits. The slide-valves are on the tops of the cylinders, and are worked through rocking levers from an ordinary link-motion. Other features by which American practice is distinguished are the use of bars instead of plates for the frames, of cast-iron wheels with chilled rims instead of wrought-iron wheels with steel rims shrunk or forced on, and steel fire-boxes and wrought-iron tubes instead of copper fire-boxes and brass tubes. Fig. 139, which is a half section through one cylinder of an American locomotive, by the Baldwin Company of Philadelphia, shows the position of the cylinders and valves.

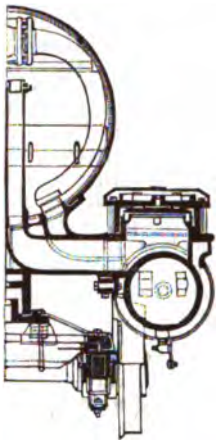

FIG. 139.—American Outside-Cylinder Locomotive.

Compound locomotives.

234. Locomotive engines have been compounded in several ways. In 1876 M. A. Mallet[1] introduced, on the Bayonne and Biarritz Railway, a type of compound locomotive in which one small high-pressure cylinder and one large low-pressure cylinder were used in place of the two equal cylinders of a common locomotive. Outside cylinders were used in the first instance, but Mallet's system is also applied to inside cylinder-engines. The pipe from the high to the low-pressure cylinder takes a winding course through the smoke-box; this gives a sufficient volume of intermediate receiver, and also dries the steam before it enters the large cylinder. A reducing valve is provided through which steam of a pressure lower than that of the boiler can be admitted direct to the low-pressure cylinder to facilitate starting. The reversing gear is arranged to act on both cylinders by one movement, and also to permit a separate adjustment of the cut-off in each. Engines on Mallet's system have been successfully used on other Continental railways and in India, in some instances by conversion from the non-compound form.[2] His plan has the advantage of permitting this (in certain cases), and of requiring scarcely any more working parts than are needed in a common locomotive; but it gives an unsymmetrical engine. He has also proposed an engine with four cylinders,—one high-pressure cylinder tandem with one low-pressure cylinder on each side. Another symmetrical form has been used, in which a pair of outside high-pressure cylinders are compounded with a pair of inside low-pressure cylinders.

Webb's system.

235. The most important experiment yet made in the compounding of locomotives is that which Mr. F. W. Webb, of the London and North-Western Railway, has been conducting on a large scale since 1881.[3] In Mr. Webb's system three cylinders are used. Two equal high-pressure cylinders are fixed outside the frames, and drive the rear driving axle by crank-pins at right angles to one another. A single low-pressure cylinder of very large size is set beneath the smoke-box, and drives a crank in the middle of the forward driving axle. The driving axles are not coupled, and the phase-relation of the low-pressure to the high-pressure stroke is liable to alter through unequal slip on the part of the wheels. This, however, is of no material consequence, on account of the large size of the intermediate receiver and the uniformity with which the two high-pressure cylinders deliver steam to it. The receiver is formed, as in M. Mallet's arrangement, by leading long connecting pipes through the smoke-box. All three slide-valves are worked by Joy's gear. Those of the low-pressure cylinders are placed below the cylinders (an arrangement which has the advantage of letting the valve fall away from the port-face when the engine is running down hill with the steam-valve closed); the valve of the large cylinder is above it. The arrangement is completely symmetrical; it has the important mechanical advantage of dispensing with coupling rods, while retaining the greater tractive power of four drivers; only one axle is cranked, and that with a single crank in the centre, which leaves ample room for long bearings. A plan of Mr. Webb's engine half in section, is given in Fig. 140. The results of Mr. Webb's experiments have been, in his judgment, so satisfactory that for express passenger service he is now building engines only of the compound type. In some recent examples the small cylinders are 14 inches, and the large cylinder 30 inches in diameter, with a stroke of 24 inches, and the boiler pressure is 175 lb. Engines of the same type are also being introduced in India, South America, and the continent of Europe.

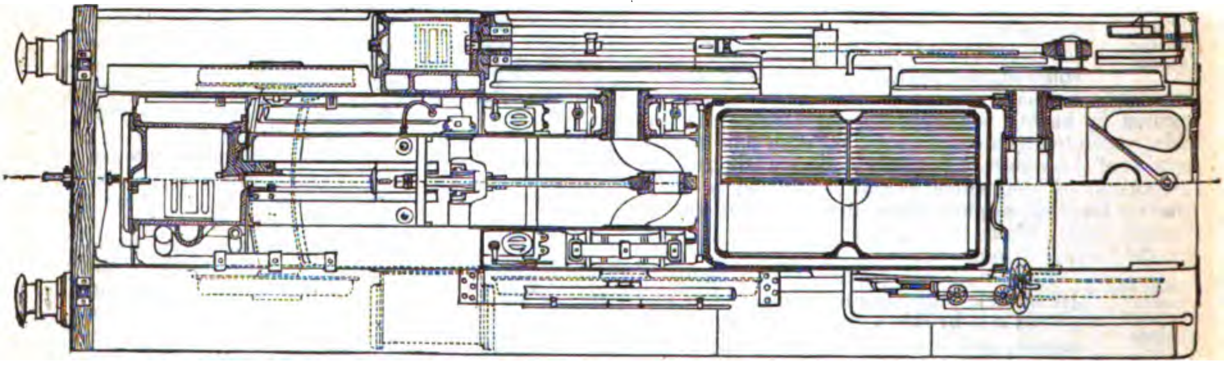

FIG. 140.—Webb's Compound Locomotive.

236. Experiments on the saving of fuel by compounding locomotives point to an economy of from 10 to 20 per cent. It may be expected, for reasons which have been discussed above, that a compound engine, even when working at the high speed of a locomotive,

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[1] *Proc. Inst. Mech. Eng.*, 1879.

[2] Von Borries, *Ztschr. des Ver. deutscher Ingenieure*, 1880; Sandiford, *Proc. Inst. Mech. Eng.*, 1886.

[3] See *Proc. Inst. Mech. Eng.*, 1883; also *Engineering*, May, 1885.

will have a somewhat higher efficiency than a non-compound engine. But, apart from this, an important merit of the compound system is that, while it absolutely prevents the grade of expansion from being reduced below a certain minimum, depending on the ratio of cylinder volumes, it also permits a comparatively high degree of expansion, which in an ordinary locomotive would involve the use of specially large cylinders and a separate cut-off valve. Experiments on the steam-jacketing of locomotive cylinders have not hitherto been attended by success.

Tramway locomotives.

237. *Tramway locomotives* for the most part resemble railway locomotives in the general features of their design. The boiler is of the usual locomotive type. A pair of cylinders in front, either inside or outside the frames, are connected directly to the hindmost of two coupled driving axles. Owing to the smallness of the driving-wheels, the axles lie near the road, and the cylinders are set sloping at a considerable angle upwards to keep them clear of dirt. To prevent the discharge of steam into the atmosphere, the exhaust steam is often led into an atmospheric condenser, consisting of a large number of pipes set on the top of the engine, and exposed to free contact with the air. In some instances the common locomotive type is widely departed from: a mixed vertical and horizontal boiler is used, and the engine is connected to the driving axle by worm-wheel or other gear, or by a rocking lever between the connecting-rod and the crank.[1]

Fireless locomotive.

238. In the "fireless" tramway locomotive of M. Léon Francq, a reservoir which takes the place of an ordinary boiler is charged at the beginning of the journey with water heated under pressure by injecting steam from stationary boilers at a pressure of 15 atmospheres. The thermal capacity of the water is sufficient—without further addition of heat—to supply steam to the engine during the journey, at a pressure which gradually falls off.[2] The system has not come into general use.[3]

239. Several forms of tramway engine have been devised in which the motive power is supplied by compressed air.[4] In the Mekarski system the compressed air, on its way from the reservoir to the cylinders, passes through a vessel containing hot water and steam under pressure (charged as in Francq's system, by injecting steam at a station). In this way the air is heated, and may then expand in the cylinder without having its temperature lowered to an objectionable degree.

Traction engines.

240. Steam *road-locomotives* or traction-engines have usually a boiler of the locomotive type, with a cylinder or compound pair of cylinders, generally on the top, driving a shaft from which motion is taken by a gearing chain or spur-wheels to a single driving axle at the fire-box end. The engine is steered by means of a leading axle, whose direction is controlled by a hand-wheel and chain-gear. To facilitate rapid turning the driving-wheels are connected to their axle by a differential or compensating gear which allows them to revolve at different speeds. This is a set of four bevel-wheels like White's dynamometer coupling: the outside bevel-wheels are attached to the driving-wheels; the intermediate ones, which gear with these, turn in bearings in a revolving-wheel driven by the engine. So long as both driving-wheels are equally resisted both are driven at the same speed, but if one is retarded (as the inner wheel is in turning a curve) it acts to some extent as a fulcrum to the bevel gear, and the outer wheel takes a greater share of the motion. An important feature in traction engines is the elasticity of the driving-wheels. Many devices have been employed, partly to give the wheels an extended tread, or arc of contact with the ground, and partly to avoid shocks in passing over rough ground. Both objects are accomplished by Mr. R. W. Thomson's plan of surrounding each wheel with a thick tire of india-rubber, protected on the outside by an armor of small plates. In most modern traction-engines the rim is itself rigid, but is connected to the nave through a system of springs which allow it to take up an eccentric position, and the tires have skew bars on the surface to increase their adhesion to the road.

XIV. Air and Gas Engines.

Air and gas engines.

241. Under this head we may include all heat-engines in which the working substance is air, or the gaseous products of the combustion of fuel and air, whether the fuel be itself solid, liquid, or gaseous. When air alone forms the working substance, it receives heat from an external furnace by conduction through the walls of a containing vessel, as the working substance in the steam-engine takes in heat through the shell of the boiler. An engine supplied with heat in this way may be called an *external-combustion* engine, to distinguish it from a very important class of engines in which the combustion which supplies heat occurs within a closed chamber containing the working substance. The ordinary coal-gas explosive engine is the most common type of *internal-combustion* engine.

242. Compared with an engine using saturated steam, air and gas engines have the important advantage that the temperature and the pressure of the working substance are independent of one another. Hence it becomes possible to use an upper limit of temperature greatly higher than in the ordinary steam-engine, and if the lower limit is not correspondingly raised an increase of thermodynamic efficiency results. It is true that the same advantage might be obtained in the case of steam, by excessive superheating; but this would mean substantially the conversion of the engine into the type we are now considering, the working substance being then steam gas.

243. A simple, thermodynamically perfect form of external combustion air-engine would be one following Carnot's cycle (§ 40), in which heat is received while the air is at the highest temperature τ_1, the air meanwhile expanding isothermally. After this the supply of heat is stopped, and the air is allowed to expand adiabatically until its temperature falls to the lower extreme τ_2. At this it is compressed isothermally, giving out heat, and finally the cycle is completed by adiabatic compression, which restores the initial high temperature τ_1.

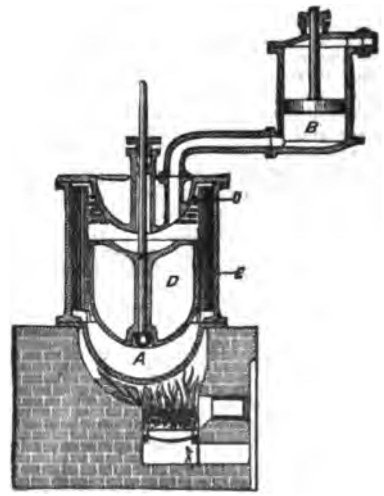

Fig. 141.—Stirling's Air-Engine.

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[1] See *Min. Proc. Inst. C. E.*, vol. xxix., 1884; also *Proc. Inst. Mech. Eng.*, 1880.

[2] *Proc. Inst. Mech. Eng.*, 1879.

[3] [An engine answering exactly to this description was constructed by Dr. Emile Lamm, the inventor of an ammoniacal gas engine. This fireless engine was patented 9th April, 1872, and employed successfully on the street railways of New Orleans. Its inventor was drowned in the following year.—Am. Ed.]

[4] *Proc. Inst. Mech. Eng.*, 1878, 1881.

Stirling's air-engine,

244. In place of adiabatic expansion as a means of changing the temperature from τ_1 to τ_2 we may follow Stirling's plan (§ 54) of storing the heat in a regenerator, from which it will afterwards be taken up and so produce the elevation of temperature from τ_2 to τ_1 which in the above cycle was performed by adiabatic compression.

Stirling's air-engine, in which the action approximated to the perfect cycle described in § 54, is diagramatically shown in Fig. 141. A is a closed vessel containing air, externally heated by a furnace beneath it. A pipe from the top of A leads to the working cylinder B. At the top of A is a refrigerator C. consisting of pipes through which cold water circulates. In A there is a displacer plunger D, which is driven by the engine; when this is raised the air in A is heated, whereas when D is lowered the air in A is brought into contact with the refrigerator and cooled. On its way from the bottom to the top of A, or *vice versa*, the air must pass through an annular lining of wire-gauze E. This is the regenerator. At the beginning of the cycle D is up. The air is then receiving heat at τ_1, and is expanding isothermally; this is the first stage in § 54. Then the plunger D descends. The air is driven through the regenerator, where it deposits heat, and its temperature on emerging at the top is τ_2. Next, the working-piston makes its down-stroke (in the actual engine the working cylinder was double-acting, another heating vessel, precisely like A, being connected with the cylinder B above the piston); this compresses the air isothermally, the heat produced by compression being taken up by C. Finally the plunger is raised, and the working air again passes through the regenerator, taking up the heat it left there, and rising to τ_1. The theoretical indicator diagram has been given in Fig. 13.

245. The actual forms in which Stirling's engine was used are described in two patents by R. & J. Stirling (1827 and 1840[1]). An important feature in them was that the air was compressed (by means of a pump) to a pressure greatly above that of the atmosphere. Stirling's cycle is theoretically perfect whatever the density of the working air, and compression did not in his case increase what may be called the theoretical thermodynamic efficiency. It did, however, very greatly increase the mechanical efficiency, and, also, what is of special importance, it increased the amount of power yielded by an engine of given size. To see this it is sufficient to consider that with compressed air a greater amount of heat was dealt with in each stroke of the engine, and therefore a greater amount of work was produced. Practically it also increased the thermodynamic efficiency by reducing the ratio of the heat wasted by external conduction and radiation to the whole heat.

A double-acting Stirling engine of 50 I.H.P., used in 1843 at the Dundee foundry, appears to have realized an efficiency of 0.3, and, notwithstanding very inadequate means of heating the air, consumed only 1.7 lb of coal per I.H.P. per hour.[2] This engine remained at work for three years, but was finally abandoned on account of the failure of the heating vessels. In some forms of Stirling's engine the regenerator was a separate vessel; in others the plunger D was itself constructed to serve as regenerator by filling it with wire-gauze and leaving holes at top and bottom for the passage of the air through it.

Ericsson's air-engine.

246. Another mode of using the regenerator was introduced in America by Ericsson, in an engine which also failed, partly because the heating surfaces became burnt, and partly because their area was insufficient. In Ericsson's engine the temperature of the working substance is changed (by passing through the regenerator) while the pressure remains constant. Cold air is compressed by a pump into a receiver, from which it passes through a regenerator into the working cylinder. In so passing it absorbs heat from the regenerator and expands. The air in the cylinder is then further expanded by taking in heat from a furnace under the cylinder. The cycle is completed by the discharge of the air through the regenerator. The indicator diagram approximates to a form bounded by two isothermals and two lines of constant pressure.[3]

247. Externally-heated air-engines are now employed only for very small powers—from a fraction of 1 H.P. up to about 3 H.P. Powerful engines of this type are impracticable on account of their relatively enormous bulk. Those that are now manufactured resemble the original Stirling engine very closely in the main features of their action, and comprise essentially the same organs.[4]

Internal-combustion engines.

248. *Internal-combustion* engines form a far more important class of motors. The earliest example of this class appears to have been the hot-air engine of Sir George Cayley,[5] of which Wenham's[6] and Buckett's[7] engines are recent forms. In these engines coal or coke is burnt under pressure in a closed chamber, to which the fuel is fed through a species of air-lock. Air for combustion is supplied by a compressing pump, and the engine is governed by means of a distributing valve which supplies a greater or less proportion of the air below the fire as the engine runs slow or fast. The products of combustion, whose volume is increased by their rise in temperature, pass into a working cylinder, raising the piston. When a certain fraction of the stroke is over the supply of hot gas is stopped, and the gases in the cylinder expand, doing more work and becoming reduced in temperature. During the return stroke they are discharged into the atmosphere, and the pump takes in a fresh supply of air. Fig. 142 is a diagram section of the Buckett engine. A is the working piston, the form of which is such as to protect the tight sliding surface (at the top) from contact with the hot gases; B is the compressing pump, C the valve by which the governor regulates the rate at which fuel is consumed, and D the air-lock through which fuel is supplied.

249. In engines of this class the degree to which the action is thermodynamically efficient depends very largely on the amount of cooling the gases undergo by adiabatic or nearly adiabatic expansion under the working piston. Without a large ratio of expansion the thermodynamic advantage of a high initial temperature is lost; but, as the gases have to be discharged at atmospheric pressure, a large ratio of expansion is possible only when there is much initial compression. Compression is therefore an essential condition, without which a heat-engine of this type cannot be made efficient. It is also, as has already been pointed out, essential in all air-engines to the development of a fair amount of power by an engine of moderate bulk.

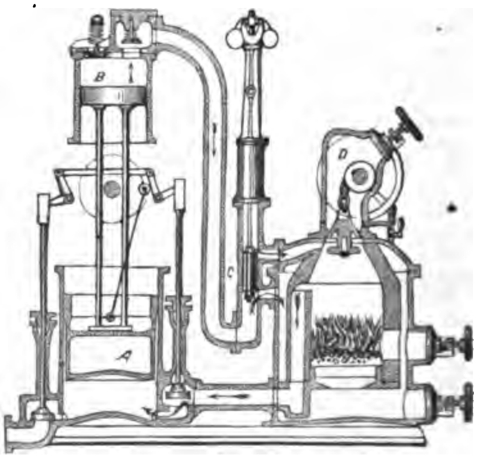

FIG. 142.—Buckett Engine.

Petroleum engines.

250. Internal-combustion engines using solid fuel have hitherto been little used, and that only for small powers. Several small engines employ liquid fuel (namely, petroleum) injected in a state of spray, or even vaporized before entering the combustion-chamber. In some forms, of which the Brayton petroleum engine is a type, combustion occurs as the fuel is injected; in others the action approaches closely that of *gas-engines*, that is to say, of engines in which fuel (generally coal-gas) is supplied in a perfectly gaseous state, and is burnt in a more or less explosive manner. These last are the only heat-engines that have as yet entered into serious competition with steam-engines.

Gas-engines.

Lenoir.

251. The earliest gas-engine to be brought into practical use was that of Lenoir (1860). During the first part of the stroke air and gas, in proportions suitable for combustion, were drawn into the cylinder. At about half-stroke the inlet valve closed, and

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[1] The 1827 patent is reproduced in F. Jenkin's Lecture on Gas and Caloric Engines, *Inst. Civ. Eng.*, Heat Lectures, 1883-84. See also *Min. Proc. Inst. C.E.*, 1845 and 1854.

[2] See Rankine's *Steam Engine*, p. 367. The consumption per brake H.P. was much greater.

[3] For a diagram of Ericsson's engine see Rankine's *Steam-Engine*, or *Proc. Inst. Mech. Eng.*, 1873.

[4] For description of Robinson's, Bailey's, and Rider's hot-air engines see F. Jenkin's lecture, *loc. cit.*

[5] *Nicholson's Art Journal*, 1807.

[6] *Proc. Inst. Mech. Eng.*, 1878.

[7] F. Jenkin, *loc. cit.* Fig. 142 is taken from this paper.

the mixture was immediately exploded by an electric spark. The heated products of combustion then did work on the piston during the remainder of the forward stroke, and were expelled during the back stroke. The engine was double-acting, and the cylinder was prevented from becoming excessively heated by a casing through which water was kept circulating. The water-jacket has been retained in nearly all later gas-engines.

Hugon.

Bischoff.

An indicator diagram from a Lenoir engine is shown in Fig. 143.[1] After explosion the line falls, partly from expansion, and partly from the cooling action of the cylinder walls; on the other hand, its level is to some extent maintained by the phenomenon of after-burning which will be discussed later. In this engine, chiefly because there was no compression, the heat removed by the water-jacket bore an exceedingly large proportion to the whole heat, and the efficiency was comparatively low; about 95 cubic feet of gas were used per horse-power per hour. Hugon's engine, introduced five years later, was a non-compressive engine very similar to Lenoir's. A novel feature in it was the injection of a jet of cold water to keep the cylinder from becoming too hot. These engines are now obsolete; the type they belonged to, in which the mixture is not compressed before explosion, is now represented by one small engine—Bischoff's—the mechanical simplicity of which atones for its comparatively wasteful action in certain cases where but little power is required.

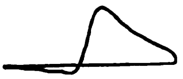

FIG. 143.—Lenoir Engine Diagram.

Otto and Langen.

252. In 1866 Otto and Langen introduced a curious engine,[2] which, as to economy of gas, was distinctly superior to its predecessors. Like them it did not use compression. The explosion occurred early in the stroke, in a vertical cylinder, under a piston which was free to rise without doing work on the engine shaft. The piston rose with great velocity, so that the expansion was much more nearly adiabatic than in earlier engines. Then after the piston had reached the top of its range the gases cooled, and their pressure fell below that of the atmosphere; the piston consequently came down, this time in gear with the shaft, and doing work. The burnt gases were discharged during the last part of the down stroke. A friction-coupling allowed the piston to be automatically thrown out of gear when rising, and into gear when descending. This "atmospheric" gas engine used about 40 cubic feet of gas per horse-power per hour, and came into somewhat extensive use in spite of its noisy and spasmodic action. After a few years it was displaced by a greatly improved type, in which the direct action of Lenoir's engine was restored, but the gases were compressed before ignition.

Otto's engine.

253. Dr. Otto's "silent" engine, introduced in 1876, was the first successful motor of the modern type. It is a single-acting engine, generally horizontal in form, and the explosive mixture is compressed in the working cylinder itself. This is done by making the cycle of the action extend through two revolutions of the engine. During the first forward stroke gas and air are drawn in by the piston. During the first back-stroke the mixture is compressed into a large clearance space, at the end of the cylinder. The mixture is then ignited, and the second forward stroke (which is the only working stroke in the cycle) is performed under the pressure of the heated products of combustion. During the second backstroke the products are discharged, with the exception of so much as remains in the clearance space, which serves to dilute the explosive mixture in the next cycle. The principal parts of Otto's engine (as made by Messrs. Crossley) are shown in the diagram section, Fig. 144. The cylinder is kept cool by a water-jacket AA. B is the clearance space into which the mixture is compressed before explosion. Its volume is usually about two-thirds of the stroke, or 40 per cent. of the whole volume to which the gases afterwards expand. C is the exhaust-valve, which is opened during the second back-stroke of each cycle. Gas and air are admitted at D, through a side-valve E, which reciprocates once in each complete cycle of two revolutions. This slide-valve is shown to a larger scale in Fig. 145, in the position it occupies while gas is entering from *g* and air from *a*. To ignite the mixture a gas jet is kept burning at *c*. In the slide-valve there is an igniting port *d*, which is supplied with gas from a groove in the cover. As the slide moves towards the right, the igniting port *d* carries a flame from *c* to D. Just before reaching D a little of the compressed mixture from the cylinder enters the igniting port by a small opening which does not appear in the figure, and by the time D is reached the contents of *d* are so much raised in pressure by their own combustion that a tongue of flame shoots into the cylinder, firing the mixture there. The speed is regulated by a centrifugal governor, which cuts off the supply of gas when the speed exceeds a certain limit. In some small Otto engines of recent construction the inertia of a reciprocating piece is used instead of the inertia of revolving pieces to effect the same end.

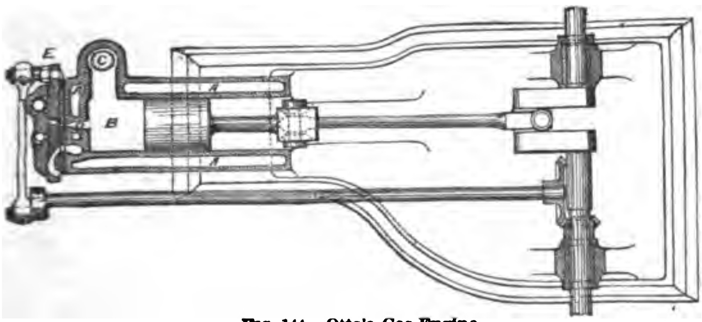

FIG. 144.—Otto's Gas Engine.

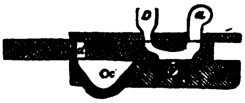

FIG. 145.

Clerk's engine.

254. In Mr. Clerk's engine the cycle of operations is essentially the same as in Otto's, but a charging cylinder is introduced, with the effect of allowing an explosion to take place in the working cylinder once in every revolution. As in Otto's, there is a large clearance space behind the piston, and the mixture is compressed into this space by the backward movement of the working piston. The peculiarity of the engine lies in the manner in which the charge is introduced. As the piston advances after an explosion it uncovers exhaust ports in the sides of the cylinder, close to the end of its forward stroke. While it is passing the dead-point there the plunger of the charging cylinder (which has meanwhile taken in a mixture of gas and air) delivers this mixture into the cylinder, driving the products of the previous combustion out of the cylinder through the exhaust ports. The charging cylinder is so arranged that the first part of the charge consists almost wholly of air, and this is followed by the explosive mixture of gas and air. The working piston then returns, closing the exhaust ports and compressing the mixture, which is ignited after compression by means of a slide-valve similar to Otto's. In Otto's engine the explosive mixture is diluted, and the sharpness of the explosion thereby reduced, by the residue of burnt products which fill the clearance space at the end of the discharge stroke. In Clerk's engine the mixture is diluted by an excess of air. It does

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[1] Slade, *Jour. Franklin Inst.*, 1866.

[2] *Proc. Inst. Mech. Eng.*, 1875.

not appear that this difference has any material effect on the action.

255. Over 20,000 Otto engines are now in use, of power ranging up to about 40 H.P. Besides the engines which have been named, others are manufactured in which the operations are essentially of the same kind, though in some cases the mechanical details are widely varied. In one of these, Mr. Atkinson's ingenious "differential" engine, the working chamber consists of the space between two pistons working in one cylinder. During exhaust the pistons come close together; they recede from each other to take in a fresh charge; they approach for compression; and finally they recede again very rapidly and farther than before, after ignition of the mixture, thus giving a comparatively large ratio of expansion. At the same time, by moving bodily along through the cylinder, the pistons uncover admission and exhaust ports and an ignition-tube, which is kept permanently incandescent.

Theoretical indicator diagram of Otto engine.

256. If the explosion of a gaseous mixture were practically instantaneous, producing at once all the heat due to the chemical reaction, and if the expansion and compression were adiabatic, the theoretical indicator diagram of an engine of the Otto type would have the form shown in Fig. 146. OA represents the volume of clearance; AB is the admission, at atmospheric pressure; BC is the compression (which is assumed to be adiabatic); CD is the rise of pressure caused by explosion; DE is adiabatic expansion during the working stroke; and EBA is the exhaust. The height of the point D above C may be calculated when we know the temperature at C (an element of considerable uncertainty in practice), the specific heat (at constant volume) of the burnt mixture, the amount of heat evolved by explosion, and the change of specific density due to the change of chemical constitution which explosion brings about. With the proportion of coal-gas and air ordinarily employed this last consideration may generally be neglected, as the volume of the products would differ by less than 2 per cent. from the volume of the mixture before explosion if both were reduced to the same pressure and temperature.

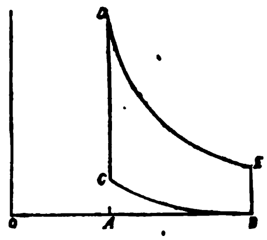

FIG. 146.

Actual diagram of Otto engine.

257. The rise of pressure observed in the indicator diagrams of gas-engines is found to be in all cases much less than the calculated rise of pressure which would be caused by a strictly instantaneous explosion. An actual diagram from an Otto engine working in its normal manner is given in Fig. 147, where the reference letters distinguish the parts of a complete cycle, as in Fig. 146. It shows a rapid rise of pressure on explosion, so rapid that the volume has not very materially altered when the maximum of pressure is reached; and the specific heat at constant volume may therefore be used without serious error in calculating the amount of heat which this rise accounts for. When this calculation is made,[1] it turns out that only about 60 or 70 per cent. of the potential heat of combustion in the mixture is required to produce the rise of temperature corresponding to the point of greatest pressure. The remainder continues to be slowly evolved during the subsequent expansion of the hot gases. The process of combustion—a term evidently more appropriate than explosion—is essentially gradual; when ignition takes place it begins rapidly, but it continues to go on at a diminishing rate throughout the stroke. That part which takes place after the maximum pressure is passed is the phenomenon of after-burning to which allusion has been made above.

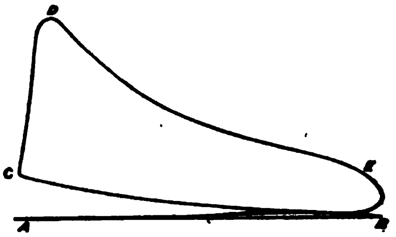

FIG. 147.—Otto Engine Diagram.

After-burning.

258. The existence of "after-burning" is proved not only by the fact that the maximum pressure after ignition is much less than it would be if combustion were then complete, but also by the form which the curve of subsequent expansion takes. During expansion the gases are losing much heat by conduction through the cylinder walls. The water-jacket absorbs rather more than half of the whole heat developed in the engine,[2] and the greater part of this is of course taken up from the gases during the working stroke. Notwithstanding this loss, the curve of expansion does not fall much below the adiabatic curve; in some cases it even lies higher than the adiabatic curve. This shows that the loss to the sides of the cylinder is being made up by continued development of heat within the gas. The process of combustion is especially protracted when the explosive mixture is weak in gas; the point of maximum pressure then comes late in the stroke; and it is probable that the products which are discharged in the exhaust contain some incompletely-burnt fuel.

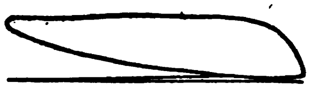

FIG. 148.—Otto Engine Diagram with weak explosive mixture.

Fig. 148 is the indicator diagram of an Otto engine supplied with a mixture containing an exceptionally large proportion of air: it exhibits well the very gradual character of the explosion in such a case.

Clerk's experiments.

259. Much light has been thrown on this subject by the experiments of Mr. Clerk, who has exploded mixtures of gas and air, and also mixtures of hydrogen and air, in a closed vessel furnished with an apparatus for recording the time-rate of variation of pressure. In these experiments the pressure fell after the explosion only on account of the cooling action of the containing walls. The temperature before ignition being known, it became possible to calculate from the diagrams of pressure the highest temperature reached during combustion (on the assumption that the specific heat of the gases remained unchanged at high temperatures), and to compare this with the temperature which would have been produced had combustion been at once complete. Mixtures of gas and air were exploded, the proportion of gas varying from $\frac{1}{13}$ to $\frac{1}{5}$, and the highest temperature produced was generally a little more than

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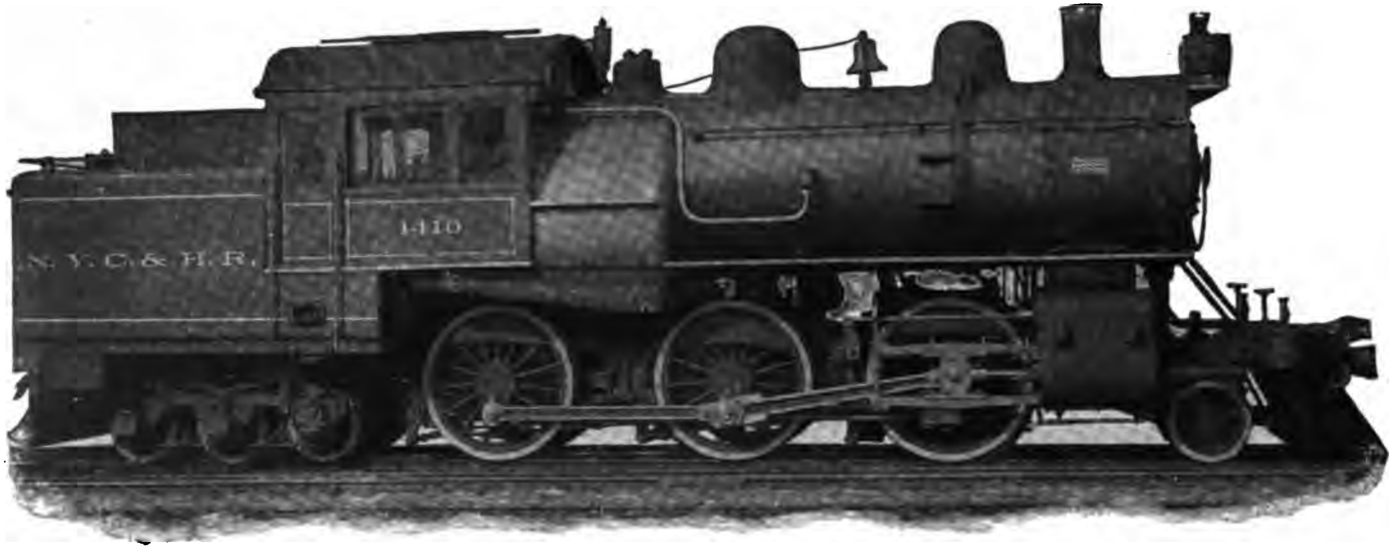
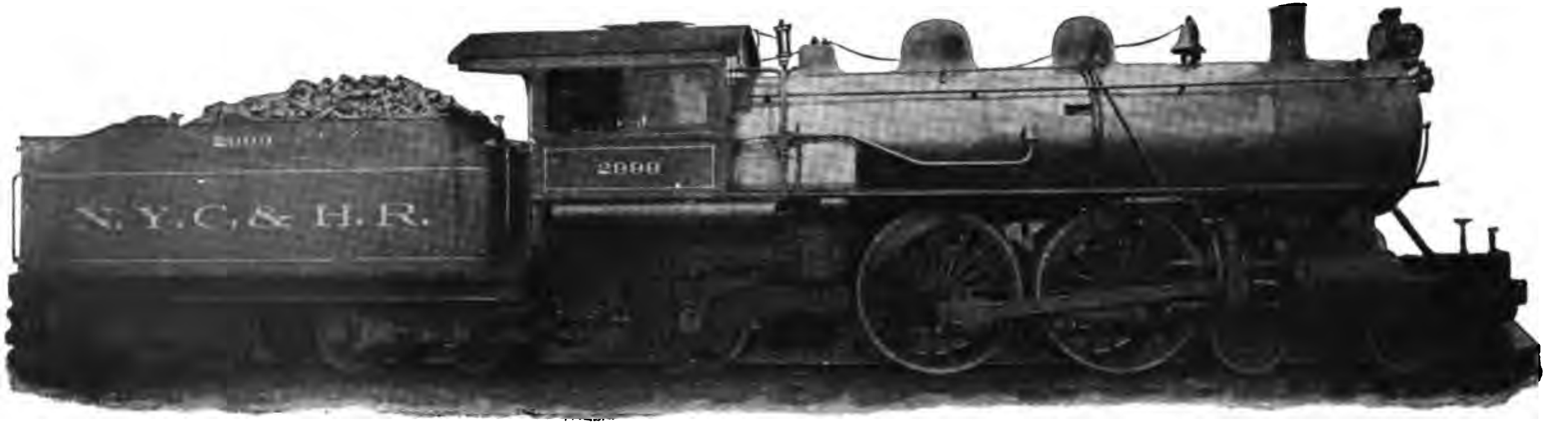
[1] See two important papers by Mr. Dugald Clerk, "On the Theory of the Gas-Engine," and "On the Explosion of Homogeneous Gaseous Mixtures," *Min. Proc. Inst. C. E.*, 1882 and 1886. Reference should also be made, on the subject of gas-engines generally, to Mr. Clerk's book, *The Gas-Engine*, 1886.

[2] Clerk, *loc. cit.* Also, Brooks and Steward, *Van Nostrand's Eng. Mag.*, 1883; Ayrton and Perry, *Phil. Mag.*, July, 1884; Slaby, Report quoted in F. Jenkin's *Lecture*, Inst. C.E., 1884.



NEW STYLE ENGINE FOR SUBURBAN PASSENGER TRAFFIC



THE LARGEST AND MOST POWERFUL HIGH SPEED LOCOMOTIVE IN THE WORLD

half that which would have been reached by instantaneous combustion of the mixture. With the best proportion of coal-gas to air (1 to 6 or 7) the greatest pressure and hottest state was found one-twentieth of a second after ignition, and the temperature was then 1800° C.,—instead of 3800°, which would have been the value had all the heat been at once evolved. With the weakest mixtures about half a second was taken to reach a maximum of temperature, and its value was 800° C., instead of 1800° C. In this case, however, the degree of completeness of the combustion is not fairly shown by a comparison of these temperatures, since much cooling occurred during the relatively long interval that preceded the instant of greatest pressure.

Dissociation.

260. To explain the phenomenon of after-burning or delayed combustion, it has been supposed that the high temperature to which the gases are raised in the first stages of the explosion prevents union from being completed,—just as high temperature would dissociate the burnt gases were they already in chemical union,—until the fall of temperature by expansion and by the cooling action of the cylinder walls allows the process of union to go on. The maximum temperature attained in the gas-engine is high enough to cause a perceptible amount of dissociation of the burnt products; it may therefore be admitted that this explanation of delayed combustion is to some extent true. On the other hand, the phenomenon is most noticeable with mixtures weak in gas, in which the maximum temperature reached is low, and the dissociation effect is correspondingly small. It appears, therefore, that dissociation is not the main cause of the action; apart from it the process of combustion of a gaseous mixture is gradual, beginning fast and going on at a continuously-diminishing rate as the combustible mixture becomes more and more diluted by the portions already burnt. If the mixture is much diluted to begin with, the process is comparatively slow from the first.

Stratification.

261. Much stress has been laid by some makers of gas-engines on the desirability of having a stratified mixture of gases in the cylinder, with a part rich in gas near the ignition port and a greater proportion of residual product or air near the piston. It has even been supposed that stratification of the gases is the cause of their gradual combustion. Mr. Clerk's experiments are conclusive against this; the mixtures he used, which gave in some cases very gradual explosions, were allowed to stand long enough to become sensibly homogeneous. In dealing with weak mixtures it is no doubt of advantage to have a small quantity of richer fluid close to the igniting port to start the ignition of the rest,—but beyond this stratification has probably little or no value. And it may be questioned whether, in the ordinary working of a gas-engine, any general stratification can occur, when account is taken of the commotion which the air and gas cause as they rush into the cylinder at a speed exceeding that of an express train.

Efficiency of gas-engines.

262. A compression gas-engine of the Otto type burns from 20 to 25 cubic feet of coal-gas per hour per indicated horse-power. Good coal-gas has a heating power equivalent to about 500,000 foot-pounds per cubic foot, and hence, with a consumption of 20 cubic feet the efficiency which the engine realizes is nearly 0.2. The efficiency of a large steam-engine is about 0.14, and in steam-engines that are small enough to be fairly compared with actual gas-engines the efficiency is not more than 0.1. The superiority of gas-engines over steam-engines, from the thermodynamic point of view, is well shown by comparing their consumption of fuel. In the steam-engine we find in good engines of large size a consumption of 2 ℔ or 1¾ ℔ of coal per I.H.P. per hour, and by triple expansion this is reduced in large marine engines to about 1⅓ ℔. On the other hand, in small-power engines the consumption is at least 2½ ℔, and is generally 3 ℔ or more. When Mr. Dowson's cheap gas,[1] which is produced by passing a mixture of superheated steam and air through red-hot anthracite, is used to drive an Otto engine, the consumption of coal has been found to be only 1.1 ℔ per I.H.P. per hour, or less than half the amount used by a steam-engine of similar size. What gives this comparison additional interest is the fact that the gas-producer for a 40 or 50 H.P. engine need not take up more space than the boiler of a steam-engine of the same power.

263. In another sense the gas-engine is much less perfect than the steam engine. The actual efficiency of the latter is about half the ideal efficiency which a perfect engine would show when working through the same range of temperature. In the gas-engine the actual is less than one-fourth of the ideal efficiency. Taking the highest temperature as 1900° C.—a value reached in some of Mr. Clerk's experiments—and the lowest temperature as 15° C., the efficiency of a perfect engine would be 0.87, while that of the actual engine is 0.2. This only means that the gas-engine has all the greater margin for future improvement.

264. At present the main causes of waste in gas-engines are the action of the sides of the cylinder and the water-jacket, and the high temperature of the exhaust gases. The water-jacket absorbs about half the whole heat, only to keep the cylinder cool enough to permit of lubrication. The waste gases are discharged at a temperature of about 420° C., and so carry away a large amount of heat which might in part be saved by having a greater ratio of expansion, or by the use of a regenerator. Another source of thermodynamic imperfection is the after-burning, which gives heat to the working substance at a temperature lower than the maximum.

In an engine constructed by the late Sir William Siemens it was attempted to do away with or reduce the two main causes of loss—(1) by using a separate combustion-chamber, distinct from the cylinder in which the piston worked, and (2) by passing the exhaust gases through a regenerator, which afterwards gave up heat to the incoming air and gas.[2] The late Prof. Fleeming Jenkin endeavored to attain the same ends by adapting the Stirling type of engine to internal combustion, a mixture of gas and air being exploded under a displacer like that of Fig. 141. Practical difficulties have hitherto prevented regenerative internal combustion engines from coming into use, but it can scarcely be doubted that their development is only a question of time. With regard to the probable future of heat-engines, it is important to notice that the internal-combustion engine using gaseous fuel, though already much more efficient than the steam-engine, is crude and full of defects which further invention ought to remove, while the steam-engine has been improved so far that little increase in its efficiency can be expected, and more than a little is impossible.

(J. A. E.)

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[1] *Min. Proc. Inst. C. E.*, vol. lxxiii. p. 311.

[2] Siemens, "Discussion on the theory of the Gas-Engine," *Min. Proc. Inst. C. E.*, 1882.

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STEAM HAMMER. See HAMMER.

STEARINE, in commerce, designates a solid mixture of fatty acids (chiefly palmitic and stearic) which is being produced industrially from animal fats and used largely for the making of candles. In chemistry it is a generic term for the three "esters" derivable from glycerin, $C_3H_5(OH)_3$, by the replacement of one or more of the three (OH)'s by the residue $C_{18}H_{35}O_2$, which, in stearic acid, is combined with "H." Of these tri-stearine, $C_3H_5(C_{18}H_{35}O_2)_3$, is the most important; it occurs in animal fats only, largely in tallow. It crystallizes from ether in white pearly nodules, insoluble in cold but easily soluble in boiling alcohol. It can be distilled undecomposed *in vacuo*. On gradual exposure to higher temperatures it fuses at 55° C.; it then resolidifies, and then fuses again (permanently) at 71.5° (Heintz). The specific gravity of the liquid is 0.9245 at 65.5° C. (Duffy).

STEEL. See IRON.

STEELE, SIR RICHARD (1672–1729), one of the most active and prominent men of letters in the reign of Queen Anne, inseparably associated in the history of literature with his personal friend Addison. He cannot be said to have lost in reputation by the partnership, because he was far inferior to Addison in purely literary gift, and it is Addison's literary genius that has floated their joint work above merely journalistic celebrity; but the advantage was not all on Steele's side, inasmuch as his more brilliant coadjutor has usurped not a little of the merit rightly due to him. Steele's often-quoted generous acknowledgment of Addison's services in *The Tatler* has proved true in a somewhat different sense from that intended by the writer: "I fared like a distressed prince, who calls in a powerful neighbor to his aid; I was undone by my auxiliary; when I had once called him in I could not subsist without dependence on him." The truth is that in this happy alliance the one was the complement of the other; and the balance of mutual advantage was much more nearly even than Steele claimed or posterity has generally allowed.

The famous literary pair were born in the same year, 1672,—Steele in Dublin, the senior by less than two months. Steele's father, who is said to have been a lawyer, died before he had reached his sixth year, but the boy found a protector in his maternal uncle, Henry Gascoigne, secretary and confidential agent to two successive dukes of Ormonde. Through his influence he was nominated to the Charterhouse in 1684, and there first met with Addison. Five years afterwards he proceeded to Oxford, and was a postmaster at Merton when Addison was a demy at Magdalen. Their schoolboy friendship was continued at the university, and probably helped to give a more serious turn to Steele's mind than his natural temperament would have taken under different companionship. Addison's reverend father also took an interest in the warm-hearted young Irishman; but their combined influence did not steady him sufficiently to keep his impulses within the lines of a regular career; without waiting for a degree he volunteered into the army, and served for some time as a cadet "under the command of the unfortunate duke of Ormonde." This escapade was made without his uncle's consent, and cost him, according to his own account, "the succession to a very good estate in the county of Wexford in Ireland." Still, he did not lack advancement in the profession he had chosen. A poem on the funeral of Queen Mary (1695), dedicated to Lord Cutts, colonel of the Coldstream Guards, brought him under the notice of that nobleman, who took the gentleman trooper into his household as a secretary, made him an officer in his own regiment, and ultimately procured for him a captaincy in Lord Lucas's fusiliers. His name was noted for promotion by King William, but the king's death took place before anything had been done for Captain Steele. He would seem to have remained in the army, though never on active service, for several years longer.

Steele probably owed the king's favor to honest admiration of the excellent principles of *The Christian Hero*, his first prose treatise, published in 1701. The "reformation of manners" was a cherished purpose with King William and his consort, which they tried to effect by proclamation and Act of Parliament; and a sensible well-written treatise, deploring the irregularity of the military character, and seeking to prove by examples—the king himself among the number—"that no principles but those of religion are sufficient to make a great man," was sure of attention. Steele complained that the reception of *The Christian Hero*, by his comrades was not so respectful; they persisted in trying him by his own standard, and would not pass "the least levity in his words and actions" without protest. The sensitive and hot-headed "hero" would seem to have been teased into fighting a duel,—his first and last, for he wounded his antagonist dangerously, and from that time was a stanch opponent of affairs of honor. His uneasiness under the ridicule of his irreverent comrades had another curious result: it moved him to write a comedy. "It was now incumbent upon him," he says, "to enliven his character, for which reason he writ the comedy called *The Funeral*." Although, however, it was Steele's express purpose to free his character from the reproach of solemn dulness, and prove that he could write as smartly as another, he showed greater respect for decency than had for some time been the fashion on the stage. The purpose, afterwards more fully effected in his famous periodicals, of reconciling wit, good humor, and good breeding with virtuous conduct was already deliberately in Steele's mind when he wrote his first comedy. It was produced and published in 1701, was received on the stage with favor, and owing to its comparative purity helped, along with *The Christian Hero*, to commend its author to King William. In his next comedy, *The Lying Lover, or the Ladies' Friendship*, produced two years afterwards, in 1703, Steele's moral purpose was directly avowed; and the play, according to his own statement, was "damned for its piety." *The Tender Husband*, produced eighteen months later (in April, 1705), though not less pure in tone, was more successful; in this play he gave unmistakable evidence of his happy genius for conceiving and embodying humorous types of character, putting on the stage the parents or grandparents of Squire Western, Tony Lumpkin, and Lydia Languish. It was seventeen years before Steele again tried his fortune on the stage with *The Conscious Lovers*, the best and most successful of his comedies, produced in 1722.

Meantime the gallant captain had turned aside to another kind of literary work, in which, with the assistance of his friend Addison, he obtained a more enduring reputation. There never was a time when literary talent was so much sought after and rewarded by statesmen. Addison had already been waited on in "his humble lodgings in the Haymarket," and advanced to office, when his friend the successful dramatist was appointed to the office of gazetteer. This was in May, 1707. It was Steele's first connection with journalism. The periodical was at that time taking the place of the pamphlet as an instrument for working on public opinion. *The Gazette* gave little opening for the play of Steele's lively pen, his main duty, as he says, having been to "keep the paper very innocent and very insipid"; but the position made him familiar with a new field of enterprise in which his inventive mind soon discerned materials for a project of his own. *The Tatler* made its first appearance on the 12th of April, 1709. It was partly a newspaper, a journal of politics and society, published three times a week. Steele's position as gazetteer furnished him with special advantages for political news, and as a popular habitué of coffee-houses he was at no loss for social gossip. But Steele not only retailed and commented on social news, a function in which he had been anticipated by Defoe and others; he also introduced into *The Tatler* as a special feature essays on general questions of manners and morality. It is not strictly true that Steele was the inventor of the English "essay,"—there were essayists before the 18th century, notably Cowley and Temple; but he was the first to use the essay for periodical purposes, and he and Addison together developed a distinct species, to which they gave a permanent character and in which they had many imitators. As a humbler motive for this fortunate venture Steele had the pinch of impecuniosity, due rather to excess of expenditure than to smallness of income. He had £300 [$1458] a year from his gazetteership, £100 [$486] as gentleman usher to Prince George, £800 [$3888] from the Barbadoes estates of his first wife,[1] and some fortune by his second wife—Mrs. Mary Scurlock, the "Dear Prue" of his charming letters. But Steele lived in considerable state after this second marriage, and was reduced to the necessity of borrowing before he started *The Tatler*. The assumed name of the editor was Isaac Bickerstaffe, but Addison discovered the real author in the sixth number, and began to contribute in the eighteenth. It is only fair to Steele to state that the success of *The Tatler* was established before Addison joined him, and that Addison contributed to only forty-two of the two hundred and seventy-one numbers that had appeared when the paper was stopped in January, 1711.

Only two months elapsed between the stoppage of *The Tatler* and the appearance of *The Spectator*, which was the organ of the two friends from March 1, 1711, till December 6, 1712. Addison was the chief contributor to the new venture, and the history of it belongs more to his life. Nevertheless it is to be remarked as characteristic of the two writers that in this as in *The Tatler* Addison generally follows Steele's lead in the choice of subjects. The first suggestion of Sir Roger de Coverley was Steele's, although it was Addison that filled in the outline of a good-natured country gentleman with the numerous little whimsicalities that convert Sir Roger into an amiable and exquisitely ridiculous provincial oddity. Steele had neither the fineness of touch nor the humorous malice that gives life and distinction to Addison's picture; the Sir Roger of his original hasty sketch has good sense as well as good-nature, and the treatment is comparatively commonplace from a literary point of view, though unfortunately not commonplace in its charity. Steele's suggestive vivacity gave many another hint for the elaborating skill of his friend.

The Spectator was followed by *The Guardian*, the first number of which appeared on the 12th of March, 1713. It had a much shorter career, extending to only a hundred and seventy-five numbers, of which Steele wrote eighty-two and Addison fifty-three. This was the last of his numerous periodicals in which he had the assistance of the great essayist. But he continued for several years to project journals, under great variety of titles, some of them political, some social in their objects, most of them very short-lived. Steele was a warm partisan of the principles of the Revolution, ardent and earnest in his political as in his other convictions. *The Englishman* was started in January, 1714, immediately after the stoppage of *The Guardian*, to assail the policy of the Tory ministry. *The Lover*, started some six weeks later, was more general in its aims; but it gave place in a month or two to *The Reader*, a direct counterblast to the Tory *Examiner*. *The Englishman* was resuscitated for another volume in 1715; and in the same year he projected in rapid succession three unsuccessful ventures,—*Town Talk*, *The Tea-Table*, and *Chit-Chat*. Three years later he started his most famous political paper, *The Plebeian*, rendered memorable by the fact that in it he had to contend against his old ally Addison. The subject of controversy between the two life-long friends was Sunderland's Peerage Bill, Steele's last venture in journalism was *The Theatre*, 1719–20, the immediate occasion of which was the revocation of his patent for Drury Lane. So ready was Steele in this kind of enterprise, which he could always conduct single-handed, that apparently whenever he felt strongly on any subject he at once started a journal to give vent to his feelings. Besides these journals he wrote also several pamphlets on passing questions,—on the disgrace of Marlborough in 1711, on the fortifications of Dunkirk in 1713, on the "crisis" in 1714, *An Apology for himself and his Writings* (important biographically) in the same year, on the South Sea mania in 1720.

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[1] The name of this lady—a widow, Mrs. Margaret Stretch—and some facts about her have been ascertained by Mr. George A. Aitken. See *Athenæum*, May 1, 1886, and Mr. Dobson's *Steele*, pp. 51, 218.

The fortunes of Steele as a zealous Whig varied with the fortunes of his party. He lost his gazetteership when the Tories came into power in 1710. Over the Dunkirk question he waxed so hot that he threw up a pension and a commissionership of stamps, and went into parliament as member for Stockbridge to attack the ministry with voice and vote as well as with pen. But he had not sat many weeks when he was expelled from the House for the language of his pamphlet on *The Crisis*, which was stigmatized as seditious. The *Apology* already mentioned was his vindication of himself on this occasion. With the accession of the house of Hanover his fortunes changed. Honors and substantial rewards were showered upon him. He was made a justice of the peace, deputy-lieutenant of Middlesex, surveyor of the royal stables, governor of the royal company of comedians—the last a lucrative post, and was also knighted (1715). After the suppression of the Jacobite rebellion he was appointed one of the commissioners of forfeited estates, and spent some two years in Scotland in that capacity. He obtained a patent for a plan for bringing salmon alive from Ireland. Differing from his friends in power on the question of the Peerage Bill in 1718, he was deprived of some of his offices, but when Walpole became chancellor of the exchequer in 1721 he was reinstated. But with all his emoluments the imprudent, impulsive, ostentatious, and generous Steele could never get clear of financial difficulties, and he was obliged to retire from London in 1724 and live in the country. He spent his last years on his wife's estate of Llangunnor in Wales, and his health broken down by a paralytic seizure, died on the 1st of September, 1729.

A selection from Steele's essays has been edited by Mr. Austin Dobson, who prefixes a careful and sympathetic memoir. Mr. Dobson has since written a fuller biography in Mr. Lang's series of *English Worthies*. (W. M.)

STEELYARD, Merchants of the, were Hanse merchants who settled in London in 1250 at the steelyard on the river side, near Cosin Lane, now Iron Bridge Wharf. Henry III. in 1259, at the request of his brother Richard, earl of Cornwall, conferred on them important privileges, which were renewed and confirmed by Edward I. It was chiefly through their enterprise that the early trade of London was developed, and they continued to flourish till, on the complaint of the Merchant Adventurers in the reign of Edward VI., they were deprived of their privileges. Though Hamburg and Lübeck sent ambassadors to intercede for them, they were not reinstated in their monopolies, but they succeeded in maintaining a footing in London till expelled by Elizabeth in 1597. Their beautiful guild-hall in Thames street, described by Stow, was made a naval store-house. It contained two famous pictures, painted in distemper by Holbein, representing Poverty and Riches, which were presented by the Hanse merchants to Henry, prince of Wales, and came into the possession of Charles I., but are supposed to have perished in the fire which destroyed Whitehall.

STEEN, Jan Havicksz (1626–1679), subject-painter, was born at Leyden in 1626, the son of a brewer of the place. He studied at Utrecht under Nicholas Knuffer, an historical painter, and about 1644 went to Haarlem, where he worked under Adrian van Ostade and under Jan van Goijen, whose daughter he married in 1649. In the previous year he had joined the painters' guild of the city. In 1667 he is said to have been a brewer at Delft, and in 1672 he received municipal authority to open a tavern. The accounts of his life, however, are very confused and conflicting. Some biographers have asserted that he was a drunkard and of dissolute life, but the number of his works—Van Westrheene, in his *Jan Steen, Étude sur l'Art en Holland*, has catalogued nearly five hundred—is sufficient in itself to disprove the charge. His later pictures bear marks of haste and are less carefully finished than those of his earlier period. He died at Leyden in 1679.

The works of Jan Steen are distinguished by correctness of drawing, admirable freedom and spirit of touch, and clearness and transparency of coloring. But their true greatness is due to their intellectual qualities. In the wide range of his subjects, and their dramatic character, he surpasses all the Dutch figure-painters, with the single exception of Rembrandt. His productions range from the stately interiors of grave and wealthy citizens to tavern scenes of jollity and debauch. He painted chemists in their laboratories, doctors at the bedside of their patients, card-parties, marriage feasts, and the festivals of St. Nicholas and Twelfth Night,—even religious subjects, though in these he was least successful. His rendering of children is especially delightful. Dealing often with the coarser side of things, his work is full of humor; he depicts the comedy of human life in a spirit of very genial toleration, but now and again there appear keenly telling touches of satire which recall such a pictorial moralist as Hogarth.

The National Gallery contains one picture by Jan Steen,—the Music Master; and other excellent examples of his art are preserved in the Royal, the Bute, the Ashburton, and the Northbrook collections, at Apsley House and Bridgewater House, and in the galleries of The Hague, Amsterdam, and the Hermitage, St. Petersburg.

STEFFANI, Agostino (1655–1730), ecclesiastic, diplomatist, and musical composer, was born at Castelfranco in 1655, and at a very early age was admitted as a chorister at St. Mark's in Venice. In 1667 the beauty of his voice attracted the attention of Count Tattenbach, by whom he was taken to Munich, where his education was completed at the expense of Ferdinand Maria, elector of Bavaria, who appointed him "Churfürstlicher Kammer- und Hofmusikus," and granted him a liberal salary. After receiving instruction from Johann Kaspar Kerl, and possibly Ercole Bernabei, he was sent in 1673 to study in Rome, where, among other works, he composed six motets, the original MSS. of which are now in the Fitzwilliam Museum at Cambridge. On his return to Munich in 1674 he published his first work, *Psalmodia Vespertina*, a part of which was reprinted in Martini's *Saggio di Contrappunto* in 1674. In 1675 he was appointed court organist, and in 1680 he was ordained priest, with the title of abbate of Lepsing. His ecclesiastical status did not, however, prevent him from turning his attention to the stage, for which, at different periods of his life, he composed works which undoubtedly exercised a potent influence upon the dramatic music of the period. Of his first opera, *Marco Aurelio*, produced at Munich in 1681, the only copy known to exist is a MS. score preserved in the royal library at

Buckingham palace. It was followed by *Solone* in 1685, *Servio Tullio* in 1686, *Alarico* in 1687, and *Niobe* in 1688; but of these four last-named works no trace can now be discovered. *Niobe* was the last opera Steffani composed at Munich. Notwithstanding the favor shown to him by the elector Maximilian Emanuel, he accepted in 1689 the appointment of kapellmeister at the court of Hanover, where he speedily gained the goodwill of Ernest Augustus, duke of Brunswick-Lüneburg (afterwards raised to the dignity of elector of Hanover), the duchess Sophia Charlotte (afterwards electress of Brandenburg), the philosopher Leibnitz, the abbate Ortensio Mauro, and many men of letters and intelligence, and where, in 1710, he showed great kindness to Handel, who was then just entering upon his glorious career. He inaugurated a long series of triumphs in Hanover by composing, for the opening of the new opera-house in 1689, an opera called *Enrico il Leone*, which was produced with extraordinary splendor and achieved an immense reputation. For the same theatre he composed *La Lotta d' Ercole con Achilleo* in 1689, *La Superbia d' Alessandro* in 1690, *Orlando Generoso* in 1691, *Le Rivali Concordi* in 1692, *La Libertà Contenta* in 1693, *I Trionfi del Fato* and *I Baccanali* in 1695, and *Briseide* in 1696. The libretto of *Briseide* is by Palmieri. Those of most if not all the others are by the abbate Mauro. The scores are preserved at Buckingham palace, where, in company with five volumes of songs and three of duets, they form part of the collection brought to England by the elector of Hanover in 1714. But it was not only as a musician that Steffani distinguished himself in his new home. The elevation of Ernest Augustus to the electorate in 1692 led to difficulties, for the arrangement of which it was necessary that an ambassador should visit the various German courts, armed with a considerable amount of diplomatic power. The accomplished abbate was sent on this delicate mission in 1696, with the title of envoy extraordinary; and he fulfilled his difficult task so well that Pope Innocent XI., in recognition of certain privileges he had secured for the Hanoverian Catholics, consecrated him bishop of Spiga *in partibus infidelium*. In 1698 he was sent as ambassador to Brussels; and after the death of Ernest Augustus in the same year he entered the service of the elector palatine, John William, at Düsseldorf, where he held the offices of privy councillor and protonotary of the holy see. Invested with these high honors, Steffani could scarcely continue to produce dramatic compositions in public without grievous breach of etiquette. But his genius was too real to submit to repression; and in 1709 he ingeniously avoided the difficulty by producing two new operas—*Enea* at Hanover and *Tassilone* at Düsseldorf—in the name of his secretary and amanuensis Gregorio Piva, whose signature is attached to the scores preserved at Buckingham palace. Another score—that of *Arminio*—in the same collection, dated Düsseldorf, 1707, and evidently the work of Steffani, bears no composer's name.

Steffani did not accompany the elector George to England; but in 1724 the Academy of Antient Musick in London elected him its honorary president for life; and in return for the compliment he sent the association a magnificent *Stabat Mater*, for six voices and orchestra, and three fine madrigals. The MSS. of these are still in existence; and the British Museum possesses a very fine *Confitebor*, for three voices and orchestra, of about the same period. All these compositions are very much in advance of the age in which they were written; and in his operas Steffani shows an appreciation of the demands of the stage very remarkable indeed at a period at which the musical drama was gradually approaching the character of a mere formal concert, with scenery and dresses. But for the MSS. at Buckingham palace, these operas would be utterly unknown; but Steffani will never cease to be remembered by his beautiful chamber duets, which, like those of his contemporary Carlo Maria Clari (1669–1745), are chiefly written in the form of cantatas for two voices, accompanied by a figured bass. The British Museum possesses more than a hundred of these charming compositions,[1] some of which were published at Munich in 1679. Steffani visited Italy for the last time in 1729, in which year Handel, who always gratefully remembered the kindness he had received from him at Hanover, once more met him at the palace of Cardinal Ottoboni in Rome. This was the last time the two composers were destined to meet. Steffani returned soon afterwards to Hanover, and died in 1730 while engaged in the transaction of some diplomatic business at Frankfort.

STEIBELT, Daniel (*c.* 1760–1823), pianist and composer, was born between the years 1755 and 1765, at Berlin, where he studied at the expense of the crown prince Frederick William, under Kirnberger. Very little is known of his artistic life before 1790, when he settled in Paris, and attained great popularity as a *virtuoso* by means of a pianoforte sonata called *La Coquette*, which he composed, in conjunction with Hermann, for Queen Marie Antoinette, and almost equal credit as a dramatic composer by an opera entitled *Romeo et Juliette*, produced at the Théâtre Feydeau in 1793. In 1796 Steibelt removed to London, where his pianoforte playing attracted an amount of attention which in 1798 was raised to an absolute *furore* by the production of his concerto (No. 3 in E♭) containing the famous "Storm Rondo,"—a work that insured his popularity, in spite of the far higher claims of Clementi, Dussek, and John Baptist Cramer, whose attainments as *virtuosi*, composers, and thoroughly accomplished artists were infinitely superior to his own. In the following year Steibelt started on a professional tour in Germany; and, after playing with some success in Hamburg, Dresden, Prague, and Berlin, he arrived May, 1800, at Vienna, where with the arrogance which formed one of the most prominent characteristics of his nature, he challenged Beethoven to a trial of skill, which naturally resulted in his irretrievable discomfiture. His position in Germany being no longer tenable after this pitiful failure, he retired to Paris, and during the next eight years lived alternately in that city and in London, where his reputation continued undiminished. In 1808 he was invited by the Emperor Alexander to St. Petersburg, and there he resided in the enjoyment of a lucrative appointment until his death on September 20, 1823.

Besides his dramatic music, Steibelt left behind him an enormous number of compositions for the pianoforte, many of which exhibit a certain amount of originality, though they can scarcely be regarded as works of genius. His playing, though exceedingly brilliant, was wanting in the higher qualities which so strikingly characterized that of his contemporaries, John Cramer and Muzio Clementi; but he was undoubtedly gifted with talents of a very high order, and the reputation he enjoyed was fairly earned and honorably maintained to the end.

STEIN, Heinrich Friedrich Karl, Baron vom und zum (1757–1831), one of the greatest of German statesmen, and perhaps the most influential forerunner of Bismarck in the creation of German unity, was born at Nassau, on October 26, 1757. He was a member of the independent noblesse or knighthood of the German empire (Reichsritterschaft), and his ancient family seat, Burg Stein, lies on a hill rising above the Lahn, opposite Nassau. In his autobiography he speaks of his parents as "pious and genuinely German," and ascribes to their teaching his own religious and patriotic feelings, his sense of the dignity of his family and order, and his conviction of the duty of devoting his life to the public weal. Though the youngest but one of ten children, Stein was selected by his parents as the "Stammhalter," or representative and maintainer of the family name and dignity, and his elder brothers acquiesced in this arrangement.

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[1] Add. MSS. 5055 *sq.*

From 1773 to 1777 Stein studied political economy, jurisprudence, and history, at the university of Göttingen, where he made his first acquaintance with English institutions, his knowledge and appreciation of which are often manifest in his later career. His original intention was to qualify for an appointment in the imperial courts, but this sphere of work was little to his taste, and in 1780 he took the step, somewhat unusual for an imperial knight, of entering the service of Prussia. He became an official in the mining department, and by 1784 had risen to be head of the administration of mines and manufactures for Westphalia. In 1796 he was made supreme president of the provincial chambers of Westphalia, an appointment which gave him opportunity to evince his great administrative talents. In 1785 his administrative career was interrupted for a short time by a diplomatic mission to the elector of Mainz, and in 1786–87 he made a long professional tour in England, chiefly in the mining districts.

In 1804 Stein was created a minister of state, with the portfolio of excise, customs, manufactures, and trade. In this capacity he abolished the internal customs duties throughout Prussia, and effected several other needed reforms; but he was unable to modify the general disastrous tenor of the Prussian policy, which was now ripening for the catastrophe of Jena. Stein's remonstrances with the king and his strictures upon the course of the administration were couched in the most open and unsparing language, and they were specially directed against the system of government through privy cabinet counsellors, who had practically come to supplant the ministers without possessing either an official knowledge of affairs or a ministerial responsibility. He refused to join in the reconstituted ministry after Jena unless this abuse were done away with, and Frederick William III., already wounded by the frankness of Stein's criticisms, sent him his dismissal in a most ungracious form (January 3, 1807). When the king, however, found himself left in the lurch by his ally, Russia, at the peace of Tilsit (July 9, 1807), he turned in despair to the strong and candid counsellor he had dismissed half a year before, and invited Stein to re-enter his service, practically on his own terms. Curiously enough, Stein's appointment as minister president was encouraged by Napoleon, who seems to have seen in him merely the clever organizer and financier, who would most easily put Prussia in a position to pay the enormous war indemnity levied on it. Stein took office on October 4, 1807, and at once began that weighty series of organic reforms with which his name is most indissolubly connected. The emancipation edict appeared on October 9, 1807, a few days after the formal receipt of his powers, and the municipal ordinance was published on November 19, 1808. In the interim he co-operated zealously with Scharnhorst in the reconstitution of the army, carried out a number of important financial and administrative reforms, and prepared the way for a thorough reconstruction of the whole framework of government, which, however, he himself was not to have an opportunity to effect.

Stein's momentous ministry did not last much more than a year. Napoleon soon awoke to the eminently patriotic and energetic character of the man he had incautiously recommended, and an intercepted letter gave him the opportunity to demand Stein's dismissal. Frederick William had no option but to comply, as he shrank from the only possible alternative of an open breach with the French emperor. Stein was proscribed by Napoleon, his property in Westphalia was confiscated, and he himself had to take refuge in Austria from the French troops.[1]

In 1812 the czar Alexander invited Stein to St. Petersburg, where he filled the post of unofficial adviser to his imperial majesty on German or rather on anti-Napoleonic affairs; and it would perhaps be difficult to overestimate the influence of the proximity of such a man in keeping Alexander's courage screwed to the sticking-point. When the scene of the campaign of 1812 was transferred to Germany, Stein was intrusted with the administration of the Prussian districts occupied by the Russian troops, and he shares with Yorck the merit of arousing East Prussia to take arms against the French, and so of calling the "Landwehr" into existence for the first time. To Stein also mainly belongs the credit of effecting that union of Russia and Prussia (treaty of Kalisch, February 27, 1813) which was perhaps the main factor in the overthrow of Napoleon. After the battle of Leipsic Stein became supreme president of a central commission appointed to administer the lands occupied by the allied armies, in which post he was indefatigable in providing the men and material necessary for a successful prosecution of the war. When the military struggle was over Stein's work was practically done. The two tendencies of absolutism on the one hand and particularism on the other which determined the tone of the Vienna congress were equally repugnant to him, and he took little part in its deliberations. He also refused the invitations of Austria and Prussia to represent them at the Frankfort diet, a makeshift in which he had no confidence or hope. The rest of his life he spent in retirement, sharing his time between Frankfort and his property in Westphalia, and the only office he ever again filled was that of marshal of the provincial estates. In 1819 he founded the society for the publication of the *Monumenta Germaniæ Historica*, which has since done such admirable work. He died on June 29, 1831, in his seventy-fourth year, on his estate of Cappenberg in Westphalia, leaving a family of three daughters. His wife was Countess von Walmoden-Gimborn of Hanover, a granddaughter of George II.

Stein's distinguishing merit as a statesman is that he was practically the first to see the urgent necessity of German unity, to contemplate its realization as possible, and to inaugurate a policy likely to bring it about. That which, now that it has been accomplished by Stein's great successor, seems to us almost a matter of course, was a mere chimera to most of our forefathers, and it required the faculty of a political seer to attain Stein's clear views of future possibilities. Stein saw, too, that the only hope of salvation lay in the people as such,—that he must enlist the sympathies of the nation and raise its moral tone. To this end a series of great and just reforms was necessary. If a deep national sentiment was to be evoked, the people must be freed from feudal burdens; if they were to carry on an effective struggle for independence, they must first acquire personal liberty. His emancipation edict, therefore, which has been called the habeas corpus act of Prussia, abolished serfdom, did away with the distinctions of caste, and abrogated the feudal restrictions upon the free disposition of person and property (compare PRUSSIA, vol. xx. p. 15). This reform, however, Stein found, in a sense, ready to his hand; it was demanded by the spirit of the times, and can hardly be looked on as a purely individual achievement. His most distinctive work was a great scheme of political reform, in which he contemplated the conversion of the absolute monarchy of Prussia into a free representative state. He wisely began the process by introducing the principle of free local government in his Städte-Ordnung, or municipal ordinance. The people had to be roused to take an interest in governing themselves, and it was easier to expand this interest from the local to the national than to work down from the national to the local. Stein did not see much more than this beginning of his plans, but the famous "Political Testament" he drew up on leaving office shows how wide-sweeping were the reforms he contemplated. The right of self-government was to be extended to the rural communes, and a thorough reform of every branch of the administration was to be effected, while the coping-stone of the new edifice was to take the form of a free representative parliament. Time, however, has been on his side, and it is not too much to say with Prof. Von Treitschke that every advance Germany has since made in political life has brought it nearer the ideals of Stein.

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[1] The belief that Stein occupied himself during his retirement in propagating his opinions through the "Tugendbund" seems from recent investigations to be erroneous. He had no sympathy with secret societies, and all indications go to show that he rather disapproved of the league than otherwise.

The standard work on Stein is the biography by G. H. Pertz, 6 vols., 1849–55, but few English readers will feel the need of going beyond Prof. Seeley's admirable *Life and Times of Stein*, London, 1879, which also contains a full bibliography. (J. F. M.)

STEINAMANGER (Hung. *Szombathely;* Lat. *Sabaria*), the chief town of the trans-Danubian county of Vas, Hungary, is an old place of some interest. Though it has only 12,000 inhabitants, it is the seat of a Roman Catholic bishop, and has a Dominican convent, a seminary, gymnasium, chamber of advocates, large orphanage, fine theatre, and a number of superior Government offices. The interior of the cathedral is of great beauty, in the Italian style. The town is at the junction of four different railways, and is rapidly rising in importance.

STEINER, Jakob (1796–1863), one of the greatest geometricians of all ages, was born on the 18th of March, 1796, at the Swiss village of Utzendorf (canton Bern). Here he grew up helping his father in his agricultural pursuits, learning to write only at the age of fourteen. At eighteen he became a pupil of Pestalozzi, and afterwards studied at Heidelberg. Thence he went to Berlin, earning a livelihood here as in Heidelberg by giving private lessons. Here he became acquainted with Crelle, who, encouraged by his ability and by that of Abel, then also staying at Berlin, founded his famous *Journal* (1826). After Steiner's publication (1832) of his *Systematische Entwickelungen* he got, through Jacobi's exertions, who was then professor at Königsberg, an honorary degree of that university; and through the influence of Jacobi and of the brothers Alexander and Wilhelm von Humboldt a new chair of geometry was founded for him at Berlin (1834). This he occupied till his death, which took place in Bern on April 1, 1863, after years of bad health.

Steiner's mathematical work was confined to geometry. This he treated synthetically, to the total exclusion of analysis, which he hated, and he is said to have considered it a disgrace to synthetical geometry if equal or higher results were obtained by analytical methods. In his own field he surpassed all his contemporaries. His investigations are distinguished by their great generality, by the fertility of his resources, and by a rigor in his proofs which rivals that of the ancients, so that he has been considered the greatest geometrical genius since the time of Apollonius.

In his *Systematische Entwickelung der Abhängigkeit geometrischer Gestalten von einander* he laid the foundation on which synthetic geometry in its present form rests. He introduces what are now called the geometrical forms (the row, flat pencil, etc.), and establishes between their elements a one-one correspondence, or, as he calls it, makes them projective. He next gives by aid of these projective rows and pencils a new generation of conics and ruled quadric surfaces, "which leads quicker and more directly than former methods into the inner nature of conics and reveals to us the organic connection of their innumerable properties and mysteries." In this work also, of which unfortunately only one volume appeared instead of the projected five, we see for the first time the principle of duality introduced from the very beginning as an immediate outflow of the most fundamental properties of the plane, the line, and the point, so that a proof of its correctness is not required.

In a second little volume, *Die geometrischen Constructionen ausgeführt mittelst der geraden Linie und eines festen Kreises* (1833), he shows, what had been already suggested by Poncelet, how all problems of the second order can be solved by aid of the straight-edge alone without the use of compasses, as soon as one circle is given on the drawing paper.

The rest of Steiner's writings are found in numerous papers mostly published in *Crelle's Journal*, the first volume of which contains his first four papers. The most important are those relating to algebraical curves and surfaces, especially the short paper *Allgemeine Eigenschaften algebraischer Curven.* This contains only results, and there is no indication of the method by which they were obtained, so that, according to Hesse, "they are, like Fermat's theorems, riddles to the present and future generations." Eminent analysts succeeded in proving some of the theorems, but it was reserved to Cremona to prove them all, and that by a uniform synthetic method, in his book on algebraical curves. Other important investigations relate to maxima and minima. Starting from simple elementary propositions, Steiner advances to the solution of problems which analytically require the calculus of variation, but which at the time altogether surpassed the powers of that calculus. Connected with this is the paper *Vom Krümmingsschwerpuncte ebener Curven*, which contains numerous properties of pedals and roulettes, especially of their areas.

Steiner's papers have been collected and published in two volumes by the Berlin Academy. His lectures on synthetic geometry, containing the theory of conics, have been published since his death, edited by Geiser and Schröter. Biographical notices are contained in Geiser's pamphlet *Zur Erinnerung an J. Steiner* (Schaffhausen), 1874.

STENDAL, a manufacturing town and important railway junction in Prussian Saxony, and the former capital of the Altmark, is picturesquely situated on the Uchte, 33 miles to the northeast of Magdeburg. Among the relics of its former importance are the cathedral, built in 1420–24 (though originally founded in 1188) and restored in 1857, the Gothic church of St. Mary, founded in 1447, a "Roland column" of 1535, and two fortified gateways, dating from the 13th century. The last form the chief remains of the ancient fortifications, the site of which is now mostly occupied by promenades. A monument to the archæologist Winckelmann (1717–68) commemorates his birth in the town. Stendal is the seat of a large railway workshop, and carries on various branches of textile industry, besides the manufacture of tobacco, machinery, stoves, gold-leaf, etc. The earliest printing-press in the Altmark was erected here, and published an edition of the *Sachsenspiegel* in 1488 as its first book. The population in 1885 was 16,186.

Stendal was founded in 1151 by Albert the Bear, on the site of a Wendish settlement, and soon afterwards acquired a municipal charter. Becoming capital of the Altmark and a frequent imperial residence, it rose to a considerable degree of prosperity, in part recently restored to it by its railway connections. When the mark was divided in 1258, Stendal became the seat of the elder or Stendal branch of the house of Ascania, which, however, became extinct in 1320. The original Wends were gradually fused with the later Saxons, although the Platea Slavonica, mentioned in 1475, was still distinguished as the Wenden Strasse in 1567. The population still exhibits a marked Slavonic element.

STENOGRAPHY. See Shorthand.

STEPHANUS BYZANTIUS, the author of a geographical dictionary entitled 'Εθνικά, of which, apart from some fragments, we possess only the beggarly epitome of one Hermolaus. This work was first edited under the title Περὶ πόλεων (Aldus, Venice, 1502); there are modern editions by Dindorf (1825), Westermann (1839), and Meineke (vol. i., 1850). Even in the imperfect form in which we have it the book is of great value from the references to ancient writers which it preserves. Hermolaus dedicates his epitome to Justinian; whether the first or second emperor of that name is meant is disputed, but it seems probable that Stephanus flourished in the earlier part of the 6th century.

STEPHEN, St., described in late MSS. of Acts xxii. 20 and in subsequent ecclesiastical tradition as *πρωτόμαρτυς*, was one of the first seven deacons who were chosen by the church in Jerusalem at the instance of the apostles. He is spoken of as "a man full of faith and the Holy Spirit," and, though his official function was rather the "serving of tables" than the ministry of the word, the narrative of the book of Acts shows him to have been principally and pre-eminently a preacher. After a brief period of popularity he was accused before the sanhedrin as a blasphemer, and, without being allowed to finish his speech in his own defence, he was hurried without the city walls and stoned to death (*c.* 37 A.D.). "Devout men"—an expression apparently used to denote the uncircumcised adherents of the synagogue (see Acts x. 2)—buried Stephen and made great lamentation over him. His martyrdom is commemorated in the Latin Church on December 26 and in the Greek on December 27.

Ecclesiastical tradition tells that in the year 415 his remains were discovered by Lucian, priest of Caphar-Gamala near Jerusalem; after being deposited for some time in Jerusalem, they were removed by the younger Theodosius to Constantinople, and thence by Pope Pelagius to Rome. Some relics of Stephen were also brought from Palestine to the West by Orosius. Their discovery is commemorated on August 3.

The ministry and martyrdom of Stephen marked a great crisis in the history of the relations of the Christian church to the Gentile world. At first, we are informed, the early disciples, numbering three thousand souls, "had favor with all the people" (Acts ii. 47), who protected them against the rulers, elders, and scribes; "for all men glorified God for that which was done" (Acts iv. 21), and the people "magnified" the apostles (v. 13). It was this great popularity of the disciples of Jesus in Jerusalem that led to the ordination of the deacons. Soon a great revulsion of feeling took place. Stephen, "full of grace and power," had wrought "great wonders and signs among the people" (vi. 8); then suddenly arose "certain of the synagogue," disputing with Stephen, and were "unable to withstand the wisdom and spirit by which he spoke." What was the new and offensive element introduced by Stephen into the apostolic preaching? The accusations against him, and his speech in his own defence, alike show that he was the first to realize with any clearness the greatness of the Christian revolution,—the incompatibility of the Mosaic institutions with the spirituality and freeness of the gospel and with its destiny to become a message of salvation for the whole world. The entire drift of his speech is to show the progressive character of revelation, and to show that, as God had often manifested Himself apart from the forms of the law and the synagogue, these could not be held to be of the essence of religion. The seed of much that is most distinctive of the Pauline epistles was sown by the preaching of Stephen.

STEPHEN I., bishop of Rome from about 254 to 257, followed Lucius I. He withdrew from church fellowship with Cyprian and certain Asiatic bishops on account of their views as to the necessity of rebaptizing heretics (Euseb., *H. E.*, vii. 5; Cypr., *Epp.*, 75). He is also mentioned as having insisted on the restoration of the bishops of Leon and Astorga, who had been deposed for unfaithfulness during persecution but afterwards had repented. He is commemorated on August 2. His successor was Sixtus II.

STEPHEN II., pope from March, 752, to April, 757, was in deacon's orders when chosen to the vacant see within twelve days after the death of Zacharias.[1] The main difficulty of his pontificate was in connection with the aggressive attitude of Aistulf, king of the Lombards. After unsuccessful embassies to Aistulf himself and appeals to the emperor Constantine, he, though in feeble health, set out to seek the aid of Pippin, by whom he was received in the neighborhood of Vitry le Brulé in the beginning of 754. He spent the greater part of that year at St. Denis. The result of his negotiations was the Frankish invasion of Aistulf's territory and the famous "donation" of Pippin (see POPEDOM, vol. xix. p. 509; and compare FRANCE, vol. ix. p. 469). The death of Stephen took place not long after that of Aistulf. He was succeeded by Paul I.

STEPHEN III., pope from August 1, 768, to January 24, 772, was a native of Sicily, and, having come to Rome during the pontificate of Gregory III., gradually rose to high office in the service of successive popes. On the deposition of Constantine II., Stephen was chosen to succeed him. Fragmentary records are preserved of the council (April, 769), at which the degradation of Constantine was completed, certain new arrangements for papal elections made, and the practice of image-worship confirmed. The politics of Stephen's reign are obscure, but he inclined to the Lombard rather than to the Frankish alliance. He was succeeded by Adrian I.

STEPHEN IV., pope from June, 816, to January, 817, succeeded Leo III., whose policy he continued. Immediately after his consecration he ordered the Roman people to swear fidelity to Louis the Pious, to whom he found it prudent to betake himself personally in the following August. After the coronation of Louis at Rheims in October he returned to Rome, where he died in the beginning of the following year. His successor was Paschal I.

STEPHEN V., pope from 885 to 891, succeeded Adrian III., and was in turn succeeded by Formosus. In his dealings with Constantinople in the matter of Photius, as also in his relations with the young Slavonic church, he pursued the policy of Nicholas I. His pontificate was otherwise unimportant.

STEPHEN VI., pope from May, 896, to July-August, 897, succeeded Boniface VI., and was in turn followed by Romanus. He is remembered only in connection with his conduct towards the remains of Formosus, his last predecessor but one (see FORMOSUS). It excited a tumult, which ended in his imprisonment and his death by strangling.

STEPHEN VII. (February, 929, to March, 931), and STEPHEN VIII. (July, 939, to October, 942), were virtually nonentities, who held the pontificate during the so-called "pornocracy" of Theodora and Marozia (see ROME, vol. xx. p. 805).

STEPHEN IX., pope from August, 1057, to March, 1058, succeeded Victor II. (Gebhard of Eichstädt). His baptismal name was Frederick, and he was a younger brother of Godfrey, duke of Upper Lorraine, who, as marquis of Tuscany (by his marriage with Beatrice, widow of Boniface, marquis of Tuscany), played a prominent part in the politics of the period. Frederick, who had been raised to the cardinalate by Leo IX., discharged for some time the functions of papal legate at Constantinople, and was with Leo in his unlucky expedition against the Normans. He shared the vicissitudes of his brother's fortunes, and at one time had to take refuge from Henry III. in Monte Cassino. Five days after the death of Victor II. (who had made him cardinal-priest and abbot of Monte Cassino), he was chosen to succeed him. He showed great zeal in enforcing the Hildebrandine policy as to clerical celibacy, and was planning large schemes for the expulsion of the Normans from Italy, and the elevation of his brother to the imperial throne, when he was seized by a severe illness, from which he only partially and temporarily recovered. He died at Florence, March 29, 1058, and was succeeded by Benedict X.

STEPHEN (1105–1154), king of England, the second son of Stephen, earl of Blois, and Adela, daughter of William the Conqueror, was born at Blois in 1105. He obtained the county of Mortain by the gift of his uncle Henry I. and that of Boulogne by marriage with Maud, daughter of Count Eustace. As one of the chief barons of Normandy he had sworn to aid in securing the succession to the crown of England for his cousin the empress Matilda, and her infant son, afterwards Henry II. Nevertheless, on the death of Henry I. in 1135, Stephen at once crossed over to England, and was welcomed by the citizens of London as king. Aided by his brother Henry, bishop of Winchester, and the justiciar, Bishop Roger of Salisbury, he made himself master of the royal treasure, and was formally elected and crowned on St. Stephen's day, December 26, 1135. In a brief charter issued at the time of his coronation he promised to observe the laws and liberties of the land. A fuller charter, the second of our great charters of liberties, was issued early in 1136. In this document, which was based on that of Henry I., each of the three estates came in for its share of promises, but the leading position of the church and the importance of the aid which it gave the king are shown by the predominant attention paid to ecclesiastical privileges. So far all seemed going well, but the troubles of the reign soon began. A false report of Stephen's death in the summer of 1136 caused revolts to break out in the east and west of England. Roger Bigot seized Norwich, and Baldwin of Redvers occupied Exeter. Stephen, who possessed considerable military skill, speedily put down these rebellions, but the outbreak showed the lightness of the feudal bond and the defectiveness of Stephen's title. In 1137 he crossed over into Normandy to defend his dominions there from Geoffrey of Anjou, and was successful enough to make a satisfactory peace, but he returned to find England aflame. A mysterious conspiracy was hatched in the diocese of Ely, where the fenlands may have still concealed some remnants of the opposition to Stephen's grandfather. David, king of Scotland, who had already taken up arms on behalf of his niece Matilda, but had been bought off by the surrender of Carlisle, marched an army into England and advanced as far as Yorkshire. Robert, earl of Gloucester, the strongest of the English nobles, raised the standard of rebellion at Bristol. Against these numerous enemies Stephen contrived at first to make head. The conspiracy at Ely was nipped in the bud; the Scotch invasion was checked in the battle of the Standard, near Northallerton, in 1138, and even against Robert of Gloucester Stephen won some success. But his own weakness and folly proved his ruin. In order to conciliate the barons who remained true to him, he allowed them to build castles, each of which became a centre of petty but intolerable tyranny. Instead of relying on the support of his English subjects, Stephen surrounded himself with a body of foreign mercenaries, who pillaged all alike. He granted earldoms at random, thereby splitting up the royal authority and diminishing the royal revenues. Lastly,—and this was the worst mistake of all,—he broke with the church, and especially with the great family of Bishop Roger, who had the administrative machinery in their hands. On the ground that they had no right to fortify their castles he arrested the bishops of Lincoln and Salisbury, together with Roger the chancellor, son of the latter. He thus enforced the surrender of the castles, but the church, with the new archbishop, Theobald, and Stephen's brother, Henry of Winchester, now legate, at its head, declared against him. Henry called a council, laid formal charges against the king, and threatened to appeal to Rome. In the midst of this crisis Matilda and her half-brother, Robert of Gloucester, landed in the south of England, and a civil war began. From this time forward, for fourteen dismal years, the land knew no peace. It is needless to go into details. Neither party was strong enough to deal a final blow at the other. The nobility changed sides as they pleased, fighting generally for their own interests or for plunder; bands of freebooters wandered up and down the country; upwards of a thousand castles, each of which was a den of robbers, were erected; the church found threats and persuasion equally ineffective to restore peace and order. "Men said openly," we are told by the chronicler, "that Christ and His saints slept." At the battle of Lincoln in 1141 Stephen was taken prisoner. After this Matilda was elected queen, but she soon forfeited the allegiance of her supporters. The Londoners revolted, the empress fled to Oxford, and the earl of Gloucester was taken prisoner. He was exchanged for Stephen, and matters went on as before. About 1147 there came a change. Matilda left the country, and her son Henry took the lead. His predominance was further secured by the death of Robert of Gloucester in 1148. Three years later Henry became count of Anjou on the death of his father, while his marriage with Eleanor of Aquitaine made him one of the most powerful princes in Europe. This great accession of strength enabled him to meet Stephen on more than equal terms, and Stephen on the death of his son Eustace was more inclined to peace. In November, 1153, the treaty of Wallingford brought the long struggle to an end. It was agreed that Stephen should reign till his death, and that Henry should succeed him. A scheme of reform was drawn up, which Stephen endeavored, during the short remainder of his reign, to carry out. He died on October 25, 1154. A brave man, a good soldier, merciful and generous, but devoid of moral strength and political insight, he was utterly incapable to discharge a task which demanded all the skill and energy of his great successor. His nominal reign was a period of anarchy in English history, important only as a full justification for the tyrannies of Henry I. and Henry II.

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[1] Zacharias died March 15, 752, and a presbyter named Stephen was forthwith chosen to succeed him, who, however, died four days afterwards and before consecration. This Stephen is occasionally called Stephen II., the number of popes of the name being thus raised to ten.

Authorities.—Ordericus Vitalis, ed. Le Prévost; William of Malmesbury, ed. Hamilton (Rolls Series); *Gesta Stephani*, ed. Sewell (Engl. Hist. Soc.); Gervase of Canterbury, ed. Stubbs (Rolls Series); Henry of Huntingdon, ed. Arnold (Rolls Series); *English Chronicle*, ed. Thorpe (Rolls Series); Freeman, *Norman Conquest*, vol. v.; Lappenberg, *Gesch. Englands*, vol. iii. (G. W. P.)

STEPHEN, Sir James (1789–1859), historian, was the son of James Stephen, master in chancery, author of *The Slavery of the West India Colonies* and other works, and was born in London 3d January, 1789. He was educated at Trinity Hall, Cambridge, graduating B.A. in 1812, after which he studied for the bar and was called at Lincoln's Inn. He obtained an extensive practice as a chancery barrister, being ultimately counsel to the colonial department and counsel to the Board of Trade. In 1834 he became assistant under-secretary for the colonies, and shortly afterwards permanent under-secretary. On his retirement in 1847 he was made a knight commander of the Bath. In 1849 he was appointed regius professor of modern history in the university of Cambridge, having already distinguished himself by his brilliant studies in ecclesiastical biography contributed to the *Edinburgh Review*, which were published that year under the title *Essays in Ecclesiastical Biography and Other Subjects*; a 4th edition, with a short memoir, appeared in 1860. He was also the author of *Lectures on the History of France*, 2 vols., 1851, 3d ed. 1857, and *Desultory and Systematic Reading*, a lecture, 1853. He died at Coblentz on the 15th of September, 1859.

STEPHENS, the incorrect English form of the name of *Estienne*, the distinguished French family of scholars and printers.

The founder of the race was Henri Estienne (d. 1520), the scion of a noble family of Provence, who came to Paris in 1502, and soon afterwards set up a printing establishment at the top of the Rue St. Jean de Beauvais, on the hill of Sainte-Geneviève opposite the law school. He died in 1520, and, his three sons being minors, the business was carried on by his foreman Simon de Colines, who in 1521 married his widow.

Robert Estienne (1503–1559) was Henri's second son. After his father's death he acted as assistant to his step-father, and in this capacity superintended the printing of a Latin edition of the New Testament in 16mo. (1523). Some slight alterations which he had introduced into the text brought upon him the censures of the faculty of theology. It was the first of a long series of disputes between him and that body. It appears that he had intimate relations with the new Evangelical preachers almost from the beginning of the movement, and that soon after this time he definitely joined the Reformed Church. In 1526 he entered into possession of his father's printing establishment, and adopted as his device the celebrated olive-tree (a reminiscence doubtless of his grandmother's family of Montolivet), with the motto from the epistle to the Romans (xi. 20), *Noli altum sapere*, sometimes with the addition *sed time*. In 1528 he married Perrette, a daughter of the scholar and printer Josse Bade (Jodocus Badius), and in the same year he published his first Latin Bible, an edition in folio, upon which he had been at work for the last four years. In 1532 appeared his *Thesaurus Linguæ Latinæ*, a dictionary of Latin words and phrases, upon which for two years he had toiled incessantly, with no other assistance than that of Thierry of Beauvais. A second edition, greatly enlarged and improved, appeared in 1536, and a third, still further improved, in 3 vols. folio, in 1543. Though the *Thesaurus* is now superseded, its merits must not be forgotten. It was vastly superior to anything of the kind that had appeared before; it formed the basis of future labors, and even as late as 1734 was considered worthy of being re-edited. In 1539 Robert was appointed king's printer for Hebrew and Latin, an office to which, after the death of Conrad Neobar in 1540, he united that of king's printer for Greek. In 1541 he was intrusted by Francis I. with the task of procuring from Claude Garamond, the engraver and type-founder, three sets of Greek type for the royal press. The middle size were the first ready, and with these Robert printed the *editio princeps* of the *Ecclesiasticæ Historiæ* of Eusebius and others (1544). The smallest size were first used for the 16mo. edition of the New Testament known as the *O mirificam* (1546), while with the largest size was printed the magnificent folio of 1550. This edition involved the printer in fresh disputes with the faculty of theology, and towards the end of the following year he left his native town forever, and took refuge at Geneva, where he published in 1552 a caustic and effective answer to his persecutors, under the title *Ad Censuras Theologorum Parisiensium, quibus Biblia a R. Stephano, Typographo Regio, excusa calumniose notarunt, eiusdem R. S. Responsio.* A French translation, which is remarkable for the excellence of its style, was published by him in the same year (printed in Rénouard's *Annales de l'Imprimerie des Estienne*). At Geneva Robert proved himself an ardent partisan of Calvin, several of whose works he published. He died there September 7, 1559.

It is by his work in connection with the Bible, and especially as an editor of the New Testament, that he is on the whole best known. The text of his New Testament of 1550, either in its original form or in such slightly modified form as it assumed in the Elzevir text of 1634, remains to this day the traditional text. But, as modern scholars have pointed out, this is due rather to its typographical beauty than to any critical merit. The readings of the fifteen MSS. which Robert's son Henri had collated for the purpose were merely introduced into the margin. The text was still almost exactly that of Erasmus. It was, however, the first edition ever published with a critical apparatus of any sort. Of the whole Bible Robert printed eleven editions,—eight in Latin, two in Hebrew, and one in French; while of the New Testament alone he printed twelve,—five in Greek, five in Latin, and two in French. In the Greek New Testament of 1551 (printed at Geneva) the present division into verses was introduced for the first time. The *editiones principes* which issued from Robert's press were eight in number, viz., *Eusebius*, including the *Præparatio Evangelica* and the *Demonstratio Evangelica* as well as the *Historia Ecclesiastica* already mentioned (1544–46), *Moschopulus* (1545), *Dionysius of Halicarnassus* (February, 1547), *Alexander Trallianus* (January, 1548), *Dio Cassius* (January, 1548), *Justin Martyr* (1551), *Xiphilinus* (1551), *Appian* (1551), the last being completed, after Robert's departure from Paris, by his brother Charles, and appearing under his name. These editions, all in folio, except the *Moschopulus*, which is in 4to, are unrivalled for beauty. Robert also printed numerous editions of Latin classics, of which perhaps the folio *Virgil* of 1532 is the most noteworthy, and a large quantity of Latin grammars and other educational works (many of them written by his friend Maturin Cordier) in the interests of that cause of which he proved himself so stout a champion,—the new learning.

CHARLES ESTIENNE (1504 or 1505–1564), the third son of Henri, was, like his brother Robert, a man of considerable learning. After the usual humanistic training he studied medicine, and became a doctor of that faculty in the university of Paris. In 1540 he accompanied the French ambassador Lazare Baif to Italy in the capacity of tutor to his natural son Antoine, the future poet. In 1551, when Robert Estienne left Paris for Geneva, Charles, who had remained a Catholic, took charge of his printing establishment, and in the same year was appointed king's printer. He died in 1564, according to some accounts in prison, having been thrown there for debt.

His principal works are *Prædium Rusticum*, a collection of tracts which he had compiled from ancient writers on various branches of agriculture, and which continued to be a favorite book down to the end of the 17th century; *Dictionarium Historicum ac Poeticum* (1553), the first French encyclopædia; *Thesaurus Ciceronianus;* and *Paradoxes*, a free version of the *Paradossi* of Ortensio Laudi, with the omission of a few of the paradoxes and of the impious and indecent passages (Paris, 1553; Poitiers, 1553). He was also the author of a treatise on anatomy and of several small educational works.

HENRI ESTIENNE (1528–1598), sometimes called "Henri II.," was the eldest son of Robert. In the preface to his edition of Aulus Gellius (1585), addressed to his son Paul, he gives an interesting account of his father's household, in which, owing to the various nationalities of those who were employed on the press, Latin was used as a common language, being understood and spoken more or less by every member of it, down to the maid-servants. Henri thus picked up Latin as a child, but at his special request he was allowed to learn Greek as a serious study before Latin. At the age of fifteen he became a pupil of Pierre Danès, at that time the first Greek scholar in France. Two years later he began to attend the lectures of Jacques Toussain, one of the royal professors of Greek, and in the same year (1545) was employed by his father to collate a MS. of Dionysius of Halicarnassus. In 1547, after attending for a time the lectures of Turnèbe, Toussain's successor, he went to Italy, where he spent two years in hunting for and collating MSS. and in intercourse with learned men. In 1550 he was in England, where he was favorably received by Edward VI. Thence he went to Flanders, where he learnt Spanish. In 1551 he joined his father at Geneva, which henceforth became his home. In 1554 he gave to the world, as the firstfruits of his researches, two first editions, viz., a tract of Dionysius of Halicarnassus and *Anacreon*, both printed by his uncle Charles. In 1556 Henri was again in Italy, where he discovered at Rome ten new books (xi.–xx.) of Diodorus Siculus. In 1557 he issued from the press which in the previous year he had set up on his own account at Geneva three first editions, viz., *Athenagoras*, *Maximus Tyrius*, and some fragments of Greek historians, including Appian's 'Αννιβαλική and 'Ιβηρική, and an edition of *Æschylus*, in which for the first time the *Agamemnon* was printed in entirety and as a separate play. In 1558 he was appointed printer to Huldrich Fugger, one of the celebrated family of Augsburg bankers, a post which he held for ten years. In 1559 he printed a Latin translation from his own pen of Sextus Empiricus, and an edition of Diodorus Siculus with the new books. In 1566 he published his best known French work, the *Apologie pour Hérodote*, or, as he himself called it, *L'Introduction au Traité de la Conformité des Merveilles Anciennes avec les Modernes ou Traité preparatif à l'Apologie pour Hérodote*. Some passages in the original edition being considered objectionable by the Geneva consistory, he was compelled to cancel the pages containing them. The book became highly popular. Within sixteen years twelve editions were printed. In 1572 Henri published the great work upon which he had been laboring for many years, the *Thesaurus Græcæ Linguæ*, in 5 vols. folio. The publication in 1578 of his *Dialogues du nouveau François Italianizé* brought him into a fresh dispute with the consistory. To avoid their censure he went to Paris, and resided at the French court for the whole of 1579. On his return to Geneva in the spring of 1580 he was summoned before the consistory, and, proving contumacious, was imprisoned for a week. From this time his life became more and more of a nomad one. He is to be found at Basel, Heidelberg, Vienna, Pesth, everywhere but at Geneva, these journeys being undertaken partly in the hope of procuring patrons and purchasers for his books (for the large sums which he had spent on such publications as the *Thesaurus* and the *Plato* of 1578 had almost ruined him), partly from the increasing restlessness of his disposition. But the result of these long absences was that his press stood nearly at a standstill. A few editions of classical authors were brought out, but each successive one showed a falling off. Such value as the later ones had was chiefly due to the notes furnished by Casaubon, who in 1586 had married Henri's daughter Florence. Henri's last years were marked by ever-increasing infirmity of mind and temper. In 1597 he left Geneva for the last time. After visiting Montpellier, where Casaubon was now professor he made for Paris, but was seized with sudden illness at Lyons, and died there in his seventieth year, at the end of January, 1598.

Few men have ever served the cause of learning more devotedly. For over thirty years the amount which he produced, whether as printer, editor, or original writer, was enormous. The productions of his press, though printed with the same beautiful type as his father's books, are, owing to the poorness of the paper and ink, inferior to them in general beauty. The best, perhaps, from a typographical point of view, are the *Poetæ Græci Principes* (folio, 1566), the *Plutarch* (13 vols. 8vo, 1572), and the *Plato* (3 vols. folio, 1573). It was rather Henri Estienne's scholarship which gave value to his editions. He was not only his own press-corrector but his own editor. Though by the latter half of the 16th century nearly all the important Greek and Latin authors that we now possess had been published, his untiring activity still found some gleanings. Eighteen first editions of Greek authors and one of a Latin author are due to his press. The most important have been already mentioned. Henri's reputation as a scholor and editor has increased of late years. His familiarity with the Greek language has always been admitted to have been quite exceptional; but he has been accused of want of taste and judgment, of carelessness and rashness. Special censure has been passed on his *Plütarch*, in which he is said to have introduced conjectures of his own into the text, while pretending to have derived them from MS. authority. But a recent editor, Sintenis, has shown that, though like all the other editors of his day he did not give references to his authorities, every one of his supposed conjectures can be traced to some MS. Whatever may be said as to his taste or his judgment, it seems that he was both careful and scrupulous, and that he only resorted to conjecture when authority failed him. And, whatever the merit of his conjectures, he was at any rate the first to shew what conjecture could do towards restoring a hopelessly corrupt passage. The work, however, on which his fame as a scholar is most surely based is the *Thesaurus Græcæ Linguæ*. After making due allowance for the fact that considerable materials for the work had been already collected by his father, and that he received considerable assistance from the German scholar Sylburg, he is still entitled to the very highest praise as the producer of a work which was of the greatest service to scholarship and which in those early days of Greek learning could have been produced by no one but a giant. Two editions of the *Thesaurus* have been published in this century—at London by Valpy (1815-25) and at Paris by Didot (1831-63). It was one of Henri Estienne's great merits that, unlike nearly all the French scholars who preceded him, he did not neglect his own language. While Budé wrote French with difficulty and considered it hardly a fit language for a scholar to use, Henri Estienne was loud in its praises and gave practical proof of its capabilities. Of his French writings three were devoted to this theme: (1) *Conformité du Langage François avec le Grec* (published in 1575, but without date; ed. L. Feugère, 1850), in which French is shown to have, among modern languages, the most affinity with Greek, the first of all languages; (2) *Deux Dialogues du nouveau François Italianizé* (Geneva, 1578; reprinted, 2 vols., 1883), directed against the fashion prevailing in the court of Catherine de' Medici of using Italian words and forms; (3) *Project du Livre Intitulé de la Precellence du Langage François* (Paris, 1579; ed. Feugère, 1853), which treats of the superiority of French to Italian. An interesting feature of this tract is the account of French proverbs, and, Henry III. having expressed some doubts as to the genuineness of some of them, Henri Estienne published, in 1594, (4) *Les Premices ou le I. livre des Proverbes Epigrammatizez* (never reprinted and very rare). Finally, there remains (5) the *Apologie pour Hérodote*, the work by virtue of which Henri Estienne belongs to literature. The ostensible object of the book is to show that the strange stories in Herodotus may be paralleled by equally strange ones of modern times. Virtually it is a bitter satire on the writer's age, especially on the Roman Church. Put together without any method, its extreme desultoriness makes it difficult to read continuously, but the numerous stories, collected partly from various literary sources, notably from the preachers Menot and Maillard, partly from the writer's own multifarious experience, with which it is packed, make it an interesting commentary on the manners and fashions of the time. But satire, to be effective, should be either humorous or righteously indignant, and, while such humor as there is in the *Apologie* is decidedly heavy, the writer's indignation is generally forgotten in his evident relish for scandal. The style is, after all, its chief merit. Though it bears evident traces of hurry, it is, like that of all Henri Estienne's French writings, clear, easy, and vigorous, uniting the directness and sensuousness of the older writers with a suppleness and logical precision which at this time were almost new elements in French prose. An edition of the *Apologie* has recently been published by Liseux (ed. Ristelhuber, 2 vols., 1879), after one of the only two copies of the original uncancelled edition that are known to exist. The very remarkable political pamphlet entitled *Discours Merveilleux de la Vie et des Déportements de Catherine de Médicis*, which appeared in 1574, has been ascribed to Henri Estienne, but the evidence both internal and external is conclusive against his being the author of it. Of his Latin writings the most worthy of notice are the *De Latinitate falso suspecta* (1576), the *Pseudo-Cicero* (1577), and the *Nizoliodidascalus* (1578), all three written against the Ciceronians, and the *Francofordiense Emporium* (1574), a panegyric on the Frankfort fair (reprinted with a French translation by Liseux, 1875). He also wrote a large quantity of indifferent Latin verses, including a long poem entitled *Musa Monitrix Principum* (Basel, 1590).

The primary authorities for an account of the Estiennes are their own works. In the garrulous and egotistical prefaces which Henri was in the habit of prefixing to his editions will be found many scattered biographical details. Twenty-seven letters from Henri to John of Craftheim (Crato) (ed. F. Passow, 1830) have been printed, and there is one of Robert's in Herminjard's *Correspondance des Réformateurs dans les Pays de Langue Française* (7 vols. published), while a few other contemporary references to him will be found in the same work. The secondary authorities are Janssen van Almeloveen, *De Vitis Stephanorum* (Amst., 1683); Maittaire, *Stephanorum Historia* (Lond., 1709); A. A. Rénouard, *Annales de l'Imprimerie des Estienne* (2d ed., Paris, 1843); the article on Estienne by A. F. Didot in the *Nouv. Biog. Gén.*; and an article by Mark Pattison in the *Quart. Rev.* for April, 1865. There is a good account of Henri's *Thesaurus* in the *Quart. Rev.* for January, 1820, written by Bishop Blomfield. (A. A. T.)

STEPHENS, ALEXANDER HAMILTON (1812–1883), American statesman, was born in Georgia, February 11, 1812. In spite of many difficulties imposed by poverty and ill-health, he became a lawyer and politician of great reputation and popularity. He was one of the Whig leaders of his State until about 1850, and then drifted into the Democratic party through the rising discussions of slavery, serving in Congress from 1843 until 1859. In 1860 he opposed secession warmly; but when his State had seceded he "followed his State," and was elected vice-president of the Confederate States. Whatever there was of opposition to the despotic tendencies of Jefferson Davis gathered around Stephens as a centre; and the vice-president was never an influential member of the Confederate administration. His popularity in Georgia was unbounded, and he was elected representative in Congress in 1877–82, and governor, 1882–83, dying in office. In person he was small and extremely emaciated, seldom weighing more than 90 pounds, and always in delicate health; but his powers as an orator were remarkable.[1]

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[1] [He graduated at Franklin College, Athens, in his own State. In 1836 he was sent to the State assembly, though opposed to the nullification views then prevailing in his district. In 1842 he was elected to the State Senate, and in the next year to Congress, after a spirited canvas, adhering to the Whigs so long as that party existed. Stephens favored the annexation of Texas, though opposed to the methods by which the Mexican war was provoked; he followed Douglass in the support of the Kansas-Nebraska bill of 1854, and resisted the Know-Nothing movement. The growth of disunion sentiment in the South seemed to leave no fitting place for Stephens in the political arena, and in 1859 he announced his determination to retire from public life. He had urged in vain that the South,

Cleveland's *A. H. Stephens in Public and Private* (1867) and Johnston and Browne's *Life of A. H. Stephens* (1880) are the main authorities for Stephens's life. His political opinions are fully given in his work, *The War between the States* (1868).

STEPHENS, JOHN LLOYD (1805–1852), traveller, was born 28th November, 1805, at Shrewsbury, N. J., United States. Having been admitted to the bar, he practiced his profession for about eight years in New York city. In 1834, the state of his health rendering it advisable that he should travel, he visited Europe, and for two years made a tour through many countries of that continent, extending his travels to Egypt and Syria. On his return to New York he published (under the name of "George" Stephens) in 1837 *Incidents of Travel in Egypt, Arabia Petræa, and the Holy Land.* This work was followed next year by the publication, also in two volumes, of *Incidents of Travel in Greece, Turkey, Russia, and Poland.* In 1839 Stephens arranged with Frederick Catherwood of London, who had accompanied him on some of his travels, and illustrated the above-mentioned publications, that they should make an exploration together in Central America, with a view to discovering and examining ancient art said to exist in the dense forests of that tropical region. Stephens, meantime, was appointed United States minister to Central America. The joint travels of Stephens and F. Catherwood occupied some eight months in 1839 and 1840.[1] As the result of these researches Stephens published in 1841 *Incidents of Travel in Central America, Chiapas, and Yucatan.* In the autumn of 1841 the two travellers made a second exploration of Yucatan, the fruits of which were gathered up in a work published by Stephens in 1843,—*Incidents of Travel in Yucatan.* This work describes the most extensive travels executed till that date by a stranger in the peninsula, and, as the author claims, "contains account of visits to forty-four ruined cities or places in which remains or vestiges of ancient populations were found." It fixed the sites of many prehistoric cities and supplied correct delineations of their existing monuments. This publication enjoyed a wide popularity, and made such an impression on Prescott the historian that he urged Stephens to prosecute his researches of American antiquities in Peru. Stephens was, however, disinclined to so distant an expedition. He became a director of the newly-formed American Ocean Steam Navigation Company, which established the first American line of trans-Atlantic steamships. He visited Panama to reconnoitre the ground with a view to the construction of a railway across the isthmus, and, first as vice-president and then as president of the Panama Railway Company, spent the greater part of two years in superintending the project. His health was, however, entirely undermined by his long and incautious exposure to the deadly climate of Central America, and he died at New York on the 10th October, 1852.

Stephens made no pretensions to the title of a scientific traveller. He had, however, a natural curiosity after all kinds of human knowledge, shrewd and accurate powers of observation, and a more than common measure of perseverance, tact, and resource.

STEPHENSON, GEORGE (1781–1848), perfecter of the locomotive, was the son of Robert Stephenson, fireman of a colliery engine at Wylam, near Newcastle, where he was born 9th June, 1781. In boyhood he was employed as a cowherd, and occupied his leisure in erecting clay engines and similar mechanical amusements. Afterwards he drove the ginhorse at a colliery, and in his fourteenth year became assistant to his father in firing the engine at a shilling a day. He set himself diligently to qualify himself for higher duties, and in his seventeenth year was appointed engineman or plugman. As yet he was unable to read, but, stimulated by the desire to obtain fuller information regarding the wonderful inventions of Boulton and Watt, he began in his eighteenth year to attend a night school, and soon made remarkably rapid progress. In 1801 he obtained the situation of brakesman, and in 1812 he was appointed engine-wright at Killingworth high pit at a salary of £100 [$486] a year. Meantime he had been employing his leisure in watch and clock cleaning, in studying mechanics, and in various experiments with a view of solving the difficulties connected with the construction of a satisfactory locomotive. Having obtained permission from Lord Ravensworth, the principal partner of the Killingworth colliery, to incur the outlay for constructing a "travelling engine" for the tramroads between the colliery and the shipping port nine miles distant, he made a successful trial with the engine, which he named "My Lord," 25th July, 1814. Setting himself diligently to improve his invention, he thoroughly satisfied himself that for the proper success of the locomotive a railway as nearly as possible level was an essential condition. In 1822 he succeeded in impressing with the importance of his invention the projectors of the Stockton and Darlington Railway, who had contemplated using horses for their wagons, and was appointed engineer of the railway, with liberty to carry out his own plans, the result being the opening, 27th September, 1825, of the first railway over which passengers and goods were carried by a locomotive. The success of the Stockton and Darlington Railway led to the employment of Stephenson in the construction of the Liverpool and Manchester Railway, which, notwithstanding prognostications of failure by the most eminent engineers of the day, he carried successfully through Chat Moss. He also succeeded in persuading the directors to give the locomotive a trial, and, as his improved invention, the "Rocket," during her trial trip made 29 miles an hour, his suggestion met with complete approval; with the opening of the line, 15th September, 1830, the modern era of railways may be said to have been definitely inaugurated. While his experiments in connection with locomotives were in progress, the construction of a safety lamp for use in mines occupied much of his attention. There can be no doubt regarding the justice of his claims to be considered the first inventor of the tube safety lamp, notwithstanding that the name of Sir Humphry Davy has been chiefly associated with the discovery. In recognition of the "valuable service he had thus rendered to mankind," subscriptions were in 1815 collected in behalf of Stephenson which amounted to £1000 [$4860], a sum which he found of great convenience in connection with his locomotive experiments. Stephenson was closely connected with the more important of the railway projects which the success of the Liverpool and Manchester line called into

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which from the formation of the Federal Union had controlled every branch of the government, had nothing to gain but everything to lose by withdrawal. Upon the election of President Lincoln, Stephens wrote to him for his views and purposes in regard to slavery, and on the strength of his reply urged before the legislature and the convention of his State the constitutional duty of the South to wait for overt acts of hostility before taking the momentous step of secession. But sharing the common political theory of his section that State allegiance was a primary obligation, when the convention voted to secede he acquiesced. Within a month after having been chosen vice-president he declared in a public speech that "slavery was the corner-stone of the Confederacy." He visited Richmond to urge the separation of Virginia from the Union. In 1865 he took part in the fruitless Hampton Roads conference, and at the close of the war he retired to his "Liberty Hall" at Crawfordsville, but was arrested in May and imprisoned at Fort Warren, in Boston Harbor, whence five months later he was dismissed on parole. In 1866 the legislature of Georgia chose him for a United States Senator, but he was not permitted to take his seat, as that State had not yet complied with the terms of reconstruction imposed by Congress.

Gov. Stephens's ability lay in the logical consistency with which he applied his principles of interpretation to the Constitution. They are contained in his *Constitutional View of the Late War Between the States, its Causes, Character, and Results* (2 vols., 1868–70).

His younger brother LINTON (1823–72) shared his political views and logical acumen, and sat for years upon the supreme court bench of Georgia, distinguished for ability and learning.—AM. ED.]

[1] [Stephens's first expedition to Central America grew out of a commission from President Van Buren to negotiate a treaty there. The two friends jointly published in London 25 colored plates of *Views of Ancient Monuments in Central America* (1844). Catherwood added a biographical sketch of Stephens to later editions of the *Incidents of Travel in Central America*, and perished himself on the ill-fated steamer "Arctic" in 1854.—AM. ED.]

existence, but he strongly disapproved of the railway mania which ensued, and predicted that only ruin could result from the prevalent disposition towards railway speculation. He was frequently consulted in regard to the construction of foreign railways, and in this connection visited Belgium and Spain in 1845. Towards the close of his life he retired from active duties, and at his residence at Tapton House, Chesterfield, interested himself chiefly in farming and horticultural pursuits. He died 12th August, 1848.

See *Story of the Life of George Stephenson*, by Samuel Smiles, 1857, new ed. 1873; and Smiles's *Lives of British Engineers*, vol. iii.

STEPHENSON, ROBERT (1803–1859), engineer, son of the preceding by his first wife Fanny Henderson, was born at Willington Quay, 16th October, 1803. Remembering his own early difficulties owing to deficient instruction, his father bestowed special care on his education, sending him in his twelfth year to attend Mr. Bruce's school in Percy Street, Newcastle, where he remained about four years. In 1819 he was apprenticed to a coalviewer at Killingworth to learn the business of the colliery, after which, to perfect his training in technical science, he was sent in 1822 to attend the science classes at the university of Edinburgh. On his return he assisted his father in the survey of various railway lines, but in 1824 he accepted an engagement to take charge of the engineering operations of the Columbian Mining Association of London. On account of the harassing difficulties of the situation he resigned it in 1827, and after his return to England undertook the management of his father's factory in Newcastle, greatly aiding him in the improvement of his locomotives, the result being the construction of the "Rocket," which firmly established the practicability of steam locomotion on railways. Subsequently his services were in great request as a railway engineer, and after the retirement of his father he was regarded as the chief authority on the subject. In this connection his most remarkable achievements were his railway viaducts on the tubular system, constructed with the aid of the practical knowledge of Sir William Fairbairn, and justly characterized as "the greatest discovery in construction in our day." Among his more notable bridges are the Royal Border bridge at Berwick-on-Tweed, the high-level bridge at Newcastle-on-Tyne, the Britannia tubular bridge over the Menai Straits, the Conway tubular bridge, and the Victoria tubular bridge over the St. Lawrence, Canada. In 1847 he entered the House of Commons as member for Whitby. He was frequently consulted in the construction of foreign railways, and was decorated for his services by the king of Belgium, the king of Sweden, and the emperor of the French. In 1855 he was elected president of the Institute of Civil Engineers. He died 12th October, 1859, and was buried in Westminster Abbey.

See *The Story of the Life of George Stephenson, including a Memoir of his Son Robert Stephenson*, by Samuel Smiles, 1857, new ed. 1873; Jeaffreson, *Life of Robert Stephenson*, 2 vols., 1864; and Smiles's *Lives of British Engineers*, vol. iii.

STEREOCHROMY. See SILICA.

STEREOSCOPE is an optical instrument for representing in apparent relief and solidity all natural objects by uniting into one image two representations of these objects as seen by each eye separately. That the two eyes form different images of any objects which are near enough to have dissimilar perspective projections has been long known, and may be readily tested by any one. Euclid proved it geometrically with reference to a sphere (26th, 27th, and 28th theorems of his *Treatise on Optics*); Galen showed how the demonstration might be made.[1] PORTA (*q.v.*), in his work on *Refraction*, also writes on the subject, and Leonardo da Vinci adduced the want of correspondence between the parts of the background intercepted by a near object seen by the two eyes singly "as the reason why no painting can show a *rilievo* equal to that of natural objects seen by both eyes within a moderate distance."[2] In 1613 Aguilonius, a Jesuit, in his work on *Optics*, attributed the union of the two unlike pictures into a clear image to a "common sense" which gave its aid equally to each eye,—this common sense being specially exerted when the object is placed much nearer to one eye than to the other, so that the sizes as well as the forms of the two retinal pictures are sensibly different. The subject was merely touched by various other writers after Aguilonius until 1775, when Harris[3] observes: "We have other helps for distinguishing prominences of small parts besides those by which we distinguish distances in general, as to their degrees of light and shade, and the prospect we have round them. Again, by the parallax, on account of the distance betwixt our eyes, we can distinguish, besides the front part, the two sides of a near object not thicker than the said distance, and this gives a visible rilievo to such objects; which helps greatly to raise or detach them from the plane in which they lie. Thus the nose on a face is the more remarkably raised by our seeing both sides of it at once." This was undoubtedly a considerable step towards a sound theory of binocular vision, but it cannot be said to have anticipated the invention of the stereoscope. This instrument owes its origin entirely to the experimental researches of Sir Charles Wheatstone on binocular vision, and the following passage from Mayo's *Outlines of Human Physiology*, p. 288, published in 1833, is the first clear enunciation of the principle on which it is constructed: "A solid object, being so placed as to be regarded by both eyes, projects a different perspective figure on each retina; now if these two perspectives be actually copied on paper, and presented one to each eye, so as to fall on corresponding parts, the original solid figure will be apparently reproduced in such a manner that no effort of the imagination can make it appear as a representation on a plane surface." Sir Charles Wheatstone's "Contributions to the Physiology of Vision, Part the First" appeared in the *Philosophical Transactions* of 1838, but this paper was the result of investigations extending over a period of years, and there is evidence that reflecting stereoscopes were constructed for Wheatstone by Newman, a well-known philosophical instrument maker, so early as the winter of 1832. Wheatstone no doubt also, as early as 1845, employed photographic pictures for his reflecting stereoscope. The subject was taken up by Sir David Brewster, and was developed more particularly in two papers read to the Royal Society of Edinburgh in January, 1843, and April, 1844. These researches led Brewster to the invention of the lenticular or refracting stereoscope. The discoveries of Daguerre and Talbot, and the rapid development of the art of photography, enabled photographs to be taken suitable for the stereoscope, thus superseding the geometrical drawings previously employed, and in 1849 Dubosq, a Parisian optician, began the manufacture of lenticular stereoscopes and executed a series of binocular daguerreotypes of living individuals, statues, bouquets of flowers, and objects of natural history. For many years the refracting stereoscope of Brewster was one of the most popular of scientific instruments, and was to be found, along with an appropriate collection of pictures, in every drawing-room, but of late years it has somewhat fallen into the background, and the manufacture by photographers of stereoscopic views now forms but a small portion of their work. Whilst much credit is due to Brewster for his writings on binocular vision, and for the efforts he made to introduce the stereoscope to the public, there is no doubt that Wheatstone was not only the real inventor of the instrument but he also laid down in his paper published in 1838, and in a second contribution which appeared in the *Philosophical Transactions* in 1852, the true principles of binocular vision.[1]

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[1] *De Usu Partium Corporis Humani*, Lyons, 1550, p. 598.

[2] *Trattata della Pictura, Scultura, ed Architettura*, Milan, 1584.

[3] *Opticks*, vol. ii. pp. 41 and 245.

When we look at an external object with both eyes it is seen generally as a single object, although there must be two retinal pictures, one for each eye. This depends on the fact that the excitation of certain associated spots on the two retinæ is referred to the same point in space, or, in other words, that the luminous impression which originates by the irritation of two associated points appears as one point in the visual field. Such associated points or areas of the retina are said to be corresponding or identical. When an object is seen single by two eyes, the two images must fall on corresponding points of the retina. If one eye be pushed to the side, the image on the retina of that eye is displaced from its appropriate identical point, and a double image is the result. Now the term *horopter* is applied to represent an imaginary surface containing "all those points of the outer world from which rays of light passing to both eyes fall upon identical points of the retina, the eyes being in a certain position." The horopter varies with the different positions of the eyes (see EYE, vol. viii. p. 723). But it is a familiar experience that we not only see a single object with two eyes, but the object, say a cube or a book lying on the table, is seen in relief, that is, we take cognizance of the third dimension occupied by the body in space, although the two retinal pictures are on a plane. It is clear that the two images of the object which do not coincide with the horopter cannot be completely united so as to furnish one single visual impression. Further, it can readily be demonstrated that the two retinal pictures are dissimilar, and yet the two images are fused into one and give the impression of a single object occupying three dimensions. To explain these phenomena, Wheatstone put forward the theory that the mind completely fused the dissimilar pictures into one, and that whenever there occurs such complete mental fusion of images really dissimilar, and incapable of mathematical coincidence, the result is a perception of depth of space, or solidity, or relief. The objection to this theory as stated by Wheatstone is that complete fusion does not take place. It is always possible by close analysis of visual perceptions to distinguish between the two retinal pictures. Further, if the fusion is mental, as stated by Wheatstone, it is an example of unconscious cerebration. Another explanation has been suggested by Brücke.[2] When we look at objects near at hand the optic axes are converged strongly, and they become less and less converged as we gaze at objects farther and farther away. There is thus a series of axial adjustments, the necessary muscular movements giving rise to definite sensations, by which we estimate the relative distance of objects in the field of view. A man with one eye cannot judge by this method. We habitually depend upon binocular vision for the guidance of all such movements as require an exact estimate of the respective proximity of two or more objects. "A very good test experiment is to suspend a curtain ring in such a manner as to present its edge at the distance of four or five feet from the eye, and then to try to push sideways through its hoop the curved handle of a walking stick held by the lower end; in this feat, which can be readily accomplished under the guidance of binocular vision, large odds may be laid that success will not be attained when one eye is closed, until a succession of trials shall have enabled the experimenter to measure the distance of the ring by the muscular movements of his arm."[3] According to Brücke, the two eyes are continually in a state of motion, and their position of convergence, now greater now less, passes from one side to the other, so that the observer combines successively the different parts of the two pictures, thus giving rise to sensations of depth of space and of subjects standing out in relief. Brücke's theory, in short, is that our perception of depth depends on the fusion of muscular sensations, or rather of nervous impressions arising from the muscles of the eyeballs. It was, however, pointed out by Dove that the sensation of relief, solidity, or perspective is perfect even when natural objects or stereoscopic pictures are seen momentarily by an electric flash lasting only $\frac{1}{24000}$ of a second, during which time it is inconceivable that there can be any change in the degree of convergence of the optic axes. This experiment is fatal to Brücke's theory, and Wheatstone was right in asserting that the sensation of relief is instantaneous. A third theory is that of Joseph Le Conte, advanced in 1871, and thus stated by himself: "All objects or points of objects either beyond or nearer than the point of sight are doubled, but differently,—the former homonymously, the latter heteronymously. The double images in the former case are united by less convergence, in the latter case by greater convergence, of the optic axes. Now, the observer knows instinctively and without trial, in any case of double images, whether they will be united by greater or less optic convergence, and therefore never makes a mistake, or attempts to unite by making a wrong movement of the optic axes. In other words, the eye (or the mind) instinctively distinguishes homonymous from heteronymous images, referring the former to objects beyond, and the latter to objects this side of, the point of sight."[4] Thus, according to Le Conte, the mind perceives relief *instantly* but not *immediately*, and it does so by means of double images. This theory does not possess the merit of simplicity, and, whilst it may explain the phenomenon of relief as experienced by those who have been specially trained to the analysis of visual perceptions, it does not satisfactorily account for the experience of everyday life. We are, therefore, obliged to fall back on the theory of Wheatstone, somewhat modified, namely, that there are, behind the phenomena referred to the retina, psychical operations, unconsciously performed, which fuse together the results of the retinal impressions. In the language of Hermann, "corresponding points are therefore such points as furnish images, which, as experience teaches, are habitually combined or fused. But, as it appears necessary to effect these combinations in order to obtain correct impressions of objects, we get into the habit of fusing also the images of the two not perfectly corresponding points which, under ordinary circumstances, we should perceive as double. It can easily be demonstrated that simultaneous images which fall upon corresponding points are not united, although it is true that they do not form second images. When the mind must unite images which do not fall upon corresponding points, the process must be associated with the conception that the corresponding points in the object occupy the situation for which the eye would have to be arranged, in order that the image should coincide."[5]

To obtain binocular pictures suitable for the stereoscope, the camera must be placed successively in two points of the circumference of a circle of which the object is the centre, and the points at which the camera is so placed must have the angular distance representing the convergence of the optic axes when the object is to be viewed in the stereoscope. For example, if the pictures are to be seen in the stereoscope at a distance of 8 inches before the eyes, the convergence will be 18°, and the camera must be stationed at two points on the circle at the same angular distance. This *distance* of the camera from the object only affects the *magnitude* of the picture. Usually two cameras are employed, fixed at the proper angular positions. Wheatstone gives the following table of the inclination of the optic axes at different distances, and it also shows "the angular positions of the camera required to obtain binocular pictures which shall appear at a given distance in the stereoscope in their true relief."

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[1] See *Brewster on the Stereoscope*, 1856; Wheatstone's *Scientific Papers*, published by the Physical Society of London, 1879; and an article by the late Dr. William Carpenter in *Edinburgh Review* for 1858.

[2] This theory is usually attributed to Brücke, but something very similar to it was taught by Brewster. Brewster, however, did not attach importance to muscular sensations as an element in the question, and was content with pointing out that, in looking at the stereoscopic pictures of a bust, for example, "the eyes will instantly, by means of their power of convergence, unite the separated points of the eyes, and then the still more separated points of the ears, running over each part of the bust with the rapidity of lightning, and uniting all the corresponding points in succession, precisely as it does in looking at the bust itself." See his article "Stereoscope," in *Encyc. Britan.*, 8th ed., vol. xx. p. 689.

[3] Carpenter, *Edinburgh Review*, 1858.

[4] *American Journal of Science and Arts*, vol. ii., 1871.

[5] Hermann's *Physiology*, translated by Gamgee, p. 430.

Inclination of the optic axes	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°
Distance in inches	71.5	35.7	23.8	17.8	13.2	11.8	10.1	8.8	7.8	7.0	6.4	5.8	5.4	5.0	4.6

"The distance is equal to ½ *a* cotang ½ *θ*,—*a* denoting the distance between the two eyes and *θ* the inclination of the optic axes" (Wheatstone, *Scientific Papers*, p. 270).

Suppose two stereoscopic pictures thus taken are presented to the two eyes; it is possible by an effort so to converge the eyes as to throw the images on corresponding points, and when this is done the objects are seen in relief (Fig. 1). Such an effort, however, soon causes fatigue, and few persons can so control their eyes and keep them in the forced position as to view the pictures in their natural perspective with any comfort. The object of all stereoscopes is to throw the two pictures on corresponding points with the eyes in an ordinary position.

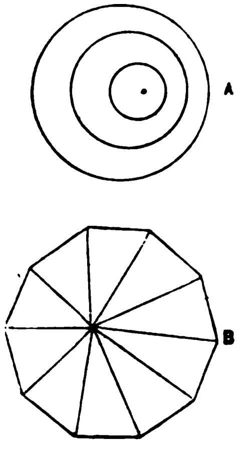

FIG. 1.—Stereoscopic figures. A, cone; B, ten-sided pyramid.

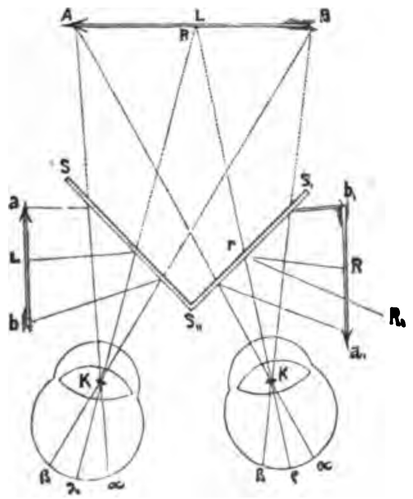

FIG. 2.—Diagram of Wheatstone's Reflecting Stereoscope. K, K, right and left eyes; S, S′,S″, mirrors; L, R, panels for holding pictures; *a b*, picture on left side; *a*₁ *b*₁, picture on right side; *α*, *β*, λ and *α*, *β*, *ρ* are corresponding points on retinæ; ALB, object as seen in relief in mirrors; *b*, seen by left eye in position B, and image on retina at *β*; L seen at L R, and retinal image at λ; *a* seen at A, and retinal image at *α*; *a′* seen at A, and retinal image at *α*; R seen at R L, and retinal image at *ρ*; *b′* seen at B, and retinal image at *β*.—Landois and Stirling's *Physiology*.

The principle of Wheatstone's reflecting stereoscope is illustrated in Fig. 2. It consisted of two plane mirrors, about 4 inches square, fixed in frames and so adjusted that their backs form an angle of 90° with each other. These mirrors are fixed to an upright against the middle line of a vertical board cut away so as to allow the eyes to be placed before the mirrors. On each side there is a panel bearing a groove above and below into which the corresponding pictures can be slid. Mechanical arrangements also exist for the purpose of moving the pictures to or from the mirrors and also for inclining the pictures at any angle (Fig. 3). There is one position in which the binocular image will be immediately seen single, of its proper size, and without fatigue, "because in this position only the ordinary relations between the magnitude of the pictures in the retina, the inclination of the optic axes, and the adaptation of the eye to distinct vision at different distances are preserved" (Wheatstone). Although somewhat cumbrous, the reflecting stereoscope is a most useful instrument, and enables one to perform a greater variety of experiments on binocular vision than can be carried out easily with the more common form.

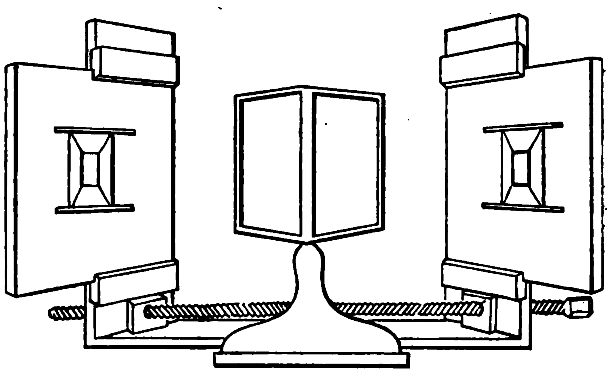

FIG. 3.—Wheatstone's Reflecting Stereoscope.

Wheatstone also invented a form of stereoscope in which the pictures were brought on corresponding points of the retina by refraction instead of by reflection. This had a form very like the ordinary stereoscope, but, instead of lenses in the apertures to which the eyes are directed, it had "a pair of glass prisms having their faces inclined 15° and their refractive angles turned towards each other. . . . . A pair of plate-glass prisms, their faces making with each other an angle of 12°, will bring two pictures, the corresponding points of which are 2½ inches apart to coincide at a distance of 12 inches, and a pair with an angle of 15° will occasion coincidence at 8 inches."[1]

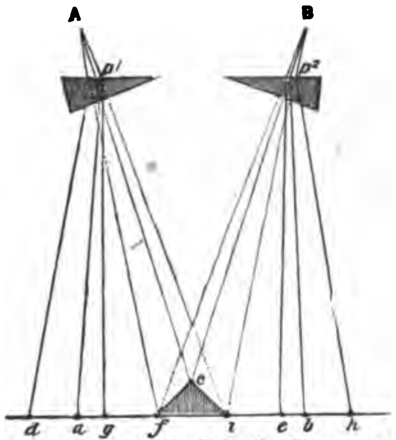

FIG. 4.—Diagram of the Refracting Stereoscope.

The form of stereoscope generally used is that invented by Sir David Brewster, and is known as the refracting stereoscope. The arrangement is shown diagrammatically in Fig. 4. Let the left eye be at A and the right at B; let *a* and *b* be the corresponding pictures for each eye, and *p*₁,

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[1] Wheatstone's *Scientific Papers*, p. 267.

p_2, two prisms of glass. A prism refracts rays of light so that the object seen through the prism appears to be nearer to the refracting edge; the prism p_1 therefore refracts the ray ap_1, in the direction p_1A, as if it proceeded from *c*. The prism p_2 refracts the ray bp_2 so that to the eye at B it also appears to proceed from *c*. The effect of this is that the object really appears to be at *c*. And as the points *a* and *b* combine to form the point *c*, so *d* and *e* unite to form the point *f*, and *g* and *h* to form the point *i* (Weinhold). This stereoscope consists of a pyramidal box blackened inside and having a lid for the admission of light (Fig. 5). At the narrow end of the box are two tubes carrying the lenses. The tubes move up and down to suit eyes of different focal lengths, and sometimes convex or concave lenses are inserted over the prisms to meet the wants of long-sighted or short-sighted persons. Fig 6 shows the upper end of the stereoscope, with the lenses in position.

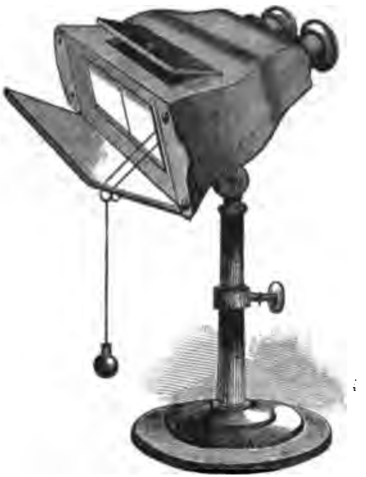

FIG. 5.—Sir David Brewster's Stereoscope.

FIG. 6.—Lenses in Refracting Stereoscope.

A. Stroh (without knowing that H. Grubb had described the essentials of the apparatus in 1879) has recently invented a new form of stereoscope based on the well-known effects of the persistence of vision. Two stereoscopic pictures are simultaneously projected by two lanterns on a screen so as to overlap, and disks having suitable slits are rotated in front of the lanterns and also in front of the eyes of the observer, in such a way that only one picture is thrown on the screen at a time, and also that the view of the picture is seen with the right and left eyes alternately. Further, the connection between the disks is so arranged that the time of obscuring the view of the observer's right eye or left eye coincides with the time when the light is shut off from the right or left lantern, and thus the left eye sees the picture of the left lantern and the right eye that of the right lantern. The two eyes never see at the same time, and each eye views its picture after the other, but the impressions come so fast as to be fused in consciousness, and the result is, the image stands out "in solid relief" (*Proc. Roy. Soc.*, No. 244, vol. xl., April 1, 1886).

During his researches into the physiology of vision, Wheatstone was led to study what he termed conversions of relief. Sometimes when we look at a geometrical figure such as a cube or rhomboid it may be imagined to represent one of two dissimilar figures. In Fig. 7 the rhomboid AX is drawn so that the solid angle A should be seen nearest, and solid angle X farthest, and face ABCD foremost, while XDC is behind. Look steadily and the position will change: X will appear nearest, solid angle A farthest; face ACDB will recede behind XDC.[1] The effects are most obvious when seen with one eye, and "no illusion of this kind can take place when an object of three dimensions is seen with both eyes while the optic axes make a sensible angle with each other, because the appearance of two dissimilar figures, one to each eye, prevents the possibility of mistake" (Wheatstone). The conversion of a cameo into an intaglio and of an intaglio into a cameo is a well-known instance of this illusion. Wheatstone observed the conversion of relief exhibited by binocular pictures in the stereoscope when they are transposed, reflected, or inverted, and this led him to the invention of the *Pseudoscope*, an instrument which conveys to the mind false perceptions of all external objects. "Two rectangular prisms of flint glass, the faces of which are 1.2 inch square, are placed in a frame with their hypothenuses parallel and 2.1 inches from each other; each prism has a motion on an axis corresponding with the angle nearest the eyes, that they may be adjusted so that their bases may have any inclination towards each other" (Wheatstone's *Scientific Papers*, p. 275). In Fig. 8 there is a diagram of the instrument. If a spherical surface be examined with this instrument, it will appear hollow; whilst a hollow surface will appear convex. It is remarkable, however, that the converting powers of this instrument are greatest where the new forms can be conceived without effort. Thus a cameo and an intaglio, a plaster cast in relief and its mould, or any object similar in its opposite reliefs is at once changed by the pseudoscope into the converse form. As pointed out by Dr. Carpenter, by gazing we can reverse the interior of a mask so as to see the countenance stand out in relief; it is more difficult to throw the features of a bust into the shape of a mould; whilst it is impossible to effect any conversion upon the features of the living face. "The optical change is identically the same in its nature in every one of these cases; and there is nothing in the form of the features which refuses to present a converse, this converted shape being presented by the mask; but the mind, which will admit the converted form when suggested by the inanimate mask or bust, is steeled by its previous experience against the notion that actual flesh and blood can undergo such a metamorphosis" (Carpenter, *Edinburgh Review*, 1858, p. 460).

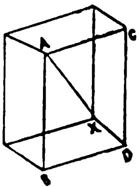

FIG. 7.

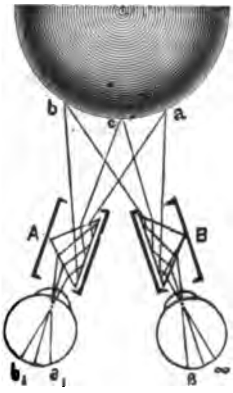

FIG. 8. — Diagram of Wheatstone's Pseudoscope. A, B, tubes containing prisms; a_1, b_1, and a β, corresponding points; *a*, *b*, *c*, position of points in visual field.

A little consideration will show that the pictures of objects placed at a great distance from the eye are practically if not wholly identical. Here there is scarcely any stereoscopic effect, and the landscape may appear to be flat, as in a picture. To obtain a stereoscopic view of a landscape Von Helmholtz invented the *Telestereoscope*, an instrument which places as it were the point of view of both eyes wide apart. It consists of two mirrors L and R, each of which projects its image upon *l* and *r*, to which the eyes O and *o* are directed. The eyes O and *o* are placed as it were at O_1 and o_1, according to the distance between L and R; consequently two dissimilar pictures are obtained; these are mentally combined, with the result that the landscape is seen like a stereoscopic view.

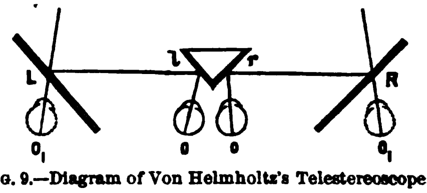

FIG. 9.—Diagram of Von Helmholtz's Telestereoscope.

The principle of the stereoscope was successfully applied by Wenham in 1854 to the construction of the binocular microscope. See MICROSCOPE (vol. xvi. p. 284–5), and also two papers in the *Jour. Roy. Micr. Soc.*, 1884: (1) "On the Mode of Vision with Objectives of Wide Aperture," by Prof. E. Abbe, p. 20; and (2) "On the Physiology of Binocular Vision with the Miscroscope," by Dr. Carpenter, p. 486. Prof. Abbe shows, however, that "oblique vision in the microscope is entirely different from that in ordinary vision, inasmuch as there is no perspective, so that we have no longer the dissimilarity which is the basis of the ordinary stereoscopic effect, but an essentially different mode of dissimilarity between the two pictures." In the microscope there is no perspective foreshortening. There is no difference in the outline of an objective viewed under the microscope by an axial or by an oblique pencil. There is simply a lateral displacement of the image—an entirely different phenomenon to that which occurs in non-microscopic vision. Thus, whilst the mode of formation of dissimilar pictures in the binocular microscope is different from the production of ordinary stereoscopic pictures, the brain mechanism by which they are so fused as to give rise to sensations of solidity, depth, and perspective is the same. (J. G. M.)

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[1] Necker *Phil. Mag.*, 3d series, vol. i. p. 357.

STEREOTYPE. See TYPOGRAPHY.

STERLING, a city of the United States, in Whiteside county, Illinois, on Rock River (a tributary of the Mississippi), 110 miles west of Chicago. Mainly on account of the abundant water-power produced by the natural rapids of the river and a dam 1100 feet long, it has become the seat of the most varied manufacturing industry. An artesian well 1000 feet deep, discharging 18,000 gallons per hour, contributes to the water-supply of the town. The population was 5312 in 1870 and 5087 in 1880. Sterling was laid out in 1836 and incorporated in 1857.

STERLING, JOHN (1806–1844), author, was descended from a family of Scottish origin which had settled in Ireland about the Cromwellian period. His father, Edward Sterling, born at Waterford 27th February, 1773, had been called to the Irish bar, but, having fought as a militia captain at Vinegar Hill, afterwards volunteered with his company into the line. On the breaking up of his regiment he went to Scotland, and took to farming at Kames Castle in Bute, where John, the second son, was born 20th July, 1806. In 1810 the family removed to Llanblethian, Glamorganshire, and during his residence there Edward Sterling, under the signature of "Vetus," contributed a number of letters to the *Times*, which were reprinted in 1812, and a second series in 1814. In the latter year he removed to Paris, but, the escape of Napoleon from Elba in 1815 compelling him to return to England, he took up his permanent residence in London, obtaining a connection with the *Times* newspaper, and ultimately being promoted editor. Carlyle, who allows him the dubious credit of being one of the best of newspaper editors, represents him as manifesting "a thoroughly Irish form of character, fire and fervor, vitality of all kinds in genial abundance, but in a much more loquacious, ostentatious, much *louder* style than is freely patronized on this side of the Channel." His fiery, emphatic, and oracular mode of writing conferred those characteristics on the *Times* which were recognized in the sobriquet of the "Thunderer." The frequent changes of the family residence during the early years of young Sterling rendered his education somewhat desultory, but on the settlement in London it became more systematic. After studying for one year at the university of Glasgow, he in 1824 entered Trinity College, Cambridge, where he had for tutor Julius Charles Hare. At Cambridge he did not distinguish himself except in the debates of the union, where "none," it was related, "ever came near him except the late Charles Buller." He removed to Trinity Hall with the intention of graduating in law, but left the university without taking a degree. During the next four years he resided chiefly in London, employing himself actively in literature. Along with Frederick Maurice he purchased the *Athenæum* from J. Silk Buckingham, but the enterprise was not a pecuniary success. Through Maurice he became an "assiduous pilgrim" to the shrine of Coleridge at Hampstead.[1] He also formed an intimacy with the Spanish revolutionist General Torrijos, in whose unfortunate expedition he took an active interest. Shortly after his marriage in 1830, symptoms of pulmonary disease induced him to take up his residence in the island of St. Vincent, where he had inherited some property, but after fifteen months he returned to England. After spending some time on the Continent he found his health so much re-established that in June, 1834, he accepted a curacy at Hurstmonceaux, where his old tutor Julius Hare was vicar. Acting on the advice of his physician he resigned his clerical duties in the following February, but according to Carlyle ill-health was only the external occasion of his resignation, the primary cause being a partly unconscious divergence from the opinions of the church. Be this as it may, the threatening progress of the insidious disease under which he labored soon rendered "public life in any professional form" quite impossible. There remained to him the "resource of the pen," but, having to "live all the rest of his days as in continual fight for his very existence," his literary achievements were necessarily fragmentary, and cannot be regarded as a criterion of his capabilities. He published in 1833 *Arthur Coningsby*, a novel, which attracted little attention, and his *Poems* (1839), the *Election, a Poem* (1841), and *Strafford*, a tragedy, were not more successful. He had, however, established a connection with *Blackwood's Magazine*, to which he contributed a variety of papers and several tales, which gave promise that under more favorable conditions he might have "achieved greatness." He died at Ventnor 18th September, 1844. His father survived him till 1847.

Sterling's papers were entrusted to the joint care of Thomas Carlyle and Archdeacon Hare, and it was agreed that the selection of his writings for publication and the preparation of a memoir should be undertaken by the latter. *Essays and Tales*, by John Sterling, collected and edited, with a memoir of his life, by Julius Charles Hare, appeared therefore in 1848 in two volumes. So dissatisfied was Carlyle with the memoir, chiefly because it unduly magnified the ecclesiastical side of Sterling's life, that he resolved to give his own "testimony" about his friend, and "record clearly" what his "knowledge of him was." His vivid portraiture of Sterling in the *Life* which appeared in 1851 has perpetuated the memory of Sterling after his writings have ceased to be of interest on their own account.

STERNBERG, a manufacturing town in Moravia, Austria, is situated 9 miles to the north of Olmütz and 47 miles to the northeast of Brünn. It is the chief seat of the Moravian cotton industry, and it also carries on the manufacture of linen, stockings, liquors, sugar, and bricks. Its six suburbs and the surrounding districts are also engaged in the textile industry. Fruit, especially cherries, and tobacco are grown in the neighborhood. The population in 1880 was 14,243. Sternberg is said to have grown up under the shelter of a castle founded by Yaroslaff of Sternberg on the site of his victory over the Mongols in 1241.

STERNE, LAURENCE (1713–1768), one of the greatest of English humorists, was the son of an English officer, and great-grandson of an archbishop of York. Nearly all our information about the first forty-six years of his life before he became famous as the author of *Tristram Shandy* is derived from a short memoir jotted down by himself for the use of his daughter. It gives nothing but the barest facts, excepting three anecdotes about his infancy, his school-days, and his marriage. The date of his birth coincides with the close of the Marlborough wars. He was born at Clonmel, Ireland, on November 24, 1713, a few days after the arrival of his father's regiment from Dunkirk. The regiment was then disbanded, but very soon after re-established, and for ten years the boy and his mother moved from place to place after the regiment, from England to Ireland, and from one part of Ireland to another. The familiarity thus acquired with military life and character stood Sterne in good stead when he drew the portraits of Uncle Toby and Corporal Trim, and the influence of the excitements, shifts, and hardships of this life of vagabond gentility may also be traced in his own character. To its hardening effect we may fairly refer some part of his later reckless defiance of clerical proprieties and comical persistence in self-conscious eccentricity. After ten years of wandering, he was fixed for eight or nine years at a school near Halifax in Yorkshire. His father died when he was in his eighteenth year, and he was indebted for his university education to one of the members of his father's family. His great-grandfather the archbishop had been master of Jesus College, Cambridge, and to Jesus College he was sent in 1732. He was admitted to a sizarship in July, 1733, and took his B.A. degree in 1736. One of his uncles was a prominent church dignitary in Yorkshire. Young Sterne took orders, and through his influence obtained in 1738 the living of Sutton, some 8 miles north of York. On his marriage three years afterwards he was presented to the neighboring living of Stillington, and did duty at both places. He was also a prebendary of York.

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[1] [Highgate. See vol. vi. p. 123, and vol. xi. p. 723.—Am. Ed.]

Sutton was Sterne's residence for twenty uneventful years—years at least concerning which his biography is silent. The only ascertained fact of consequence is that he kept up an intimacy which had begun at Cambridge with John Hall Stevenson, a witty and accomplished epicurean, owner of Skelton Castle in the Cleveland district of Yorkshire. Skelton Castle is nearly 40 miles from Sutton, but Sterne, in spite of his double duties, seems to have been a frequent visitor there, and to have found in his not too strait-laced friend a highly congenial companion. Stevenson's various occasional sallies in verse and prose—his *Fables for Grown Gentlemen*, his *Crazy Tales*, and his numerous skits at the political opponents of Wilkes, among whose "macaronies" he numbered himself,—were collected after his death, and it is impossible to read them without being struck with their close family resemblance in spirit and turn of thought to Sterne's work, inferior as they are in literary genius. Without Stevenson Sterne would probably have been a more decorous parish priest, but he would probably never have written *Tristram Shandy* or left any other memorial of his singular genius. The two friends began to publish late in life and in the same year. The first two volumes of *Tristram Shandy* were issued on the 1st of January, 1760, and at once made a sensation. York was scandalized at its clergyman's indecency and indignant at his caricature of a local physician; London was charmed with his audacity, wit, and graphic unconventional power. He went to London early in the year to enjoy his triumph, and found himself at once a personage in society,—was called upon and invited out by lion-hunters, was taken to Windsor by Lord Rockingham, and had the honor of supping with the duke of York.

For the last eight years of his life after this sudden leap out of obscurity we have a faithful record of Sterne's feelings and movements in letters to various persons, published after his death by his daughter. At the end of the famous Sermon on Conscience in vol. ii. of *Tristram* he had intimated that, if this sample of Yorick's pulpit eloquence was liked, "there are now in the possession of the Shandy family as many as will make a handsome volume at the world's service—and much good may they do it." Accordingly, when a second edition of the first instalment of *Tristram* was called for in three months, two volumes of *Sermons* by Yorick were announced. Although they had little or none of the eccentricity of the history, they proved almost as popular. Sterne's clerical character was far from being universally injured by his indecorous freaks as a humorist: Lord Faulconberg presented the author of *Tristram Shandy* with the living of Coxwold. To this new residence he went in high spirits with his success, "fully determined to write as hard as could be," seeing no reason why he should not give the public two volumes of Shandyism every year and why this should not go on for forty years. By the beginning of August he had another volume written, and was "so delighted with Uncle Toby's imaginary character that he was become an enthusiast." The author's delight in this wonderful creation was not misleading; it has been fully shared by every generation of readers since. For two years in succession Sterne kept his bargain with himself to produce two volumes a year. Vols. iii. and iv. appeared in December, 1760; vols. v. and vi. in January, 1762. But his sanguine hopes of continuing at this rate were frustrated by ill-health. He was ordered to the south of France; it was two years and a half before he returned; and he came back with very little accession of strength. His reception by literary circles in France was very flattering. He was overjoyed with it. "'Tis *comme à Londres*," he wrote to Garrick from Paris; "I have just now a fortnight's dinners and suppers upon my hands." And again, "Be it known I Shandy it away fifty times more than I was ever wont—talk more nonsense than ever you heard me talk in your days, and to all sorts of people." Through all his pleasant experiences of French society, and through the fits of dangerous illness by which they were diversified, he continued to build up his history of the Shandy family, but the work did not progress as rapidly as it had done. Not till January, 1765, was he ready with the fourth instalment of two volumes; and one of them, vol. vii., leaving the Shandy family for a time, gave a lively sketch of the writer's own travels to the south of France in search of health. This was a digression of a new kind, if anything can be called a digression in a work the plan of which is to fly off at a tangent whenever and wherever the writer's whim tempts him. In the first volume, anticipating an obvious complaint, he had protested against digressions that left the main work to stand still, and had boasted—not without justice in a Shandean sense—that he had reconciled digressive motion with progressive. But in vol. vii. the work is allowed to stand still while the writer is being transported from Shandy Hall to Languedoc. The only progress we make is in the illustration of the buoyant and joyous temper of Tristram himself, who, after all, is a member of the Shandy family, and to whom was due a volume for the elucidation of his character. Vol. viii. begins the long-promised story of Uncle Toby's amours with the widow Wadman. After seeing to the publication of this instalment of *Tristram* and of another set of sermons,—more pronouncedly Shandean in their eccentricity,—he quitted England again in the summer of 1765, and travelled in Italy as far as Naples. The ninth and last and shortest volume of *Tristram*, concluding the episode of Toby Shandy's amours, appeared in 1767. This despatched, Sterne turned to a new project, which had probably been suggested by the ease and freedom with which he had moved through the travelling volume in *Tristram*. The *Sentimental Journey through France and Italy* was intended to be a long work: the plan admitted of any length that the author chose, but, after seeing the first two volumes through the press in the early months of 1768, Sterne's strength failed him, and he died in his London lodgings on the 18th of March, three weeks after the publication. The loneliness of his end has often been commented on; it was probably due to its unexpectedness. He had pulled through so many sharp attacks of his "vile influenza" and other lung disorders that he began to be seriously alarmed only three days before his death.

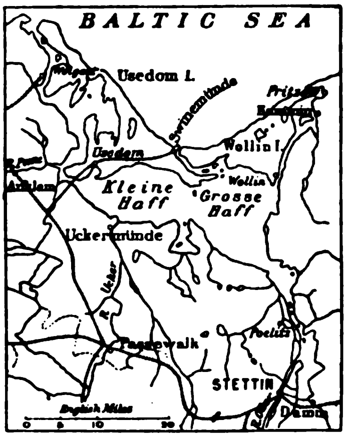
Sterne's character defies analysis in brief space. It is too subtle and individual to be conveyed in general terms. For comments upon him from points of view more or less diverse the reader may be referred to Thackeray's *Humorists*, Prof. Masson's *Novelists*, and Mr. H. D. Traill's sketch in the "English Men of Letters" series. The fullest biography is Mr. Percy Fitzgerald's. But the reader who cares to have an opinion about Sterne should hesitate till he has read and re-read in various moods considerable portions of Sterne's own writing. This writing is so singularly frank and unconventional that its drift is not at once apparent to the literary student. The indefensible indecency and overstrained sentimentality are on the surface; but after a time every repellent defect is forgotten in the enjoyment of the exquisite literary art. In the delineation of character by graphically significant speech and action, introduced at unexpected turns, left with happy audacity to point their own meaning, and pointing it with a force that the dullest cannot but understand, he takes rank with the very greatest masters. In Toby Shandy he has drawn a character universally lovable and admirable; but Walter Shandy is almost greater as an artistic triumph, considering the difficulty of the achievement. Dr. Ferriar, in his *Illustrations of Sterne* (published in 1812), pointed out several unacknowledged plagiarisms from Rabelais, Burton, and others; but it is only fair to the critic to say that he was fully aware that they were only plagiarisms of material, and do not detract in the slightest from Sterne's reputation as one of the greatest of literary artists. (W. M.)

STESICHORUS of Himera, a very famous lyric poet, lived between 630 and 550 B.C. His name was originally Tisias, if we may trust Suidas, but it was changed to Stesichorus on account of his eminence in choral poetry. He was famed in antiquity for the richness and splendor of his imagination and his style, although Quintilian censures his redundancy and Hermogenes remarks on the excessive sweetness that results from his abundant use of epithets. We are told that he warned his fellow-citizens against Phalaris, whom they had chosen as their general, by relating to them the well-known fable of the horse and the stag. The story that he was struck blind for slandering Helen in a poem, and afterwards recovered his sight when he had sung a recantation, is told first by Plato, and afterwards, with many additions, by Pausanias and others. We possess some fragments of the former poem, censuring the daughters of Tyndareus, who "wed two, nay three husbands, and leave their lords" (Fr. 26), and three lines from the palinode, "This is no true tale, nor yet wentest thou in the strong benched ships, or camest to the tower of Troy" (Fr. 32). It seems probable that Stesichorus did really write his recantation in consequence of a dream which he had soon after composing his poem on Helen; and his is not the only case in literature where an apparently miraculous cure is said to have followed some such act of atonement. We possess about thirty fragments of his poems, not counting single words, preserved in Athenæus and elsewhere. None of them is longer than six lines. They are written in the Doric dialect, with epic licenses and occasional Æolisms; the metre is dactylico-trochaic. Brief as they are, they show us what Longinus meant by calling Stesichorus "most like Homer"; they are full of epic grandeur, and have a stately sublimity that reminds us of Pindar. Stesichorus indeed made a new departure by using lyric poetry to celebrate gods and heroes rather than human feelings and passions; this is what Quintilian means by saying that he "sustained the burden of epic poetry with the lyre." Several of his poems sung of the adventures of Heracles; one dealt with the siege of Thebes, another with the sack of Troy. The last—to which the *Tabula Iliaca* (see Otto Jahn's *Griechische Bilderchroniken*, ed. A. Michaelis) is a sort of commentary—possesses an interest for us as the first poem in which occurred that form of the story of Æneas's flight to which Virgil afterwards gave currency in his *Æneid*. Stesichorus also completed the choral ode by adding to the strophe and antistrophe the epode; and not to know "Stesichorus's three" passed into a proverbial expression for unpardonable ignorance.

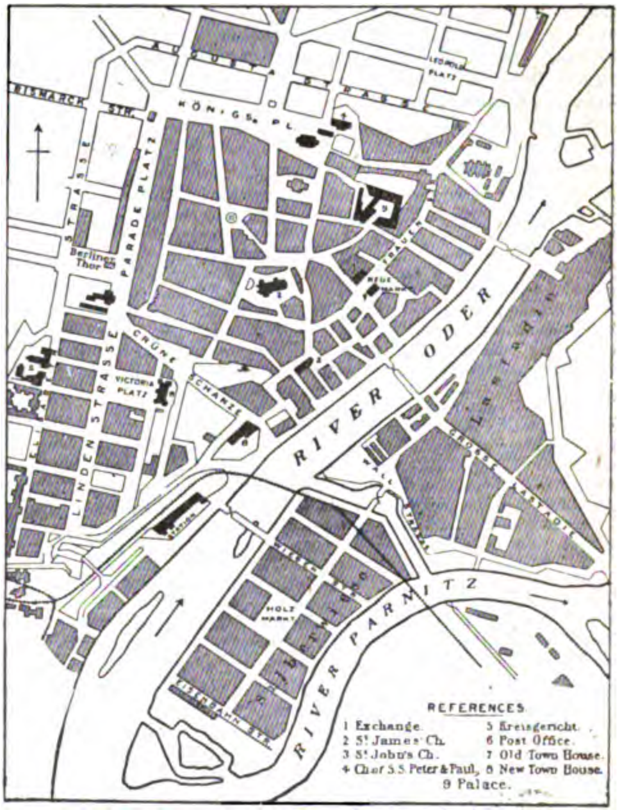
Bergk, *Poetæ Lyrici Græci*, vol. iii. pp. 205–234, Leipsic, 1882.

STETHOSCOPE. See AUSCULTATION.

STETTIN, the chief town of Pomerania, and the leading seaport in Prussia, is situated on the Oder, 17 miles to the south of the Stettiner Haff and 30 miles from the Baltic Sea. The main part of the town occupies a hilly site on the left bank of the river, and is connected by four bridges (including a massive railway swing-bridge) with the suburbs of Lastadie ("lading place," from *lastadium*, "burden,") and Silberwiese, on an island formed by the Parnitz and Dunzig, which here diverge from the Oder to Dammsche-See. Until 1874 Stettin was closely girdled by very extensive and strong fortifications, which prevented the expansion of the town proper, but the steady growth of its commerce and manufactures encouraged the foundation of numerous industrial suburbs beyond the line of defence. Some of these are themselves "towns," as Grabow, with 13,672 inhabitants in 1880, and Bredow with 11,255 inhabitants; but all combine with Stettin to form one industrial and commercial centre. Since the removal of the fortifications their



Environs of Stettin.



Plan of Stettin.

site has begun to be built upon. Apart from its commerce, Stettin is a comparatively uninteresting city. The church of Sts. Peter and Paul, originally founded in 1124 and restored in 1816–17, was the earliest Christian church in Pomerania. St. James's church, dating from the 13th and the two following centuries, is remarkable, like several other Pomeranian churches, for its size. The old palace, now occupied by Government offices, is a large unattractive edifice, scarcely justifying the boast of an old writer that it did not yield in magnificence even to the palaces of Italy. Among the more modern structures are the theatre and the new town-house, superseding an earlier one of 1245. Statues of Frederick the Great and of Frederick William III. adorn one of the five open squares of the old town. As a prosperous commercial town Stettin has numerous educational, benevolent, and scientific institutions.

The manufactures are very important; many of the largest factories are in the neighboring villages, beyond Stettin proper. The shipbuilding yards (among which that of the Vulcan Company deserves mention) have comparatively recently attained some reputation for their iron-clads and war-vessels. Machinery, cement, chemicals, and soap are produced in large quantities, and there are also large sugar-refineries, besides a vast miscellany of other smaller industrial establishments. The trade of Stettin is very flourishing. More than any other harbor it may be regarded as the port of Berlin, from which it is 93 miles northeast by railway; and a larger number of vessels enter and clear at Stettin than at any other German port except Hamburg and Bremerhaven. Swinemünde (*q.v.*) serves as its fore-port. The forest and river scenery of the neighborhood of Stettin is picturesque, but the low level and swampy nature of the soil render the climate bleak and unhealthy. In 1885 the population was 99,475; in 1880 it was 91,756, of whom 85,727 were Protestants, 3112 Roman Catholics, and 2388 Jews.

In 1885 3809 ocean vessels (2207 steamers) and 1965 coasting and river craft, beside 10,039 Oder barges, entered the port. In 1885 Stettin possessed (besides a large number of river craft) a fleet of 127 sea-going ships, with a burden of 47,066 tons, of which 26,754 tons were distributed in 59 steamers. The chief exports are grain, spirits, and wood; the chief imports petroleum, train-oil, wine, and herrings. The annual value of the former is about £7,500,000 [$36,450,000] and of the latter about £6,000,000 [$29,160,000].

Stettin is said to have existed as a Wendish fishing-village as early as 830 A.D., and it appears as Stedyn in the time of the Saxon emperors. From the 12th century it was the seat of the dukes of Pomerania, who became extinct in 1637. Passing then to Sweden, it remained united with that kingdom for eighty-three years, with one brief interval, but in 1720 it was ceded to Prussia. Gustavus Adolphus undertook to improve its fortifications in 1630, but Frederick the Great was the first to convert it into a strong modern fortress. From 1806 till 1813 it was held by the French, to whom it was surrendered without a blow. Known even in the 12th century as the leading trading-town on the Oder, Stettin entered the Hanseatic League in 1360. The development of its trade in modern times dates chiefly from the deepening and protection of the Swine in the former half of last century. See Oder.

STEUART, Sir James Denham (1712–1780), Bart., author of *An Inquiry into the Principles of Political Economy* (see Political Economy, vol. xix. p. 378), was the only son of Sir James Steuart, solicitor-general for Scotland under Queen Anne and George I., and was born at Edinburgh on October 21, 1712. After passing through the university of Edinburgh he was admitted to the Scottish bar at the age of twenty-four. He then spent some years on the Continent, and while in Rome entered into relations with the Pretender. He was in Edinburgh in 1745, and so compromised himself that after the battle of Culloden he found it necessary to return to the Continent, where he remained until 1763. It was not indeed until 1771 he was fully pardoned for any complicity he may have had in the rebellion. He died at his family seat, Coltness, in Lanarkshire, on November 26, 1780.

The Works, Political, Metaphysical, and Chronological, of the late Sir James Steuart of Coltness, Bart., now first collected, with Anecdotes of the Author, by his Son, General Sir James Denham Steuart, were published in 6 vols. 8vo in 1805. Besides the *Inquiry* (originally published in 2 vols. 4to in 1767), they include: *A Dissertation upon the Doctrines and Principles of Money applied to the German Coin* (1758), *Apologie du Sentiment de M. le Chevalier Newton sur l'Ancienne Chronologie des Grecs* (4to, Frankfort-on-the-Main, 1757), *The Principles of Money applied to the Present State of Bengal*, published at the request of the East India Company (4to, 1772), *A Dissertation on the Policy of Grain* (1783), *Plan for Introducing Uniformity in Weights and Measures within the Limits of the British Empire* (1790), *Observations* on Beattie's *Essay on Truth*, *A Dissertation concerning the Motive of Obedience to the Law of God*, and other treatises.

STEUBENVILLE, a city of the United States, county seat of Jefferson county, Ohio, lies 43 miles west of Pittsburgh, on the west bank of the Ohio river, here a third of a mile wide and crossed by a railway bridge. Built above a productive coalfield, and with an abundant supply of natural gas for fuel purposes, Steubenville has naturally become a manufacturing centre (foundries, rolling-mills, nail and glass factories, potteries, machine-shops, flour-mills, etc.), and as the surrounding district is a good farming, wool-growing, and stock-raising country it is the seat of considerable commercial activity. The court-house is a particularly fine building. In 1870 the population was 8107, in 1880 12,093. Steubenville, so called after Baron Steuben, one of Washington's generals, grew up round a fort erected in 1787. It became a city in 1851.

STEVENS, Alfred. See Sculpture, vol. xxi. p. 588.

STEVENS, Thaddeus (1792–1868), was born at Peacham, Vermont, U. S., April 4, 1792, graduated at Dartmouth College in 1814, and then settled in Pennsylvania. He soon became a leading lawyer of Lancaster, Pa., so far interested in politics as to be elected by the Whig party to the State legislature for several terms and to the federal house of representatives 1849–63. When the mass of the Northern Whig party went into the new Republican party he went with it, and returned to Washington as a Republican representative in 1859, just before the outbreak of the Civil War. This position he retained until his death, just outlasting the Civil War and reconstruction. During this period of American history he was one of the leading characters. The methods on which he proposed to conduct the war were always drastic: the wholesale confiscation of lands in the seceding States, the disfranchisement of insurgent citizens, the emancipation and enfranchisement of the negroes, all found in him their earliest and warmest advocate. While other parties and leaders were continually shifting their ground, changing their theories of the relations of the Union to the seceding States as the struggle grew more intense, Stevens was consistent from beginning to end. The almost universal theory was that the war was prosecuted only to enforce the constitution; it was therefore incumbent on those who prosecuted it to obey the constitution punctiliously, however puzzling might be the difficulties into which it led them. Stevens, on the contrary, insisted that armed resistance to the constitution had the effect of suspending the constitution within the area of the resistance; that the success of the resistance would show whether the suspension was to be temporary or permanent; and that, in the meantime, those who resisted the constitution were entitled to no rights under it,—in fact, to no rights except those reserved under the laws of war. This was too radical even for the war party; but, at the end of the war, Stevens's pronounced ability gave him the leadership of the house committee on reconstruction. Even in this position, he never obtained a formal endorsement of his theory; but the practical management of reconstruction shows its strong influence in many features otherwise inexplicable. He lived to take a leading part in the unsuccessful impeachment of President Johnson, and to see the admission of the first instalment of reconstructed States, and died at Washington, August 11, 1868.[1]

Stevens's life has been written from a friendly and from a hostile point of view,—the former in the volume entitled *Thaddeus Stevens, Commoner,* the latter in Harris's *Political Conflict in America.*

STEVENSON, **Robert** (1772–1850), civil engineer, was the only son of Alan Stevenson, partner in a West Indian house in Glasgow, and was born in that city 8th June, 1772. Having lost his father in infancy, he removed with his mother to Edinburgh. In his youth he assisted his stepfather, Thomas Smith, in his lighthouse schemes, and at the early age of nineteen was sent to superintend the erection of a lighthouse on the island of Little Cumbrae. During successive winters he attended classes at Anderson's College, Glasgow, and at Edinburgh University. He succeeded his stepfather, whose daughter he married in 1799, as engineer to the Board of Northern Lighthouses, and at the same time began general practice as a civil engineer. During his period of office from 1797 to 1843, he designed and executed no fewer than eighteen lighthouses, the most important being that on the Bell Rock, begun in 1807 and completed in 1810, in which he improved considerably on the designs of Smeaton for the Eddystone lighthouse (see Lighthouse, vol. xiv. p. 621). For its illumination he introduced an improved apparatus; he was also the author of various other valuable inventions in connection with lighting, including the intermittent and flashing lights, and the mast lantern for ships. In his general practice as a civil engineer he was employed in the construction of many county roads, in various important improvements in connection with the approaches to Edinburgh, including that by the Calton Hill, in the erection of slips at ferries, in the construction of harbors, docks, and breakwaters, in the improvement of river and canal navigation, and in the construction of several important bridges. It was he that brought into notice the superiority of malleable iron rods for railways over the old cast iron, and he was the inventor of the movable jib and balance cranes. It was chiefly through his interposition that an Admiralty survey was established, from which the Admiralty sailing directions for the coasts of Great Britain and Ireland have been prepared. Stevenson was elected a fellow of the Royal Society of Edinburgh in 1815, and afterwards became a member of the Geological and Astronomical Societies of London and the Wernerian and Antiquarian Societies of Scotland. He published an account of the Bell Rock lighthouse in 1824, and besides contributing important articles on engineering subjects to Brewster's *Edinburgh Encyclopædia* and the *Encyclopædia Britannica,* was the author of various papers read before the societies he was connected with. He died at Edinburgh, 12th July, 1850.

A *Life of Robert Stevenson,* by his son David Stevenson, appeared in 1878. David Stevenson (1815–86), who along with his brother Alan succeeded to his father's business, was the author of a *Sketch of the Civil Engineering of North America* (1838, republished in "Weale's Series," 1859), *Marine Surveying* (1842), *Canal and River Engineering* (1858; 2d ed. enlarged, 1872; 3d ed. 1886), and of various papers read before learned societies.

STEVINUS, **Simon** (1548–1620). This great mathematician was born in 1548 at Bruges (where the Place Simon Stevin contains his statue by Eugen Simonis) and died in 1620 at The Hague or in Leyden. Of the circumstances of his life very little is recorded; the exact day of his birth and the day and place of his death are alike uncertain. It is known that he left a widow with two children; and one or two hints scattered throughout his works inform us that he began life as a merchant's clerk in Antwerp, that he travelled in Poland, Denmark, and other parts of northern Europe, and that he was intimate with Prince Maurice of Orange, who asked his advice on many occasions, and made him a public officer,—at first director of the so-called "waterstaet," and afterwards quartermaster-general. The question whether Stevinus, like most of the rest of the prince's followers, belonged to the Protestant creed hardly admits of a categorical answer. A Catholic, it may be said, would never in those times have risen to so high a position. A Catholic would perhaps not have been so ready as Stevinus to deny the value of all authority, whether of an Aristotle, of an Euclid, or of a Vitruvius. A Catholic could not well have boasted, as Stevinus in a political pamphlet did, that he had always been in harmony with the executive power. But against these considerations it might be urged that a Protestant had no occasion to boast of a harmony most natural to him, while his further remark, in the same pamphlet, to the effect that a state church is indispensable, and that those who cannot belong to it on conscientious grounds ought to leave the country rather than show any opposition to its rites, seems rather to indicate the crypto-Catholic, who wishes for reasons of his own to remain in the Netherlands. The same conclusion is supported by the ascertained fact that Stevinus, a year before his death, bequeathed a pious legacy to the church of Westkerke in Flanders, out of the revenues of which masses were to be said. But, however it may be answered, the question is fortunately of little importance to us, as Stevinus was neither a political personage nor did he engage in religious controversy. He was mainly, as already said, a great mathematician, and it is chiefly in this quality that we must try to get acquainted with him. His claims to fame are most varied. Some of them appealed strongly to the men of his time, but many were such as could not well be understood by most of his contemporaries, and have found due acknowledgment only in later times.

His contemporaries were most struck by his invention of a carriage with sails, a little model of which was preserved at Scheveningen till 1802. The carriage itself had been lost long before; but we know that about the year 1600 Stevinus, with Prince Maurice of Orange and twenty six-others, made use of it on the sea-shore between Scheveningen and Petten, that it was propelled solely by the force of the wind, and that it acquired a speed which exceeded that of horses. Another idea of Stevinus, for which even Grotius gave him great credit, was his notion of a bygone age of wisdom. Mankind once knew everything knowable, but gradually forgot most of it, till a time came when little by little the forgotten knowledge was reacquired; the goal to be aimed at is the bringing about of a second age of wisdom, in which mankind shall have recovered all its early knowledge. The fellow-countrymen of Stevinus were proud that he wrote in their own dialect, which he thought fitted for a universal language, as no other abounded like Dutch in monosyllabic radical words.

History has been much less enthusiastic than his contemporaries in admiring these claims to fame; but it has discovered in Stevinus's works various inventions which did not at once receive the notice they deserved. He was the first to show how to fashion regular and semiregular polyhedra by delineating their frames in a plane. Stevinus also distinguished stable from unstable equilibrium. He proved the law of the equilibrium on an inclined plane. He demonstrated before Varignon the resolution of forces, which, simple consequence of the law of their composition though it is, had not been previously remarked. He discovered the hydrostatic paradox that the downward pressure of a liquid is independent of the shape of the vessel, and depends only on its height and base. He also gave the measure of the pressure on any given portion of the side of a vessel. He had the idea of explaining the tides by the attraction of the moon.

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[1] [Mr. Stevens practiced law in Gettysburg from 1816 to 1842, which place he represented five times in the Pennsylvania House of Representatives. He began his political career as an anti-Mason with Adams, Wirt, and Seward. The cause of public schools found in him a vigorous and successful advocate, for his fiery energy averted the repeal of the Pennsylvania school-laws in 1836, and he urged a like system upon the District of Columbia. From 1853 to 1859 he was not in Congress, but from that time until his death he was leader of the House by virtue of his position at the head of the Ways and Means Committee, as well as by his honesty and ability. He, more than any other man, perceived the reactionary purposes of President Johnson, and promptly threw himself into uncompromising conflict with him. Lame from infancy and compelled to work his way up through adverse conditions Mr. Stevens's generosity to the maimed and the struggling was profuse and constant. His will provided for the interment of his body in a cemetery not "limited by charter rules as to race, that he might illustrate in his death the principles which he had advocated through a long life—equality of man before his Creator."—Am. Ed.]

It remains to enumerate those claims of Stevinus to immortality which were recognized from the first and which succeeding ages have not lessened,—his writings on military science, on bookkeeping, and on decimal fractions.

That the man who was quartermaster-general to Maurice of Orange should have been possessed of more than ordinary merit, and have left behind him military papers of lasting value, is hardly more than might have been expected. This expectation, in the case of Stevinus at least, is fully borne out in the opinion of competent judges. Prince Maurice is known as the man who conquered the greatest number of fortresses in the shortest time, and fortification was the principal aim of his adviser. Stevinus seems to be the first who made it an axiom that strongholds are only to be defended by artillery, the defence before his time having relied mostly on small firearms. He wrote upon temporary fortifications, but the excellence of his system was only slowly discerned. He was the inventor of defence by a system of sluices, which proved of the highest importance for the Netherlands. His plea for the teaching of the science of fortification in universities, and the existence of such lectures in Leyden, have led to the impression that he himself filled this chair; but the belief is quite erroneous, as Stevinus, though living at Leyden, never had direct relations with its university.

Book-keeping by double entry may have been known to Stevinus as clerk at Antwerp, either practically or through the medium of the works of Italian authors like Paccioli and Cardan. He, however, was the first to recommend the use of impersonal accounts in the national household. He practiced it for Maurice, and recommended it in a small pamphlet to Sully, the French statesman; and, if public book-keeping has grown more and more lucid by the introduction of impersonal accounts, it is certainly to Stevinus that the credit of the improvement is due.

His greatest success, however, was a small pamphlet, first published in Dutch in 1586, and not exceeding seven pages in the French translation (which alone we have seen). This translation is entitled *La Disme, enseignant facilement expédier par Nombres Entiers sans rompuz, tous Comptes se rencontrans aux Affaires des Hommes.* Decimal fractions had been employed for the extraction of square roots some five centuries before his time, but nobody before Stevinus established their daily use; and so well aware was he of the importance of his innovation that he declared the universal introduction of decimal coinage, measures, and weights, to be only a question of time. His notation is rather unwieldy. The point separating the integers from the decimal fractions seems to be the invention of Bartholomæus Pitiscus, in whose trigonometrical tables (1612) we have found it, and it was accepted by Napier in his logarithmic papers (1614 and 1619). Stevinus printed little circles round the exponents of the different powers of one-tenth. For instance $237\frac{578}{1000}$ was printed 237 ⓪ 5 ① 7 ② 8 ③; and the fact that Stevinus meant those encircled numerals to denote mere exponents is evident from his employing the very same sign for powers of algebraic quantities, *e.g.*, 9 ④ — 14 ③ + 6 ① — 5 to denote $9x^4 - 14x^3 + 6x - 5$. He does not even avoid fractional exponents ("Racine cubique de ② serait $\frac{2}{3}$ en circle"), and is ignorant only of negative exponents. Powers and exponents have also been carried back to a period several centuries earlier than Stevinus, and it is not here intended to give him any undue credit for having maintained them; but we believe it ought to be recognized more than it generally is, that for our author there was a connection between algebraic powers and decimal fractions, and that even here Stevinus the profound theorist is not lost to view behind Stevinus the man of brilliant practical talents.

(M. CA.)

STEWART, or **Stuart**. For the royal house of this name, see **Stuart**.

STEWART, Dugald (1753–1828) one of the most influential of the Scottish philosophers, was born at Edinburgh on the 22d of November, 1753. His father, Matthew Stewart (1715–85), was professor of mathematics in the university of Edinburgh from 1747 till 1772, and was an eminent investigator in his own department applying the geometrical methods of Simson, who had been his teacher in Glasgow. Dugald Stewart's early years were passed partly in Edinburgh and partly at Catrine in Ayrshire, where his father had a small property, to which the family removed every summer on the close of the academical session. Burns was an occasional visitor at Catrine, which is only a few miles from Mossgiel; and the philosopher and the poet had various meetings as well as some slight correspondence in later years. Dugald Stewart was educated at the high school and university of his native town. At school he laid the foundation of the classical knowledge and literary taste which are conspicuous in his works, and which lent a charm to his prelections. At the university his chief subjects were the mathematical sciences—in which he attained great proficiency—and philosophy. Adam Ferguson, the historian of the Roman republic, was then professor of moral philosophy in Edinburgh, and his bracing ideal of ethical and political virtue commended itself highly to Stewart. In 1771, having thoughts of entering the English Church, Stewart proceeded to Glasgow with a view to the Snell exhibitions tenable by Glasgow students at Oxford. Here he listened to the lectures of Reid, whose *Inquiry*, published seven years before, had laid the effective foundation of what is called distinctively the Scottish philosophy. Reid became Stewart's acknowledged master, and also his friend, while Stewart's academic eloquence and powers of elegant exposition gained for their common doctrines a much wider acceptance than they could have secured in the clumsier and less attractive presentation of Reid himself. In Glasgow, Stewart boarded in the same house with Archibald Alison, afterwards author of the *Essay on Taste*, and a close friendship sprang up between them, which remained unbroken through life. After no more than a single session in Glasgow, Dugald Stewart was summoned by his father, whose health was beginning to fail, to conduct the mathematical classes in the university of Edinburgh. Though only nineteen years of age he discharged his duties with marked ability and success; and after acting three years as his father's substitute he was elected professor of mathematics in conjunction with him in 1775. Three years later, Adam Ferguson was appointed secretary to the commissioners sent out to the American colonies, and at his urgent request Stewart lectured as his substitute. Thus during the session of 1778–79, in addition to his mathematical work, he delivered an original course of lectures on morals. "To this season," says his son, "he always referred as the most laborious of his life; and such was the exhaustion of the body from the intense and continued stretch of the mind that on his departure for London at the close of the academical session it was necessary to lift him into the carriage." In 1783 Stewart married Helen Bannatyne, who died in 1787, leaving an only son, Colonel Matthew Stewart, from whose short memoir of his father the above is a quotation.

In 1785, on the resignation of Ferguson, he was transferred to the chair of moral philosophy, which he filled for a quarter of a century and made a notable centre of intellectual and moral influence. Young men of rank and of parts were attracted by his reputation from England, and even from the Continent and America. A very large number of men who afterwards rose to eminence in literature or in the service of the state were thus among his students. Sir Walter Scott, Jeffrey, Cockburn, Francis Horner, Sydney Smith, Lord Brougham, Dr. Thomas Brown, James Mill, Sir James Mackintosh, and Sir Archibald Alison may be mentioned among others. There is a unanimous testimony to the attractive eloquence of Stewart's lectures and the moral elevation of his teaching. "Dugald Stewart," says Lord Cockburn, "was one of the greatest of didactic orators. Had he lived in ancient times, his memory would have descended to us as that of one of the finest of the old eloquent sages. No intelligent pupil of his ever ceased to respect philosophy, or was ever false to his principles, without feeling the crime aggravated by the recollection of the morality that Stewart had taught him." Dr. John Thomson, afterwards medical professor in Edinburgh, was accustomed to say that the two things by which he had been most impressed in the course of his life were the acting of Mrs. Siddons and the oratory of Dugald Stewart. Lord Cockburn, in his *Memorials*, has left an interesting portraiture of Stewart's appearance and manner: "Stewart was about the middle size, weakly-limbed, and with an appearance of feebleness which gave an air of delicacy to his gait and structure. His forehead was large and bald, his eyebrows bushy, his eyes gray and intelligent, and capable of conveying any emotion from indignation to pity, from serene sense to hearty humor, in which they were powerfully aided by his lips, which, though rather large perhaps, were flexible and expressive. The voice was singularly pleasing; and, as he managed it, a slight burr only made its tones softer. His ear, both for music and for speech, was exquisite; and he was the finest reader I have ever heard. His gesture was simple and elegant, though not free from a tinge of professional formality; and his whole manner was that of an academical gentleman, . , . . calm and expository, but rising into greatness or softening into tenderness whenever his subject required it." The course on moral philosophy embraced, besides ethics proper, lectures on political philosophy or the theory of government, and from 1800 onwards a separate course of lectures was delivered on political economy. These last were extremely important in spreading a knowledge of the fundamental principles of the science at a time when they were still almost unknown to the general public. Stewart's enlightened political teaching was sufficient, in the times of reaction succeeding the French Revolution, to draw upon him the undeserved suspicion of disaffection to the constitution.

In 1790 Stewart married a second time. Miss Cranstoun, who became his wife, was a lady of birth and accomplishments, and he was in the habit of submitting to her criticism whatever he wrote. A son and a daughter were the issue of this marriage. The death of the former in 1809 was a severe blow to the failing health of his father, and was the immediate cause of his retirement from the active duties of his chair. Before that, however, Stewart had not been idle as an author. In 1792 he published the first volume of the *Elements of the Philosophy of the Human Mind;* the second volume appeared in 1814, and the third not till 1827. In 1793 he printed a text-book, *Outlines of Moral Philosophy*, which went through many editions; and in the same year he read before the Royal Society of Edinburgh his account of the *Life and Writings of Adam Smith*. Similar memoirs of Robertson the historian and of Reid were afterwards read before the same body and appear in his published works. In 1805 Stewart took an active part in what was known as the Leslie case, that is to say, the public controversy arising out of the appointment of Mr. (afterwards Sir John) Leslie to the chair of mathematics in the university of Edinburgh. Leslie was attacked by the presbytery of Edinburgh, ostensibly on account of his views on the nature of causal connection, which were said to approximate to Hume's. In two pamphlets Stewart defended Leslie's doctrine as philosophically tenable and theologically innocuous. In 1806 he received in lieu of a pension the nominal office of the writership of the *Edinburgh Gazette*, with a salary of £300 [$1458]. When the shock of his son's death incapacitated him from lecturing during the session of 1809–10, his place was taken at his own request, by Dr. Thomas Brown, who in 1810 was appointed conjoint professor. On the death of Brown in 1820, Stewart, who had taken no further active part in lecturing, retired altogether from the professorship, which was conferred upon John Wilson, better known as "Christopher North." From 1809 onwards Stewart lived mainly at Kinneil house, Linlithgowshire, which was placed at his disposal by the duke of Hamilton. From this retirement he continued to send forth a succession of works. In 1810 appeared *Philosophical Essays*, in 1814 the second volume of the *Elements*, in 1815 the first part and in 1821 the second part of the "Dissertation" written for the *Encyclopædia Britannica* "Supplement," entitled "A General View of the Progress of Metaphysical, Ethical, and Political Philosophy since the Revival of Letters." In 1822 he was struck with paralysis, but recovered a fair degree of health, sufficient to enable him to resume his studies. In 1827 he published the third volume of the *Elements*, and in 1828, a few weeks before his death, *The Philosophy of the Active and Moral Powers*. He died in Edinburgh after a short illness on the 11th of June, 1828. A monument to his memory was erected on the Calton Hill by his friends and admirers.

An edition of his *Collected Works*, in eleven volumes (1854–58), was edited by Sir William Hamilton, on whose death in 1856 it was carried to completion and furnished with a memoir of Stewart by Prof. Veitch. Stewart was an elegant writer rather than a profound or original thinker, and he cannot be said to have added much to the philosophy of Reid (see REID), though he contributed very largely to its dissemination. His psychological observations, however, are acute and varied, and his general powers of mind contributed largely to elevate the study of philosophy in the United Kingdom. His reputation rests more upon the tradition of his inspiring and elevating eloquence than upon any definite achievements within the province of philosophy proper. (A. SE.)

STEYR, STEIER, or STEYER, an industrial town in Upper Austria, is situated on an island at the junction of the Steyr and Enns, 20 miles to the south of Linz and 92 miles to the west-southwest of Vienna. The main town is connected by two bridges with the suburbs of Steyrdorf and Ennsdorf. The Gothic parish church was built in 1443; the town-house is modern. The interesting old castle of the princes of Lamberg, dating from the 10th century, rises on an eminence near the town. Steyr is one of the chief seats of the iron and steel industry in Upper Austria (AUSTRIA, vol. iii. p. 105), and very large quantities of cutlery, scythes, sickles, and edge-tools are annually produced in the town and neighborhood. The Werndl small-arms factory, now carried on by a joint-stock company, and employing 4500 hands, is the largest in Austria. The population in 1880 was 17,199. Steyr was the capital of an early countship or grafschaft, at first belonging to Styria, but annexed to Austria in 1192.

STICKLEBACK is the name applied to a group of small fishes (*Gastrosteus*) which inhabit the fresh and brackish waters as well as the coasts of the temperate zone of the northern hemisphere. Although some of the species live chiefly either in fresh or in salt water, they readily accommodate themselves to a change, and, as far as the European kinds are concerned, all may be met with in the brackish water of certain littoral districts. The majority have a compressed well-proportioned body, which in the marine species is of a more elongate form, leading to the allied group of Flute-Mouths (*Fistulariidæ*), which are, in fact, gigantic marine sticklebacks. Their mouth is of moderate width, oblique, and armed with small but firmly set teeth. But their most distinctive characteristic consists in the armature of their head and body. The head is nearly entirely protected by hard bone; even the cheeks, which in the majority of fishes are covered with a naked or scaly skin, are in this genus cuirassed by the dilated infraorbital bones. There are no scales developed on any part of the body, but a series of hard and large scutes protects a greater or lesser portion of the sides. The first dorsal fin and the ventrals are transformed into pointed formidable spines, and joined to firm bony plates of the endoskeleton. With regard to the degree in which this armature is developed, not only do the species differ from each other, but almost every species shows an extraordinary amount of variation, so that some older naturalists have distinguished a multitude of species, whilst the majority of the present day are inclined to reduce their number considerably. About ten kinds may be taken to be specifically distinct.

So far as is known at present, all sticklebacks construct a nest for the reception of the spawn, which is jealously guarded by the male until the young are hatched, which event takes place in from ten to eighteen days after oviposition. He also protects them for the first few days of their existence, and provides them with food, until they gradually stray from their home. The construction of the nest varies in the different species.

Sticklebacks are short-lived animals; they are said to reach an age of only three or four years; yet their short life, at least that of the males, is full of excitement. During the first year of their existence, before the breeding-season begins, they live in small companies in still pools or gently flowing brooks. But with the return of the warmer season each male selects a territory, which he fiercely defends against all comers, especially against intruders of his own species and sex, and to which he invites all females, until the nest is filled with ova. At this period he also assumes a bridal dress, painted with blue and red tints. The eggs are of comparatively large size, one female depositing only from 50 to 100; but, as the females deposit their spawn in nests of different males, the number of ova contained in one nest does not exceed one hundred.

Of the species known not one has so wide a geographical range, and has so well been studied, as the common British Three-Spined Stickleback (*Gastrosteus aculeatus*). It is found everywhere in northern and central Europe, northern Asia, and North America. The development of its scutes and spines varies exceedingly, and specimens may be found without any lateral scutes and with short spines, others with only a few scutes and moderately sized spines, and again others which possess a complete row of scutes from the head to the caudal fin, and in which the fin-spines are twice as long and strong as in other varieties. On the whole, the smooth varieties are more numerous in southern than in northern localities. This species swarms in some years in prodigious numbers; in Pennant's time amazing shoals appeared in the fens of Lincolnshire every seven or eight years. Their numbers may perhaps be conceived from the fact that a man employed in collecting them gained, for a considerable time, four shillings a day by selling them at the rate of a halfpenny a bushel. No instance of a similar increase of this fish has been observed in our time, and this possibly may be due to the diminished number of suitable breeding-places in consequence of the general introduction of artificial drainage. This species usually constructs its nest on the bottom, excavating a hollow in which a bed of grass, rootlets, or fibres is prepared; walls are then raised, and the whole is roofed over with the like material. The nest is an inch and more in diameter, with a small aperture for an entrance.

Gastrosteus aculeatus, var. *noveboracensis*, Three-Spined Stickleback.

The Ten-Spined Stickleback (*Gastrosteus pungitius*) is so called from the number of spines usually composing its first dorsal fin, which, however, may be sometimes reduced to eight or nine or increased to eleven. It is smaller than the three-spined species, rarely exceeding 2 inches in length. Its geographical range nearly coincides with that of the other species, but it is more locally distributed, and its range in northern Asia is not known. With regard to its habits, it differs from the common species only in the selection of the site for its nest, which is generally placed among weeds above the bottom of the water. Breeding males are readily recognized at a distance by the intensely black color of the lower parts of their body.

Both these species are for their size extremely voracious, causing no small amount of injury if allowed in breeding-ponds in which valuable fish are preserved. During the whole time they are not engaged in their breeding operations, they are in pursuit of food. A small stickleback kept in an aquarium devoured, in five hours' time, seventy-four newly-hatched dace, which were about a quarter of an inch long. Two days after it swallowed sixty-two, and would probably have eaten as many every day, could they have been procured.

The Sea Stickleback (*Gastrosteus spinachia*) is a much larger and more slender species than those mentioned; it attains to a length of 7 inches, and is armed with fifteen short spines on the back. It is extremely common round the British coasts, but never congregates in large shoals. At suitable localities of the coast which are sheltered from the waves and overgrown with sea-weed, especially in rock-pools, one or two males establish themselves with their harems, and may be observed without difficulty, being quite as fearless as their freshwater cousins. Harbors and shallows covered with *Zostera* are likewise favorite haunts of this species, although the water may be brackish. The nest is always firmly attached to sea-weed, and sometimes suspended from an overhanging frond. This species inhabits only the northern coasts of Europe.

STIGMATIZATION, literally the infliction of *stigmata*, *i.e.*, marks tattooed or branded on the person, the term used with specific reference to the infliction of wounds like those of Christ.

An ancient and widespread method of showing tribal connection, or relation to tribal deities, is by marks set upon the person; thus Herodotus, in describing a temple of Hercules in Egypt (ii. 113), says that it is not lawful to capture runaway slaves who take refuge therein if they receive certain marks on their bodies, devoting them to the deity. Some such idea is perhaps alluded to by Paul (Gal. vi. 17) in the words, "from henceforth let no man trouble me, for I bear branded on my body the stigmata of Jesus"; and some few authors have even understood the passage as referring to stigmatization in the modern sense (Molanus, *De Historia SS. Imaginum et Picturarum*, ed. Paquot, iii. 43, p. 365). Branding, as indicative of servitude, is mentioned in many of the classics (Pliny, *H. N.*, xviii. 3; Varro, *De Re Rustica*, i. 18; Suetonius, *Caligula*, xxvii., etc.), and was forbidden by Constantine.

In the period of persecution Christian martyrs were sometimes branded with the name of Christ on their foreheads (Pontius, "De Vit. S. Cypriani," *Biblioth. Veterum Patrum*, iii. p. 472, § vii.). This was sometimes self-inflicted as a disfigurement by nuns for their protection, as in the case of St. Ebba, abbess of Coldingham (see Baronius, *Annales*, xv. p. 215, anno 870, also Tert., *De Vel. Virg.*). Some Christians likewise marked themselves on their hands or arms with the cross or the name of Christ (Procopius, *In Esaiam*, ed. Curterius, p. 496), and other voluntary mutilations for Christ's sake are mentioned (Matt. xix. 12; Fortunatus, *Life of St. Rhadegund*, ed. Migne, col. 508; Palladius, *Lausiac History*, cxii.; Jerome's *Letter to St. Eustochium*, etc.).

In the life of St. Francis of Assisi we have the first example of the alleged miraculous infliction of stigmata (see vol. ix. p. 611). While meditating on the sufferings of our Lord, in his cell on Mount Alverno, we are told by his biographers, Thomas of Celano and Bonaventura, that the Lord appeared to him as a seraph and produced upon his body the five wounds of Christ; of these we are told that the side wound bled occasionally, though Bonaventura calls it a scar, and the wounds in the feet had the appearance and color of nails thrust through. After his death St. Clare endeavored, but in vain, to extract one of these. Pope Alexander IV. and other witnesses declared that they had seen these marks both before and after his death (Raynaldus, ad annum 1255, p. 27). The divinely-attested sanctity of their founder gave to the newly-established order of Franciscans a powerful impulse, so that they soon equalled and threatened to overshadow in influence the previously founded order of St. Dominic.

The reputation of the latter order was, however, equally raised in the next century by the occurrence of the same wonder in the case of a sister of the third rule of St. Dominic, Catherine Benincasa,—better known as St. Catherine of Siena. From her biographer's account we gather that she was subject to hystero-epileptic attacks, in one of which, when she was twenty-three years old, she received the first stigma (see vol. v. pp. 200–1). In spite of her great reputation, and the number of attesting witnesses, this occurrence was not universally believed in. Pope Sixtus IV. published a bull in 1475 ordering, on pain of anathema, the erasure of stigmata from pictures of St. Catherine, and prohibiting all expressions of belief in the occurrence. Pope Innocent VIII. similarly legislated "ne de cætero S. Catherina cum stigmatibus depingatur; neve de ejus stigmatibus fiat verbum, aut sermo, vel prædicatio ad tollendam omnem scandali occasionem" (see references in Raynaud, *De Stigmatisme*, cap. xi., 1665). In the years which followed, cases of stigmatization occurred thick and fast,—now a Franciscan, now a Dominican, very rarely a religieuse of another order, showing the marks. Altogether about ninety instances are on record, of which eighteen were males and seventy-two females. Most of them occurred among residents in religious houses, and took place after the austerities of Lent, usually on Good Friday, when the mind was intently fixed on our Lord's Passion; and, from their occurrence being for the most part among members of the two orders to which St. Francis and St. Catherine belonged, the possibility of the reception of the marks was constantly before their eyes and thoughts. The order of infliction in the majority of cases was that of the crucifixion, the first token being a bloody sweat, followed by the coronation with thorns; afterwards the hand and foot wounds appear, that of the side being the last. The grade of the infliction varied in individual cases, and they may be grouped in the following series:

I. As regards full stigmatization, with the visible production of the five wounds, and generally with the mark of the crown as well, the oldest case, after St. Francis, is that of Ida of Louvain (1300), in whom the marks appeared as colored circles; in Gertrude von Oosten of Delft (1344) they were colored scars, and disappeared in answer to prayer as they also did on Dominica de Paradis; in Sister Pierona, a Franciscan, they were blackish gray. They were true wounds in Margaret Ebnerin of Nuremberg (d. 1351), but they also disappeared in answer to her prayer (see her *Life*, Augsburg, 1717), as was the case with Brigitta, a Dominican tertiary (1390), and also with Lidwina. An intermission is described in the marks on Johanna della Croce of Madrid (1524), in whom the wound in the side was large, and the others were rose-colored circular patches. The marks appeared on each Friday and vanished on Sunday. These emitted an odor of violets; but in Sister Apollenia of Volaterra they were fetid while she lived. Angela della Pace (1634) was fully stigmatized at nine years of age, being even marked with the sponge and hyssop on the mouth; while Joanna de Jesu-Maria at Burgos (1613), a widow, who had entered the convent of Poor Clares, was marked in her sixtieth year. To her in vision two crowns were offered,—one of flowers and one of thorns; she chose the latter and immediately was seized with such pain that her confessor heard her skull cracking. This case was investigated by the officers of the Inquisition. The stigmatization of Veronica Giuliani (1696) was also the subject of inquiry, and in this case the nun drew on a paper a representation of the images which she said were engraved on her heart. On a post-mortem examination being made in 1727 by Prof. Gentili and Dr. Bordiga, the image of the cross, the scourge, etc., were said to have been impressed on the right side of the organ (*Vita della Veronica Giuliani*, by Salvatori, Rome, 1803). The case of Christina Stumbelen, a Dominican at Cologne, is noteworthy, as on her skull there was found a raised ridge or crown which was at first green, with red dots. This relic is still preserved. In Lucia di Narni (1546) the marks were variable, as they also were on Sister Maria di S. Dominico. On the body of St. Margaret of Hungary the stigmata were found fresh and clear when her body was exhumed some time after her death for transportation to Presburg. Other stigmatized persons were Elizabeth von Spalbeck, a Cistercian; Sister Coleta, a Poor Clare; Matilda von Stanz; Margaret Bruch of Endringen (1503); Maria Razzi of Chios (1582); Catharina Januensis; Elizabeth Reith of Allgau; Stieva zu Hamm in Westphalia; Sister Mary of the Incarnation at Pontoise; Archangela Tardera in Sicily (1608); Catharina Ricci in Florence (1590); and Joanna Maria della Croce, a Poor Clare at Roveredo (d. 1673), upon whom the markings of the thorn crown and spear wound were especially deep.

II. In some cases, although the pains of stigmatization were felt, there were no marks apparent. This occurred to Helen Brumsen (1285); Helena of Hungary (1270); Osanna of Mantua (1476); Columba Rocasani; Magdalena de Pazzis; Anna of Vargas; Hieronyma Carvaglio; Maria of Lisbon, a Dominican; Joanna di Vercelli; Stephania Soncinas, a Franciscan; Sister Christina, a Carthusian; and Joanna Rodriguez, a Poor Clare. In the case of Ursula Aguir de Valenza, a tertiary of St. Dominic (1608), and Catharine Cialina (d. 1619) the pain was chiefly that of the crown of thorns, as it was also in Amelia Bicchieri of Vercelli, an Augustinian.

III. In a third series some of the marks were visible on the body, while others were absent or only subjectively indicated by severe pains. The crown of thorns only was marked on the head of Vincentia Ferreria at Valencia (d. 1515) and Philippa de Santo Tomaso of Montemor (1670), while according to Torellus the Augustinian Ritta von Cassla (d. 1430) had a single thorn wound on the forehead. The crown was marked on Catharina of Raconizio (b. 1486), who also suffered a severe bloody sweat. In the case of Stephano Quinzani, in Soncino (1457), there was a profuse bloody sweat and the wounds were intermitting, appearing on Friday and Saturday, vanishing on Sunday. Blanche Gazinan, daughter of Count Arias de Sagavedra (1564), was marked only on the right foot, as also was Catherine, a Cistercian nun. The heart wound was visible in Christina Mirabilis (1232). Gabrielda de Piezolo (d. 1473) died from the bleeding of such a wound, and similar wounds were described in Maria de Acosrin in Toledo; Eustochia, a tertiary of St. Francis; Clara de Bugny, a Dominican (1514); Cecilia Nobili, a Poor Clare of Nuceria (d. 1655). In the last instance the heart wound was found after death—a three-cornered puncture. A similar wound was seen in the heart of Martina de Arilla (d. 1644). Maria Villana, a Poor Clare, daughter of the margrave of La Pella, was marked with the crown and the spear thrust, and after death the impresses of the spear, sponge, and reed were found on her heart (d. 1670). The wound was usually on the left side, as in Sister Masrona of Grenoble, a tertiary of St. Francis (1627); it was on the right in Margareta Columna, also a Clare. In Maria de Sarmiento it was said to have been inflicted by a seraph in a vision.

IV. In a fourth set of cases the imprints were said to have been found on the heart, even though there was no surface marking. Thus the Dominican Paula de St. Thomas was said to have had the stigmata on her heart. The heart of Clare of Montfaucon (1308) was said to have been as large as a child's head and impressed with the cross, the scourge, and the nails. Similar appearances were found in Margaret of Citta di Capello and Johanna of Yepes (1591).

The instances of masculine stigmatization are few.

Benedict di Rhegio, a Capuchin at Bologna, had the marks of the crown (1602); Carolus Sazia, an ignorant lay brother, had the wound in his side. Dodo, a Præmonstratensian lay brother, was fully stigmatized, as also was Philip de Aqueria. The marks after death were found on the heart of Angelos del Pas, a minorite of Perpignan, as also on Matheo Carery in Mantua, Melchior of Arazel in Valentia, Cherubin de Aviliana (an Augustinian), and Agolini of Milan. Walter of Strasburg, a preaching friar (1264), had the heart-pain but no mark, and the same was the case with a Franciscan, Robert de Malatestis (1430), and James Stephanus. On Nicholas of Ravenna the wounds were seen after death, while John Gray, a Scotsman, a Franciscan martyr, had one wound on his foot.

Within the last hundred years several cases have occurred. Anna Katharina Emmerich, a peasant girl born at Münster in 1774, afterwards an Augustinian nun at Agnetenberg, was even more famous for her visions and revelations than for the stigmata. Biographies, with records of her visions, have been published by Brentano at Munich in 1852 and the Abbé Cazalès at Paris (1870). Colombe Schanolt of Bamberg (1787) was fully stigmatized, as also was Rose Serra, a Capuchin of Ozieri in Sardinia (1801), and Madeleine Lorger (1806). Two well-known cases occurred in Tyrol,—one "L'Ecstatica" Maria von Mörl of Caldaro, a girl of noble family, stigmatized in 1839, the other "L'Addolorata" Maria Dominica Lazzari, a miller's daughter at Capriana, stigmatized in 1835 (see Boré, *Les Stigmatisées du Tyrol*, Paris, 1846). A case of the second class is that of Elizabeth Eppinger of Niederbrunn in Bavaria (1814), reported on by Kuhn. An interesting example of stigmatic trance also occurred in the case of a Protestant young woman in Saxony in 1820, who appeared as if dead on Good Friday and Saturday and revived on Easter Sunday.

The last case recorded is that of Louise Lateau, a peasant girl at Bois de Haine, Hainault, upon whom the stigmata appeared April 24, 1868. This case was investigated by Professor Lefebvre of Louvain, who for fifteen years was physician to two lunatic asylums. In her there was a periodic bleeding of the stigmata every Friday, and a frequent recurrence of the hystero-cataleptic condition. Her biography has been written by Lefebvre and published at Louvain (1870).

On surveying these ninety cases, we may discount a certain number, including all those of the second class, as examples of subjective sensations suggested by the contemplation of the pains of crucifixion. A second set, of which the famous case of Jetzer (Wirz, *Helvetische Kirchengeschichte*, 1810, iii. p. 389) is a type, must be also set aside as obvious and intentional frauds produced on victims by designing persons. A third series, and how large a group we have not sufficient evidence to decide, we must regard as due to the irresponsible self-infliction of injuries by persons in the hystero-epileptic condition, those perverted states of nervous action which Charcot has done so much to elucidate. To any experienced in this form of disease, many of the phenomena described in the records of these examples are easily recognizable as characteristic of the hystero-epileptic state.

There are, however, some instances not easily explained, where the self-infliction hypothesis is not quite satisfactory. Parallel cases of physical effects due to mental suggestion are well authenticated. Beaunis vouches for rubefaction and vesication as produced by suggestion in the hypnotic state, and Bourru and Burot describe a case, still under observation, of bloody sweat, and red letters marked on the arm by simple tracing with the finger. See *Congrès Scientifique de Grenoble*, *Progrès Medicale*, 29 Aug., 1885, and Berjon's *La Grande Hystérie chez l'Homme*, Paris, 1886. We know so little of the trophic action of the higher nerve centres that we cannot say how far tissue nutrition can be controlled in spots. That the nerve centres have a direct influence on local nutrition is in some cases capable of experimental demonstration, and, in another sphere, the many authenticated instances of connection between maternal impression and congenital deformities seem to indicate that this trophic influence has wider limits and a more specific capacity of localization than at first sight seems possible. There is no known pathological condition in which blood transudation can take place through an unbroken skin.

Literature.—See references to each name in *Acta Sanctorum* or Hueber, *Menologium Franciscanorum*, 1698; Henriquez, *Menologium cistersiense;* Marchese, *Sagro Diario;* Steill, *Ephemerides Dominicano Sacræ*, Dillingen, 1692; Petrus de Alva y Astorga, *Prodigium Naturæ Portentium Gratiæ*, Strasburg, 1664; Thiepolus, *De Passione Christi*, tract. xii.; Meyer, *Blätter für höhere Wahrheit*, vii. 5; Hurter, *Tableau des Institutions et des Mœurs de l'Église au Moyen Âge*, Paris, 1842; Gōrres, *Die Christliche Mystik*, Ratisbon, ii. p. 410 *sq.;* Franciscus Quaresmius, *De Vulneribus Domini*, Venice, 1652, i. 4.; Raynaud, *Opera*, vol. xiii., Lyons, 1665; *Dublin Review*, 1871, p. 170; Maury, *Magie et Astrologie;* Beaunis, *Recherches exp. sur l'Activité Cerebrale*, Paris, 1886; Bourbeyre, *Les Stigmatistes*, Paris, 1886; Ennemoser, *Der Magnetismus im Verhältniss zur Religion*, Stuttgart, 1853, § 92; Tholuck's *Vermischte Schriften*, Hamburg, 1839, p. 97; Schmieder, in *Evang. Kirchenzeitung*, Berlin, 1875, pp. 180, 345; *Comptes Rendus de la Société de Biologie*, 12th July, 1885. (A. MA.)

STILICHO, FLAVIUS, Roman general and statesman, was of Vandal origin, and was born about 359 A.D. At an early age he entered the imperial army, where his father before him had served under Valens; and he speedily attained high promotion. He had already become magister equitum when in 384 he was sent by Theodosius as his ambassador to Persia; his mission was very successful, and soon after his return he was made comes domesticus and commander-in-chief, receiving also in marriage Serena, the emperor's niece and adoptive daughter. Theodosius, when dying, made Stilicho and Serena the guardians of Honorius and his other children. Honorius, in 398, was married to Stilicho's daughter Maria, and in 408 to her sister Thermantia. It was by Stilicho that Alaric in 396 was compelled to quit the Peloponnesus (see ALARIC), and that in 398 the revolt of the Mauretanian prince Gildo was repressed. Stilicho again encountered Alaric at Pollentia in 402, and at Verona in 403, compelling his retreat into Illyria, and was rewarded with a triumph on his return to Rome. In 405 he almost annihilated the army of Radagaisus, the leader of the Ostrogoths, at Fiesole. The arrangements into which he subsequently entered with Alaric (see ALARIC) were made use of by his enemies to alienate the emperor from him, and when at last revolt was the only course that might possibly have saved him his continued loyalty proved fatal. Abandoned by his troops he fled to Ravenna, and, having been induced by false promises to quit the church in which he had taken sanctuary, he was beheaded on August 23, 408. Stilicho is the hero of much of the poetry of CLAUDIAN (*q.v.*).

STILL, JOHN (*c.* 1543–1607), bishop of Bath and Wells, and now best known as the probable author ("Mr. S., Master of Arts") of *Gammer Gurton's Needle*, the earliest comedy but one in the English language (see DRAMA, vol. vii. p. 370), was a native of Grantham, Lincolnshire, and was born about 1543. He became a student of Christ's College, Cambridge, where he duly graduated and took orders. He was appointed in 1570 Lady Margaret's professor of divinity in his university, subsequently held livings in Suffolk and Yorkshire, and was master successively of St. John's College (1574) and of Trinity College (1577). Still was raised to the bishopric of Bath and Wells in 1592, and, after enjoying considerable fame as a preacher and disputant, he died on February 26, 1607, leaving a large fortune from lead mines discovered in the Mendip Hills.

STILLING, HEINRICH. See JUNG.

STILLINGFLEET, EDWARD (1635–1699), a conspicuous figure in the church of the Restoration, was descended from the Stillingfleets of Stillingfleet, in the neighborhood of York, and was born at Cranbourne in Dorset on the 17th April, 1635. There and at Ringwood he received his preliminary education, and at the age of thirteen was entered at St. John's College, Cambridge, as Isaac Barrow five years before and at the same age had been entered at Peterhouse. He took his bachelor's degree in 1652, and in the following year was elected to a fellowship. After residing as tutor first in the family of Sir Roger Burgoin in Warwickshire and then with the Hon. Francis Pierrepont in Nottingham, he was in 1657 presented by the former to the living of Sutton in Bedfordshire. Here he brought to completion and published (1659) his *Irenicum*, in which he sought to give expression to the prevailing weariness of faction and to find some ecclesiastical compromise in which all could conscientiously unite. Schemes of comprehension were then the most familiar topics of conversation. There seemed every probability that a moderate Episcopacy might attract all parties; and it was to be expected that a learned and able scholar fresh from the atmosphere of Cambridge Platonism should desire to help present entanglements towards a liberal solution. Much may still be learned from his cogent and earnest exposition of the great principle that it is unwarrantable for the church to make other conditions of her communion than our Saviour did of discipleship. In 1662 he reprinted the *Irenicum* with an appendix, in which he sought to prove that "the church is a distinct society from the state, and has divers rights and privileges of its own, . . . resulting from its constitution as a Christian society, and that these rights of the church cannot be alienated to the state after their being united in a Christian country." In the same year the country gave its answer to his and all similar proposals in the Act of Uniformity, which, by requiring that all clergymen should be episcopally ordained and should use the revised liturgy, lost to the church of England such men as Richard Baxter, John Howe, and Philip Henry. Stillingfleet's actions were as liberal as his opinions. He sheltered in his rectory at Sutton one ejected minister and took for another a large house to be used as a school. But, as time wore on, his liberalism degenerated and gave occasion to Howe's remark that the rector of Sutton was a very different person from the dean of St. Paul's. But, though in 1680 he published his *Unreasonableness of Separation*, his willingness to serve on the ecclesiastical commission of 1689, and the interpretation he then proposed of the damnatory clauses of the Athanasian creed, are proof that to the end he leaned towards toleration. Another work which Stillingfleet published in 1662 won for him the confidence and admiration of his church. This was his *Origines Sacræ, or a Rational Account of the Christian Faith as to the Truth and Divine Authority of the Scriptures and the Matters therein contained.* Rendered obsolete though it be by the general advance of the discussion, this apologetic made a deep impression at the time, and rapid preferment followed its publication. Henchman, bishop of London, employed him to write a vindication of Laud's answer to Fisher the Jesuit. In 1665 the earl of Southampton presented him to St. Andrew's, Holborn; two years later he became prebendary of St. Paul's, in 1668 chaplain to Charles II., in 1670 canon residentiary and in 1677 dean of St. Paul's. Finally, but under different auspices, he was consecrated bishop of Worcester, 13th October, 1689. During these years he was ceaselessly engaged in controversy with Nonconformists, Romanists, Deists, and Socinians. His unrivalled and various learning, his dialectical expertness, and his massive judgment rendered him a formidable antagonist; but the respect entertained for him by his opponents was chiefly aroused by his recognized love of truth and superiority to personal considerations. He had the courage, along with the saintly and noble-minded Ken and the other six bishops, to incur the anger of James II. by resisting his proposed Declaration of Indulgence (1688). Strangely enough, he crossed swords both with Dryden and Locke,—with Dryden in connection with the papers favorable to the authority of the Church of Rome which were found in the strong box of Charles II. and were supposed to have been written by him, and with Locke because the theologian considered that the philosopher's definition of substance was prejudicial to the doctrine of the Trinity. In most of his writings there is a small residuum of permanent value. The range of his learning is most clearly seen in his *Bishop's Right to Vote in Parliament in Cases Capital.* His *Origines Britannicæ, or Antiquities of the British Church* (1685), is a surprising mixture of critical and uncritical research; and his *Discourse Concerning the True Reason of the Sufferings of Christ* (1669), written in answer to Crellius, contains a most forcible statement of the doctrine of Christ's substitution. So handsome in person as to have earned the sobriquet of "the beauty of holiness," Stillingfleet was twice married,—first to Andrea, daughter of William Dobbyns of Wormington, by whom he had two daughters, who died in infancy, and one son; afterwards to Elizabeth, daughter of Sir Nicholas Pedley, by whom he had seven children. He died in his house at Westminster, 28th March, 1699, and was buried in his own cathedral, where a handsome monument briefly records his virtues. His library was bought by Marsh, archbishop of Armagh, to form the foundation of a public library in Dublin.

A collected edition of his works, with life prefixed, was published in London (1710); and a most useful edition of *The Doctrines and Practices of the Church of Rome Truly Represented* was published in 1845 by Dr. Cunningham.

STILLWATER, a city of the United States, at the head of Washington county, Minnesota, on the west bank of the St. Croix river, 18 miles northeast of St. Paul. It is a great centre of the lumber trade, contains a State prison, a high school, and a public library, and increased its population from 4124 to 9055 between 1870 and 1880.

STILT, or Long-legged Plover, a bird so-called for reasons obvious to any one who has seen it, since, though no bigger than a Snipe, the length of its legs (their bare part measuring 8 inches), in proportion to the size of its body, exceeds that of any other bird's. The first name (a translation of the French *Échasse*, given in 1760 by Brisson) seems to have been bestowed by Rennie only in 1831; but recommended by its definiteness and brevity, it has wholly supplanted the second and older one. The bird is the *Charadrius himantopus*[1] of Linnæus, the *Himantopus candidus* or *melanopterus* of modern writers, and belongs to the group *Limicolæ*, having been usually placed in the Family *Scolopacidæ*, though it might be quite as reasonably referred to the *Charadriidæ*, and, with its allies to be immediately mentioned, would seem to be not very distant from *Hæmatopus*, notwithstanding the wonderful development of its legs and the slenderness of its bill.

The very peculiar form of the Stilt naturally gave Buffon occasion (*Hist. Nat. Oiseaux*, viii. pp. 114–116) to lament the shortcomings of Nature in producing an animal with such "enormous defects,"—its long legs in particular, he supposed, scarcely allowing it to reach the ground with its bill. But he failed to notice the flexibility of its proportionately long neck, and admitted that he was ill-informed as to its habits. No doubt, if he had enjoyed even so slight an opportunity as occurred to a chance observer (*Ibis*, 1859, p. 397), he would have allowed that its structure and ways were in complete conformity, for the bird obtains its food by wading in shallow water and seizing the insects that fly over or float upon its surface or the small crustaceans that swim beneath, for which purpose its slender extremities are, as might be expected, admirably adapted. Widely spread over Asia, North Africa, and Southern Europe, the Stilt has many times visited Britain—though always as a straggler, for it is not known to breed to the northward of the Danube valley,—and its occurrence in Scotland (near Dumfries) was noticed by Sibbald so long ago as 1684. It chiefly resorts to pools or lakes with a margin of mud, on which it constructs a slight nest, banked round or just raised above the level so as to keep its eggs dry (*Ibis*, 1859, p. 360); but sometimes they are laid in a tuft of grass. They are four in number, and, except in size, closely resemble those of the OYSTERCATCHER (vol. xviii. p. 114). The bird has the head, neck, and lower parts white, the back and wings glossy black, the irides red, and the bare part of the legs pink. In America the genus has two representatives, one[1] (Fig. 1) closely resembling that just described, but rather smaller and with a black crown and nape. This is *H. nigricollis* or *mexicanus*, and occurs from New England to the middle of South America, beyond which it is replaced by *H. brasiliensis*, which has the crown white. The Stilt inhabiting India is now recognized to be *H. candidus*, but Australia possesses a distinct species, *H. novæ-hollandiæ*, which also occurs in New Zealand, though that country has in addition a species peculiar to it, *H. novæ-zelandiæ*, differing from all the rest by assuming in the breeding-season an altogether black plumage. Australia, however, presents another form, which is the type of the genus *Cladorhynchus*, and differs from *Himantopus* both in its style of plumage (the male having a broad bay pectoral belt), in its shorter tarsi, and in having the toes (though, as in the Stilt's feet, three in number on each foot) webbed.

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[1] The possible confusion by Pliny's transcribers of this word with *Hæmatopus* has been already mentioned (OYSTERCATCHER, vol. xviii., p. 114, note 2). *Himantopus*, with its equivalent, *Loripes*, "by an awkward metaphor," as remarked by Gilbert White, "implies that the legs are as slender and pliant as if cut out of a thong of leather."

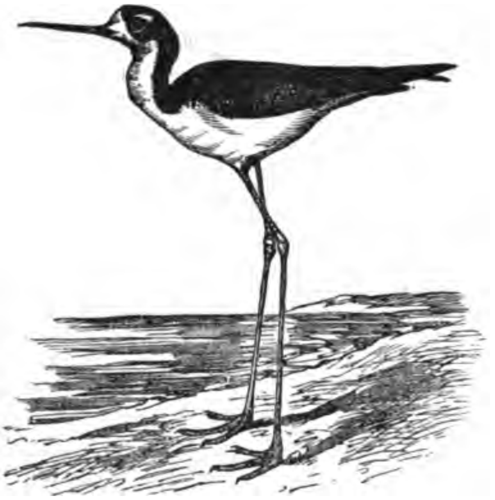

FIG. 1.—Black-Necked American Stilt. (After Gosse.)

Allied in many ways to the Stilts, but differing in many undeniably generic characters, are the birds known as Avosets,[2] forming the genus *Recurvirostra* of Linnæus. Their bill, which is perhaps the most slender to be seen in the whole Class, curves upward towards the end, and has given the oldest known species two names which it formerly bore in England,—"Cobbler's awl," from its likeness to the tool so called, and "Scooper," because it resembled the scoop with which mariners threw water on their sails. The legs, though long, are not extraordinarily so, and the feet, which are webbed, bear a small hind toe.

This species (Fig. 2), the *R. avocetta* of ornithology, was of old time plentiful in England, though doubtless always restricted to certain localities. Charleton in 1668 says that when a boy he had shot not a few on the Severn, and Plot mentions it so as to lead one to suppose that in his time (1686) it bred in Staffordshire, while Willughby (1676) knew of it as being in winter on the eastern coast, and Pennant in 1769 found it in great numbers opposite to Fossdyke Wash in Lincolnshire, and described the birds as hovering over the sportsman's head like Lapwings. In this district they were called "Yelpers" from their cry;[3] but whether that name was elsewhere applied is uncertain. At the end of the last century they frequented Romney Marsh in Kent, and in the first quarter of the present century they bred in various suitable spots in Suffolk and Norfolk,—the last place known to have been inhabited by them being Salthouse, where the people made puddings of their eggs, while the birds were killed for the sake of their feathers, which were used in making artificial flies for fishing. The extirpation of this settlement took place between 1822 and 1825 (*cf.* Stevenson, *Birds of Norfolk*, ii. pp. 240, 241.)[4] The Avoset's mode of nesting is much like that of the Stilt, and the eggs are hardly to be distinguished from those of the latter but by their larger size, the bird being about as big as a LAPWING (vol. xiv. p. 308), white, with the exception of its crown, the back of the neck, the inner scapulars, some of the wing-coverts and the primaries, which are black, while the legs are of a fine light blue. It seems to get its food by working its bill from side to side in shallow pools, and catching the small crustaceans or larvæ of insects that may be swimming therein, but not, as has been stated, by sweeping the surface of the mud or sand—a process that would speedily destroy the delicate bill by friction. Two species of Avoset, *R. americana* and *R. andina*, are found in the New World; the former, which ranges so far to the northward as the Saskatchewan, is distinguished by its light cinnamon-colored head, neck, and breast, and the latter, confined so far as known to the mountain lakes of Chili, has no white in the upper parts except the head and neck. Australia produces a fourth species, *R. novæ-hollandiæ* or *rubricollis*, with a chestnut head and neck; but the European *R. avocetta* extends over nearly the whole of middle and southern Asia as well as Africa.

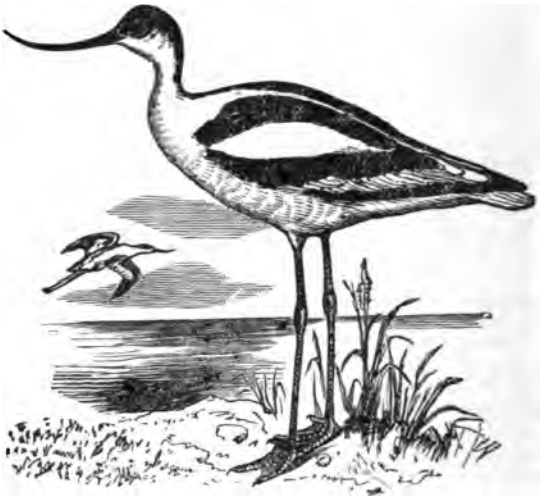

FIG. 2.—Avoset. (After Naumann.)

A recent proposal (*Ibis*, 1886, pp. 224–239) to unite the Avosets and Stilts in a single genus seems to have little to recommend it but its novelty, and will hardly meet with acceptance by systematists. (A.-N.)

STIRLING, a midland county of Scotland, is bounded N. by Perthshire, N.E. by Clackmannan, and the Firth of Forth, S.E. by Linlithgowshire, S. by Lanarkshire, and a detached portion of Dumbartonshire, and S.W. and W. by Dumbartonshire. In the northeast there are two isolated portions,—one forming the parish of Alva, bounded partly by Clackmannan and partly by Perthshire, and the other forming part of the parish of Logie and bounded by Perthshire. The outlines of the main portion are extremely irregular, the boundary on the north following for the most part the windings of the Forth, while on the west it passes through the middle of Loch Lomond, and on the south coincides to a considerable extent with various streams. The extreme length of the county from northwest to southeast is about 45 miles, and the greatest breadth from north to south about 18 miles. The land area is 286,338 acres, and the total area 298,579 acres, or about 466 square miles. Apart from the district round Loch Lomond, the principal charm of the scenery of Stirlingshire is in the views of the valley of the Forth with the winding river, and for background the distant peaks of the Grampians, or the nearer ranges of the Ochils, which encroach on the northeastern corner and detached sections of the county. The valley of the Forth runs along nearly the whole of the northern border, widening towards the east. The centre of the county from northeast to southwest is occupied by the broad irregular ranges of the Lennox Hills, which are known under four different names, according to the parishes in which they are principally situated,—the Gargunnock Hills (attaining a height of 1591 feet), the Fintry Hills (1676), the Kilsyth Hills (1393), and the Campsie Fells (1894). Nearly the whole of the county to the northeast of Loch Lomond is occupied by a spur of the Grampians, reaching in Ben Lomond a height of 3192 feet. Besides Loch Lomond, situated partly in Dumbartonshire, and Loch Katrine, which bounds the county at its northwestern corner, the principal lakes are Loch Arklet to the south of Loch Katrine, Loch Coulter, in the south of St. Ninians parish, Loch Ellrig in Falkirk parish, and Black Loch partly in Lanarkshire. The river Forth, from its junction with the Kelty near Gartmore, forms the northern boundary of the county, except where it bounds on the north the part of Kippen parish which is in Perthshire and separates a portion of Lecropt parish from that of St. Ninians and a portion of Logie from that of St. Ninians and Sterling. It receives from the north the Teith, which touches the county at Lecropt parish, and the Allan, which separates the parishes of Lecropt and Logie, and from the south the Boquhan burn, the Touch burn, and the Bannock burn. The Carron water flows eastwards from the Fintry Hills to the Firth of Forth at Grangemouth. On the south there are a number of streams which form at various places the boundary of the county,—the Endrick water flowing westwards from the Fintry Hills to Loch Lomond, the Kelvin from near Kilsyth flowing southwestwards to the Clyde, and the Avon from Lanarkshire flowing northeastwards to the Firth of Forth. The Forth and Clyde Canal crosses the southeastern corner of the county from Castlecary to Grangemouth.

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[1] This species was made known to Ray by Sloane, who met with it in Jamaica, where in his day it was called "Longlegs."

[2] This word is from the Bolognese *Avosetta*, which is considered to be derived from the Latin *avis*—the termination expressing a diminutive of a graceful or delicate kind, as *donetta* from *donna* (Prof. Salvadori *in epist.*).

[3] *Cf.* "Yarwhelp" (GODWIT, vol. x. p. 642) and "Yaup" or "Whaup" (CURLEW, vol. vi. p. 628). "Barker" and "Clinker" seem to have been names used in Norfolk.

[4] The same kind of lamentable destruction has of late been carried on in Holland and Denmark, to the extirpation probably of the species in each country.

The whole of the district to the north of Loch Lomond is occupied by the crystalline schists of the Highlands, which, by the existence of a great fault, are connected on the east with the Old Red Sandstone, which occupies the broad valley between the base of the Highland hills and the chain of the Ochils. These latter heights, portions of which are included in detached areas of the county, consist of volcanic rocks associated with the Old Red Sandstone (see vol. x. p. 304). The Lennox Hills in the centre of the county are formed by volcanic rocks of Carboniferous age resting on strata of red and white sandstone (see vol. x. p. 307). The lower grounds are deeply buried under glacial drifts, and conspicuously marked by broad terraces that represent former sea-margins. On one of these, at a height of 50 feet above the present sea-level, lies the Carse of Falkirk. Another stands at an elevation of about 100 feet. There are saline mineral springs at Bridge of Allan.

The coal-field runs obliquely along the southeast of the county, the principal seams being in Denny, Kilsyth, Larbert, Falkirk, and Slamannan parishes. Ironstone, fireclay, and oil-shale are also found. Limestone is extensively wrought in the Campsie district, and there are a number of sandstone quarries in various parts of the county. The total output of coal in 1884 was 1,182,891 tons, of ironstone 75,351 tons, of fireclay 15,872, and of oil-shale 4535.

Agriculture.—According to the landowners' return of 1872-73 the land was held by 4257 proprietors, possessing 284,751 acres, at an annual valuation of £521,407 [$2,534,038], an average value all over of £1, 16s. 3¼d. [$8.82]. Of the proprietors 3409 possessed less than one acre. The following possessed over 5000 acres each: Duke of Montrose, 68,878; William Forbes, 13,041; Rear-admiral Sir William Edmonstone, 9778; Hon. Mrs. Margaret Lennox, 7606; Alex. Graham Speirs, 7172; W. C. G. Bontine, 6931; Lieutenant-Col. John Murray, 6813; Sir Alex. C. R. Gibson-Maitland, 6023; Henry Fletcher Campbell, 5679; and James Johnstone, 5340. The two arable soils of Sterlingshire are distinguished locally as carse and dryfield, the remainder of the county being occupied by mountain pasture land, moor, and moss. The Carse of Sterling extends along the banks of the Forth from Buchlyvie to the eastern extremity of the county,—a length of about 28 miles, with a breadth varying from 1 to 4 miles, the total area being about 30,000 acres. The carse soil consists of the finest clays, without stones, but interspersed with strata of marine shells. It has been partly reclaimed from superincumbent peat moss, of which there are still considerable areas adjoining it. It requires a great deal of labor, but, by means of draining, subsoil ploughing, and the use of lime, has been rendered one of the most fertile soils in Scotland, being specially well adapted for wheat and beans. The dryfield occupies the slopes of the hills above the carse and the valleys in the interior of the county, which constitute the more fertile portions, the crops for which it is best suited being potatoes and turnips. A great part of the dryfield has been reclaimed from moor within the present century. The Lennox Hills, occupying about a fourth of the total area of the county, form one of the most valuable tracts of pasture land in Scotland. The following table gives a classification of the holdings in 1875 and 1885:

	50 acres and under		50 to 100 acres.		100 to 300 acres.		300 to 500 acres.		500 to 1000 ac.		Above 1000 ac.		Total.	
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Ac.	No.	Ac.	No.	Acres
1875	789	13,130	382	28,493	329	52,080	29	10,411	7	4299	1	1418	1537	109,831
1885	725	12,550	363	27,876	370	59,418	28	10,325	5	3489	1	1418	1492	115,076

According to the agricultural returns for 1886, out of a total of 295,285 acres 115,477, or nearly 39 per cent., were arable land, the area under corn crops amounting to 29,306 acres, under green crops to 8752, rotation grasses 30,664, permanent pasture 45,232, flax 15, and fallow 1508. Oats, the principal corn crop, occupied 19,662 acres, wheat 2065 acres (a decrease of about one-half within twenty years), barley 4297 acres, rye 30, beans 3221, and pease 31. Of green crops the principal are potatoes (3500 acres) and turnips (4623 acres). Considerably more than half of the arable area is occupied by rotation grasses and permanent pasture, and their acreage is constantly increasing, which is sufficiently accounted for by the steady increase in the numbers of sheep and cattle. The number of horses in 1886 was 4616, of which 3176 were used solely for purposes of agriculture, and 1440 were unbroken horses and mares kept solely for purposes of breeding. The Clydesdale breed are in general use on the larger farms. Cattle in 1886 numbered 29,422, of which 10,745 were cows and heifers in milk or in calf, and 8684 were other cattle two years old and above. Butter-making is largely practiced on the dryfield farms, the Ayrshire being the principal breed of cows, but cattle-feeding is also an important industry, for which Irish cattle and cross breeds are frequently bought, a considerable number of shorthorns being also reared. Sheep, chiefly blackfaced, for which there is extensive pasturage on the Lennox Hills and the slopes of the Grampians, numbered 109,897 in 1886, and pigs 1775.

Though, as is evident from the remains of trees in the mosses, an extensive district of the county was at one time occupied by forest, it is now comparatively devoid of timber, the area under woods in 1881 being only 12,483 acres. There is a natural tendency to the growth of birch on the lower slopes of the mountains in the parishes of Buchanan and Drymen, and oaks grow extensively on the borders of Loch Lomond. Larch and Scotch firs principally occupy the modern plantations in the other parts of the county. In 1886 there were only 31 acres under orchards, 27 under market gardens, and 53 under nursery grounds.

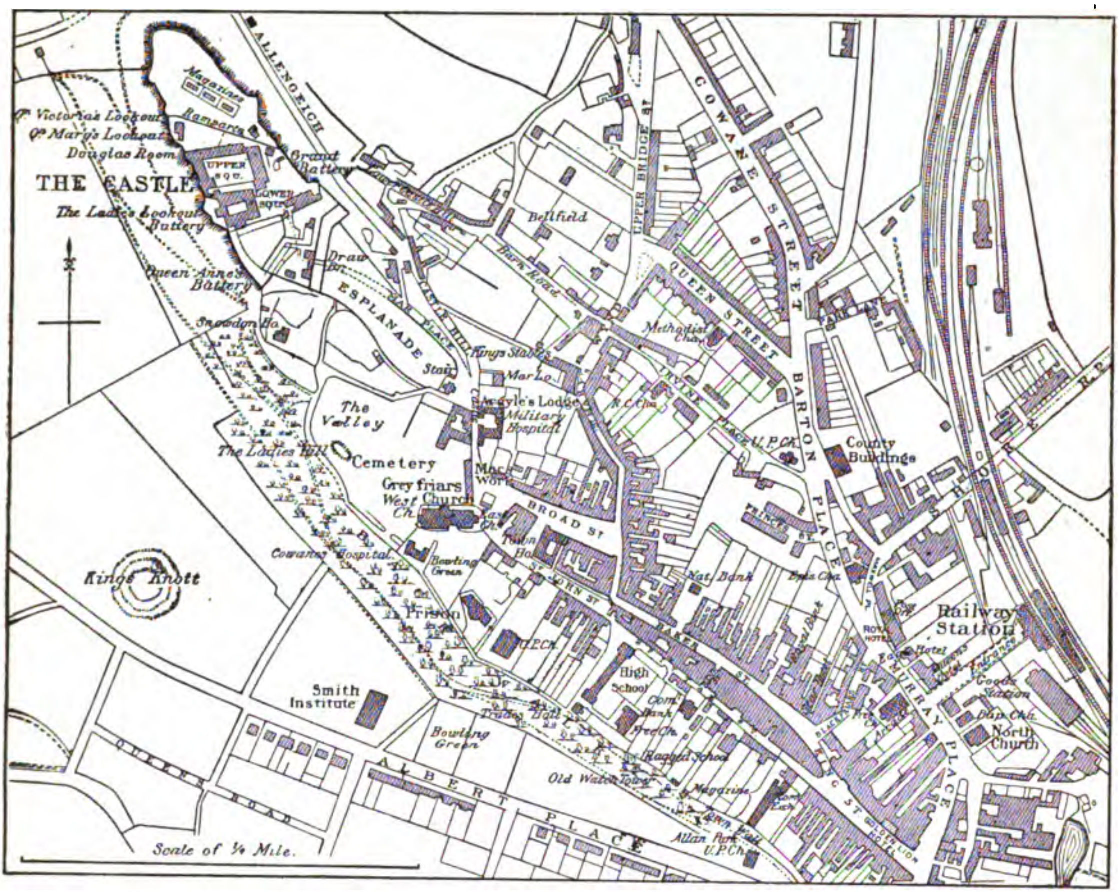
Manufactures.—The Carron ironworks, founded in 1760, for a long time led the van in British iron manufacture, and are still among the most extensive in the kingdom. The Falkirk ironworks, founded in 1819, are the next to them in importance in the county, but there are many others in the same district. The woollen manufacture is next to iron in importance. It includes carpets, tartans, shawls, and tweeds, the principal seats of the industry being Alva, Bannockburn, Cambusbarron, and Stirling. Calico printing is carried on in the western part of the county, especially at Campsie and Milngavie. There are chemical works at Stirling, Falkirk, Denny, and Campsie. Throughout the county there are a considerable number of breweries and distilleries. At Grangemouth, the principal port in the county, shipbuilding is carried on.

Administration and Population.—Stirling is included with Dumbarton and Clackmannan in the same sheriffdom, but has two sheriff-substitutes, who sit at Stirling and Falkirk respectively, and there are prisons in both towns. The high court of justiciary holds circuit courts at Stirling. There are 21 entire civil parishes within the county and parts of 5 others. Stirling (population 12,194) is a royal and police burgh, Falkirk (13,170) a police burgh and burgh of regality, Kilsyth (5405) a police burgh and burgh of barony, and Alva (4961), Bridge of Allan (3005), Denny and Dunipace (4080), Grangemouth (4424), and Milngavie (2636) police burghs. In addition to these the following places had each upwards of 2000 inhabitants: Bannockburn (2549), Lennoxtown (3249), and Stenhousemuir (2617). From 39,761 in 1765 the population of the county had by 1801 increased to 50,825, by 1831 to 72,621, by 1861 to 91,926, by 1871 to 98,176, and by 1881 to 112,443, of whom 56,147 were males and 56,296 were females. The number of persons to the square mile is 251, and in point of density Stirling ranks ninth among the counties of Scotland. One member is returned to parliament by the county, and Stirling and Falkirk are members of separate districts of burghs, which are respectively named from them, each returning one member.

History.—In 81 A.D. the Romans under Agricola penetrated as far north as the firths of Clyde (Clota) and Forth (Bodotria). To secure their conquests they erected between these a line of forts or *præsidia*, generally two miles apart. In 139 Lollius Urbicus erected along the line of the forts the rampart of Antoninus's wall, afterwards known as Graham's dyke. The wall, after crossing the parish of East Kilpatrick, passed outside the present county of Stirling, till it reached Castlecary, whence it passed by Camelon and Falkirk to Carriden in Linlithgowshire. Castlecary, where many Roman remains have been found, was perhaps the principal Roman station on the line of the wall, and there was another important one at Camelon. A Roman road, the Camelon causeway, passed eastwards from Castlecary to the south of the rampart, and after two miles crossed it and held on to Camelon, whence it went northward by Bannockburn, St. Ninians, and Stirling to the Forth, where there was an important station near the present bridge of Drip. Thence it passed north by Keir to Dunblane. To the northeast of the Carron ironworks there was at one time a finely-preserved circular Roman building, called Arthur's Oon (oven) or Julius's Hof, which was demolished in 1743, but of which a drawing is preserved in Camden's *Britannia*. In the parish of Dunipace are two beautiful mounds called "the Hills of Dunipace," which some have supposed to have been erected as monuments of peace between the Romans and Caledonians, but which are more probably of natural origin. The remains of what was supposed to have been an early British stronghold were discovered at Torwood in 1864. A group of cairns at Craigmaddie, near Milngavie, is supposed to mark the scene of a battle between the Picts and Danes. Among the remains of old feudal castles may be mentioned Graham's castle, among the Fintry Hills, which belonged to Sir John de Graham, who was killed in the battle of Falkirk in 1298; Herbertshire, on the north bank of the Carron near Denny, originally a royal hunting seat, and still one of the finest embattled residences in the county (now a boarding school); the ancient keep of Castlecary, partly destroyed by the Highlanders in 1715; Torwood, surrounded by the remains of the Caledonian forest, in one of the oaks of which Wallace took refuge; and the round tower of Carnock, called Bruce's castle, of unknown history. Sir William Wallace lived occasionally with his uncle, the parson of Dunipace, and the county is specially associated with his exploits and those of Robert Bruce, being the scene of some of the principal battles in the struggle for Scottish independence (Stirling bridge, September 10, 1297; Falkirk, July 22, 1298; Bannockburn, June 24, 1314). At Sauchieburn, 11th June, 1488, James III. was defeated by his insurgent nobles, and during his flight, having stopped at a cottage in the village of Milton, was there stabbed to death. Kilsyth saw the defeat of the Covenanters by Montrose, 15th August, 1645, a result which for a time laid Scotland at Montrose's feet; and a hundred years afterwards—17th January, 1746—the Highlanders under Prince Charles Edward routed the Hanoverians at Falkirk.

See Sir Robert Sibbald's *Description of Stirlingshire*, 1710, and Nimmo's *History of Stirlingshire*, 1777 (MacGregor Stirling's edition is the best). (T. F. H.)

STIRLING, a royal and parliamentary burgh and the county town of Stirlingshire, is finely situated on the slopes of an isolated eminence overlooking the valley of the Forth and abruptly precipitous towards the northwest, at the junction of several railway lines, 36 miles west-northwest of Edinburgh and 30 north-northeast of Glasgow. Originally the town was protected on all the accessible sides of the rock by a wall, of which there are still some remains at the southern end of the Back Wall. There were two principal entries to the town,—the South Port, originally 100 yards more to the west of the present line of Port Street, and the bridge over the Forth to the north. The earliest bridge was at Kildean, a mile to the west; the existing old bridge, now disused, probably dates from about the end of the 13th century; the new bridge was erected in 1829, from the designs of Stevenson, at a cost of £17,000 [$82,620]. The streets of the old town are for the most part steep, narrow, and irregular, and contain a large number of quaint and antique dwellings. The town has now much outgrown its ancient limits, and the surrounding suburbs on the low grounds contain numerous villas. The castle crowning the eminence, and commanding a splendid panoramic view of the wide valley between the Lennox Hills and the Highland mountains and Ochils, with the links of the Forth and the widening estuary to the east, is of unknown antiquity, but from the time that Alexander I. died within its walls in 1124 till James VI. ascended the throne of England it was intimately associated with the fortunes of the Scottish monarchs, and after the accession of the Stuarts it became a favorite royal residence. The building was extended by James III., who erected the parliament hall, now used as a barrack-room. The palace, begun by James V. and finished in the reign of Mary, is at the southwest of the fortress, and forms a quadrangle, the front and pillars of which are adorned by quaintly sculptured figures. The royal chapel founded by Alexander I., rebuilt in the 15th century, and again by James VI., was subsequently converted into an armory and is now used as a store. To the west of it is the Douglas room, the scene of the treacherous murder of William, eighth earl of Douglas, by James II., in 1452. Below the castle on the northeast is the road of Ballangeich, which supplied a fictitious title to James V. when wandering in disguise. Beyond it is the Gowan or Gowlan Hill, at the west corner of which is Mote Hill or Heading Hill, where Murdoch, duke of Albany, and several of his relatives were beheaded in 1425. On the northeast side of the esplanade a statue of King Robert Bruce was erected in 1877. Below the castle rock to the southwest were the king's gardens, now laid out in grass, with an octagonal mound, called the King's Knot, in the centre. Farther south is the King's Park, now used for recreation, and as a drill ground. In the cemetery to the south of the castle esplanade there are a number of interesting monuments. Near the main entrance to the esplanade is the building called Argyll's Lodging, erected by the poet, Sir William Alexander, who was created earl of Stirling by Charles I. It passed into the possession of the Argylls in 1640, and was the headquarters of John, duke of Argyll, during the rebellion of 1715. Southwest of it is Mar's Work, the ruins of the palace built as a residence by the earl of Mar about 1570, from the ruins of Cambuskenneth Abbey. Next to the castle the most interesting public building is the Greyfriars church, some portions of which date from the 13th century, although the monastery with which it was connected was not founded till 1494. The greater part of it is in the Later Pointed style. The church was the scene of the coronation of James VI., 29th July, 1567, when John Knox preached the coronation sermon. The site of the Dominican monastery founded by Alexander II. in 1223 is now occupied by the National Bank. In the immediate neighborhood of Stirling, on the other side of the Forth, in Clackmannan county, is the beautiful ruin of Cambuskenneth Abbey, chiefly Early English or First Pointed, founded by David I. in 1147 for canons regular, associated with the meeting of parliaments and other interesting events in Scottish history, and the burial-place of James III. and his queen, Margaret of Denmark.



Plan of Stirling.

The principal secular buildings are the old town-house, erected in 1701; the new town buildings; the jail erected in 1848 at a cost of £12,000 [$58,320]; the county buildings (1875, £15,000 [$72,900]); the Smith institute, founded by the bequest of £22,000 [$106,920], and a valuable collection of paintings by Thomas Stewart Smith, and embracing a picture gallery, a museum, and a reading room; the public halls (1883, £12,000 [$58,320]); and the high school (1855, £5000 [$24,300]; now being extended at a cost of £8000 [$38,880]). Among the benefactions are Cowane's hospital, founded by the bequest of John Cowane, dean of guild in 1633, for twelve decayed members of the guildry, but the distribution of the charity has since been altered, and the building erected in 1639 now forms the guild hall; Spittal's hospital, founded by Robert Spittal, tailor to James IV., about 1530 for decayed tradesmen; Allan's hospital, founded in 1725 for the maintenance of children of poor townsmen; and Cunningham's mortification, founded in 1808 with an endowment of £4000 [$19,440] for the clothing and schooling of sons of mechanics. By the operation of the Endowed Schools and Hospitals Act the charities are now largely devoted to education.

As early as the 15th century Stirling had a trade with the Netherlands in worsted cloth, shalloons, stockings, and thread, but, the manufactures afterwards declined. The cotton manufacture carried on in the beginning of the present century has now entirely ceased. During the last century the manufacture of tartans and carpets was carried on, but this also languished about the end of the century, and was not revived till about 1820. The woollen manufacture is now the staple industry, the principal goods being carpets, tartans, tweeds, and shawls. There are also breweries, coachbuilding works, and agricultural implement works. The population of the royal burgh in 1871 was 10,873, and in 1881 12,194. The population of the parliamentary burgh, which includes the village of St. Ninians, in 1871 was 14,279, and in 1881 it was 16,001.

The town is of unknown antiquity, and undoubtedly owed its origin to the fortress on the rock, which became one of the most important strongholds in Scotland and the centre of the struggle between Scotland and England. As early as 1119 the town was a royal burgh, and under Alexander I. it became one of the four towns which constituted the Court of the Four Burghs, superseded under James III. by the Convention of Royal Burghs. Its earliest charter was that of Alexander II. in 1226, who first made the castle a royal residence. Its last governing charter was obtained from Charles I. in 1641. On account of a combination of three members of the council to retain themselves in office it was deprived of its corporate privileges in 1773, and they were not restored till 1781. The castle was held by William the Lion before 1174, was occupied by Edward I. with his army in 1296, and was burned with the town in 1298 by the Scots on their retreat from the battle of Falkirk. Between this time and 1341 it was frequently besieged and taken by the English, the longest period during which it remained in their hands being from its capture by Edward I. in 1304 till his son's defeat 10 years afterwards at the battle of Bannockburn. It was the birthplace of James II. in 1430, and, it being the jointure house of his mother, he was removed to it in 1438 from Edinburgh to thwart the ambitious purposes of Sir William Crichton. It was in one of its rooms that James, as stated above, slew the earl of Douglas, after which the town was burned by the earl's brothers. James V. took refuge in it after his escape from Falkland in 1528. During the reign of Mary and the period of the Reformation, Stirling occupied a position of almost as great prominence as during the wars of Scottish independence. Here the infant queen was crowned by the cardinal's party in 1543; here her son, afterwards James VI., was baptized according to the Roman Catholic ritual, 17th December, 1566; and here he was crowned by the leaders of the congregation on July 29th of the following year. In 1571 rival parliaments were held by the queen's party in Edinburgh and the king's lords at Stirling, shortly after which an attempt was made by the queen's adherents to surprise Stirling castle, which was almost successful, the regent (Lennox) being slain in the fray. On the 26th April, 1578, the castle was surprised by Morton, after which a reconciliation took place between the two parties. In 1584 the castle was occupied by the earls of Angus and Mar, the Protestant leaders, but on the approach of the king with a large force they fled to England. Returning with a formidable army collected in the south in the following year, they compelled James after the flight of Arran to open the gates to them, safety to his person having been guaranteed. The town was the scene of the baptism of Prince Henry with great pomp in August, 1594, for which purpose the chapel royal was rebuilt on a larger scale "to entertain the great number of strangers expected." The meetings of the privy council and court of session were held in 1637 at Stirling on account of the disturbed condition of Edinburgh, and a parliament was held at it in 1645, on account of Edinburgh having been visited by the plague, but the outbreak of the disorder in Stirling caused an adjournment to Perth. During the Civil War Stirling was held by the Covenanters, and the committees of church and state adjourned to it after the victory of Cromwell at Dunbar, 3d September, 1650. In August of the following year the castle was taken by General Monk. In 1715 it was held by Argyll to prevent the passage of the Forth by the Jacobites; and during the rebellion of 1745 it was unsuccessfully besieged by the Highlanders.

See *History of the Chapel Royal of Stirling*, Grampian Club, 1882; *Local Notes and Queries relating to Stirling*, 1888; *Charters of Stirling*, 1884; Burton, *History of Scotland*. (T. F. H.)

STIRLING, EARL OF. See ALEXANDER, SIR WILLIAM, vol. i. p. 435.

STIRLING, JAMES (1692–1770), mathematician, third son of Archibald Stirling of Garden, and grandson of Sir Archibald Stirling of Keir (Lord Garden, a lord of session), was born at Garden, Stirlingshire, in 1692. Part of his early education was probably obtained at Glasgow, but at eighteen years of age he went to Oxford, where, chiefly through the influence of the earl of Mar he was nominated (1711) one of Bishop Warner's exhibitioners at Balliol. During his residence at Oxford he made for himself considerable reputation as a student of mathematics. In 1715, however, he was expelled on account of his correspondence with members of the Keir and Garden families, who were noted Jacobites, and had been accessory to the "Gathering of the Brig of Turk," in 1708. From Oxford he made his way to Venice, where he occupied himself as a professor of mathematics. In 1717 appeared his *Lineæ Tertii Ordinis Newtonianæ, sive* . . . . (8vo, Oxford), which contained one or two notable additions to the theory. While in Venice, also, he communicated, through Sir Isaac Newton, to the Royal Society a paper entitled "Methodus Differentialis Newtoniana illustrata" (*Phil. Trans.*, 1718, p. 1050; Abridg., vi. p. 428). Fearing assassination on account of having discovered a trade secret of the glass-makers of Venice, he returned with Newton's help to London about the year 1725. In London he remained for ten years, being most part of the time connected with an academy in Tower Street, and devoting his leisure to mathematics and correspondence with eminent mathematicians. In 1730 his most important work was published, the *Methodus Differentialis, sive Tractatus de Summatione et Interpolatione Serierum Infinitarum* (4to, London), which, it must be noted, is something more than an expansion of the paper of 1718. In 1735 he communicated to the Royal Society a paper "On the Figure of the Earth, and on the Variation of the Force of Gravity at its Surface" (*Phil. Trans.*, Abridg., viii. pp. 26–30). In the same year his worldly fortunes changed permanently for the better, through his appointment to be manager for the Scots Mining Company at Leadhills, an appointment which gave scope both to his scientific talents and to his great, though hitherto latent, administrative ability, and which was eminently fortunate for his employers. We are thus prepared to find that his next paper to the Royal Society was concerned, not with pure, but with applied science—"Description of a Machine to blow Fire by the Fall of Water" (*Phil. Trans.*, 1745, p. 315; Abridg., ix. pp. 109, 110). His name is also connected with another practical undertaking since grown to vast dimensions. The accounts of the city of Glasgow show that the very first instalment of ten millions sterling [$48,600,000] spent in making Glasgow a seaport, viz., a sum of £28, 4s. 4d. [$137.13], was for a silver tea-kettle to be presented to "James Stirling, mathematician, for his service, pains, and trouble in surveying the river towards deepening it by locks." This was in 1752. Stirling died in Edinburgh on 5th December, 1770.

See W. Fraser, *The Stirlings of Keir, and their Family Papers*, Edinburgh, 1858; "Modern History of Leadhills," in *Gentleman's Magazine*, June, 1853; Brewster, *Memoirs of Sir Isaac Newton*, ii. pp. 300, 307, 411, 516; J. Nicol, *Vital Statistics of Glasgow*, 1881–5, p. 70; *Glasgow Herald*, 5th August, 1886.

Another edition of the *Lineæ Tertii Ordinis* was published in Paris in 1797; another edition of the *Methodus Differentialis* in London in 1764; and a translation of the latter into English by Halliday in London in 1749. A considerable collection of literary remains, consisting of papers, letters, and two manuscript volumes of a treatise on weights and measures, are still preserved at Garden by Stirling's great-grandson and namesake.

STOAT. See ERMINE.

STOBÆUS, JOANNES, a native of Stobi in Macedonia,—whence the surname Stobæus or Stobensis,—is known to us as the compiler of a very valuable series of extracts from Greek authors. Of his life nothing is known, but he probably belongs to the latter half of the 5th century. From his silence in regard to Christian authors, it is inferred with some probability that he was not a Christian; that he was a man of wide culture and general reading is clear from the anthology which bears his name.

The extracts were intended by Stobæus for his son Septimius, and were preceded by a letter briefly explaining the purpose of the work and giving a summary of the contents. From this summary (which is preserved in Photius's *Bibliotheca*) we learn that Stobæus divided his work into four books; the first contained sixty chapters, the second forty-six, the third forty-two, and the fourth fifty-eight. In most of our MSS. the work is divided into three books, of which the first and second are generally called 'Εκλογαὶ φυσικαὶ καὶ ἠθικαί, and the third 'Ανθολόγιον (*Florilegium* or *Sermones*). As each of the four books is sometimes called 'Ανθολόγιον, it is probable that this name originally belonged to the entire work; the full title, as we know from Photius, was 'Εκλογῶν ἀποφθεγμάτων ὑποθηκῶν βιβλία τέτταρα. Between the account which Photius gives of Stobæus's work and the form in which we have it there are several marked discrepancies. The second book in particular is little more than a fragment. From this and other indications Wachsmuth has made it probable that our Stobæus is only an epitome of the original work, made about the end of the 11th century at Byzantium, "ab homine Platonis Aristotelisque amantissimo."

The didactic aim of Stobæus's work is apparent throughout. The first book teaches physics—in the wide sense which the Greeks assigned to this term—by means of extracts. It is often untrustworthy: Stobæus betrays a tendency to confound the dogmas of the early Ionic philosophers, and he occasionally mixes up Platonism with Pythagoreanism. For part of this book and much of book ii. he depended on the works of Aetius, a Peripatetic philosopher, and Didymus. The third and fourth books, like the larger part of the second, treat of ethics; the third, of virtues and vices, in pairs; the fourth, of more general ethical and political subjects, frequently citing extracts to illustrate the pros and cons of a question in two successive chapters. In all, Stobæus quotes more than five hundred writers, generally beginning with the poets, and then proceeding to the historians, orators, philosophers, and physicians. It is to him that we owe many of our most important fragments of the dramatists, particularly of Euripides.

The first complete edition of Stobæus was published at Geneva in 1609; the last is Meineke's (Leipsic, 1855–1864). The best critical edition of books i. and ii. is by Wachsmuth (Berlin, 1884); a companion edition of books iii. and iv. (the *Florilegium*) is promised by Otto Hense.

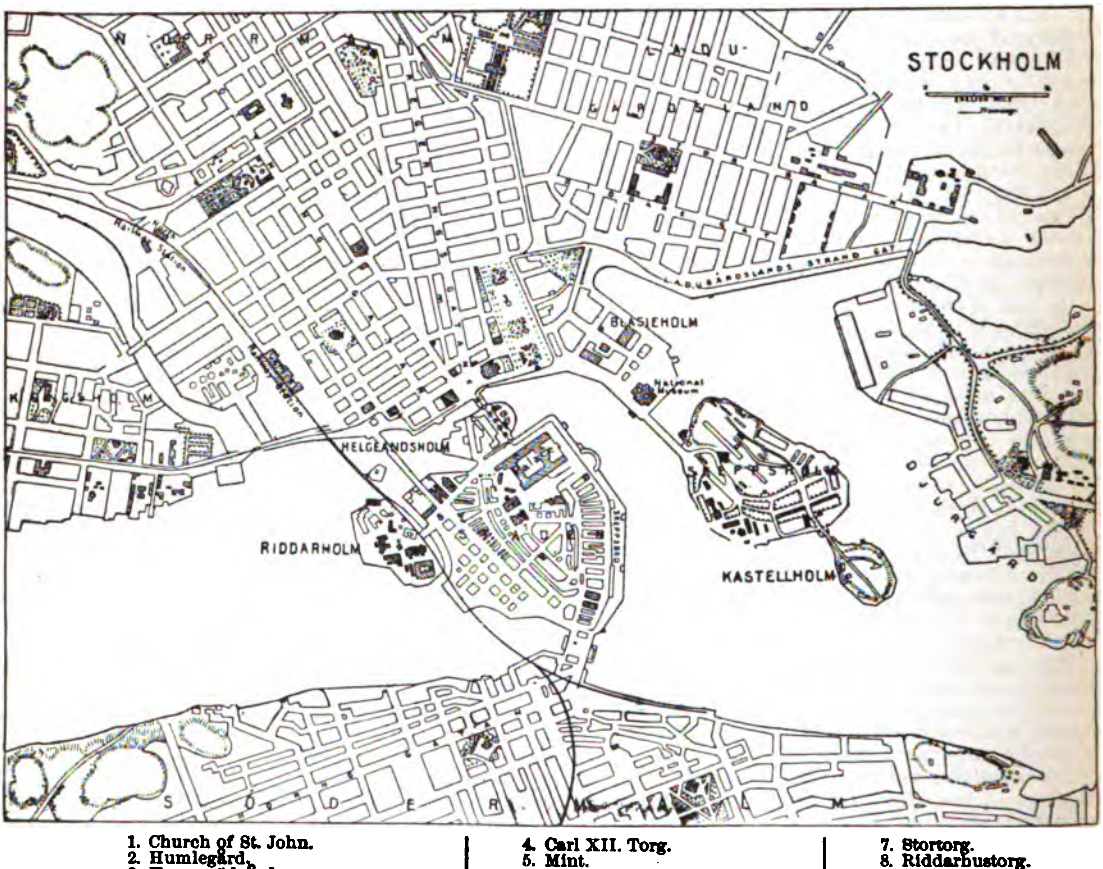
STOCK EXCHANGE, a market for the purchase or sale of all descriptions of public securities. Previous to 1773 the London stockbrokers conducted their business in and about the Royal Exchange, but in that year, having formed themselves into an association under the designation of the Stock Exchange, they, after temporarily locating their headquarters in Sweeting Ally, Threadneedle Street, removed to Capel Court, Bartholomew Lane. The growth of business necessitating improved accommodation, a capital of £20,000 [$97,200] in four hundred shares of £50 [$243] each was raised in 1801 for the purpose of erecting a new building in Capel Court, which was finished and occupied in the following year, the members at that date numbering about five hundred. With the occupation of the new building new rules came into force; all future members were admitted by ballot, while both members and their authorized clerks were required to pay a subscription of ten guineas [$51.03] each. As only the wealthier members of the association had provided the capital for the new building, the Stock Exchange henceforth consisted of two distinct bodies—proprietors and subscribers. In 1854, the membership having increased to about one thousand persons, an extension of the premises in Capel Court was effected at a cost of £16,000 [$77,760]. A further and very extensive increase in the accommodation was made in 1885, the number of members and authorized clerks having risen at that date to above two thousand five hundred. The extended buildings now occupy the whole of a triangle to the east of the Bank of England, having as its base Bartholomew Lane, its north side Throgmorton Street, and its south side portions of Threadneedle Street and Old Broad Street. The completed buildings comprise two large halls, where the various markets are held, settlement rooms, reading room, committee rooms, managers' rooms, and various other offices. It is intended ultimately to remove the partition between the two halls, when a vast business apartment, having an area of about 16,000 square feet, will be available for the use of members. The immensely valuable property of the Stock Exchange is now owned by about 1050 proprietors, additions both to the proprietary and to the capital invested in the buildings having been from time to time effected during the past fifty years. The interests of the proprietors are attended to by nine of their number, who are termed managers, and by a secretary and staff of clerks. The income of the association now amounts to about £130,000 [$631,800] per annum, and is derived from the annual subscriptions of members and their clerks, from entrance fees paid by new members, and from rents and investments. All members of the Stock Exchange are not proprietors, neither are all proprietors necessarily members. Admission as a member is open to any person not engaged in another business. He must, however, be recommended by three members, who each guarantee to the committee of the house payment of £750 [$3645] in the event of a new member being declared a defaulter within two years of his election. A personal guarantee of this description is imperative, the object being to exclude all persons of doubtful character. Elections are by ballot, and for one year only, all members being theoretically liable to exclusion at the expiry of that period.

The stock exchange opens every morning at 11 o'clock and closes at 4, except on Saturday, on which day the doors are shut at 2 o'clock. All members of the house are either jobbers or brokers, the former term being applied to those who are dealers in stocks. It is contrary to the etiquette of the London Stock Exchange for brokers to deal with brokers, and all transactions are accordingly effected between brokers (representing their clients) and jobbers. Brokers' charges vary from one-sixteenth to as much as one-half per cent., and the jobbers' "turn" or profit from one-eighth to two or three per cent., according to the character of the stock dealt in. The turn of the jobber amounts in the aggregate to an enormous tax upon the British public, and the question of the utility of this intermediary has been much discussed at various times. On buyers and sellers the tax operates in this way: A wishes to buy and B wishes to sell £1000 [$4860] of Caledonian Railway stock, but, brokers being forbidden to deal with brokers, recourse is had to the jobber C, who makes a price to the brokers of say 98 to 98¼, that is to say, he offers to buy at 98 or to sell at 98¼; the buyer A accordingly pays 98¼ plus his broker's commission, and the seller B receives 98 minus his brokers' commission, the jobber C pocketing the difference or "turn" of ¼ per cent. The argument in favor of the jobber is that he supplies at all times and in all circumstances a ready market, and it must be allowed that in ordinary times he is a very convenient functionary. But, as a matter of fact, in excited times the system often breaks down, as the jobbers frequently shut their books and refuse to deal at the very moment when their help is most needed. What are known as the "markets" in the stock exchange are simply groups of jobbers distributed here and there on the floor of the house. Habit or convenience seems to have determined the particular spots occupied, which are known as the consol market, the English railway market, the foreign stock market, and so on.

In active times the business transacted daily on the London stock exchange amounts to an enormous total. Yet no written contracts or notes pass between jobbers and brokers, verbal communications being alone in use. Notwithstanding this apparent looseness of practice where millions of property are bought and sold almost hourly, there is hardly a single instance of attempted repudiation on record. All transactions are entered into for the fortnightly settlements, the precise dates for which are always fixed a few weeks in advance by the committee of the house. Each fortnightly settlement includes three days: the first is the continuation or contango day, when all transactions of a merely speculative description are continued for another fortnight, the second the ticket day, when names are passed for actual purchases or sales, and the third the pay day, when all amounts or balances are paid or received. As the great bulk of business is purely speculative, the contango or continuation day is by far the busiest of the entire fortnight. The floor of the house is then crowded with an eager throng of from 2000 to 3000 brokers, jobbers, and clerks, and during the greater part of the day little is done beyond arranging the account. Continuation rates or contangos vary with the value of money and the state of the account. When money is dear, or speculative buying active, rates are high, but when speculative selling has preponderated, and the account has become what is called a "bear" account, rates are light. An enormous amount of capital is engaged in stock exchange speculation in London. Banks, financial companies, and private firms and individuals lend freely on stock exchange securities, and thus encourage, if they do not initiate, most of the great speculative movements. Besides the great central institution in London, stock exchanges exist in nearly all the large cities of the United Kingdom. The principal are those of Glasgow, Liverpool, and Manchester, which provide excellent markets for local stocks and shares.

On the Continent the two chief centres for the transaction of stock exchange business are Paris and Berlin. In Paris the business can be traced back for about five hundred years, but it was not until 1726 that the Bourse was legally recognized, sixty *agents de change* for the transaction of business being appointed in that year by the king. The Bourse now consists of two distinct bodies, known as the *parquet* and the *coulisse*. The *parquet* is composed of the sixty official brokers or *agents de change* appointed by the Government, who alone are admitted to the inner business ring of the Bourse. The *coulisse* are the outside dealers or brokers, but, unlike the same class in London, these comprise firms of solid standing, bankers, and arbitrage houses. Although a partial settlement occurs once a fortnight, the great bulk of the business on the Paris Bourse is settled for once a month, the arrangements connected therewith occupying no less than six days. Another peculiarity in the mode of conducting business in Paris is that sellers can be compelled to deliver stock at any time during the currency of the account. At Berlin the Bourse is not under Government control, and although a certain number of licenses are issued any one may act as a broker. The Bourse can be used by the public on payment of an annual subscription, and all debts incurred there are as obligatory in law as ordinary commercial debts. The settlement occupies three days, and occurs at the end of each month.

Although stock exchange business in the United States has now attained enormous proportions, it is of comparatively recent origin. The first organization of brokers in New York dates from about 1820. The mode of conducting business in Wall Street differs in some respects from both the English and the Continental procedure. Transactions entered into on one day are settled on the following, and the full amounts involved, and not the mere differences, are paid and received. The jobber, who is of so much importance under the English system, is unknown in New York, as in all cases brokers deal direct with brokers. While stock exchange business in London is of immense variety, and comprises all descriptions of home and foreign Government bonds, railway stocks, and miscellaneous shares, in New York it is confined almost entirely to American railway bonds and shares. In these securities, however, the volume of business in active times is enormous, the vast railway system of the United States providing an ample choice for the investor and a wide field for speculative manipulation. (W. P. H.)



1. Church of St. John.
2. Humlegård.
3. Kungsträdgård.
4. Carl XII. Torg.
5. Mint.
6. Church of St. Nicholas.
7. Stortorg.
8. Riddarhustorg.
9. Birger Jarls Torg.

STOCKHOLM, the capital of Sweden, is situated at the point where Lake Mälar mixes its waters with those of the Baltic, and at the meeting-place of two provinces, Upland and Södermanland. The old cities of Sweden are regularly found in places where in early times the inhabitants of neighboring districts came together for purposes of exchange or sometimes of worship, or where a river brought the interior of the country into closer connection with the coast. By the passages that wind among the numerous isles off Stockholm ships at an early date came to the mouth of the lake, only to continue their voyage into its remoter parts. The two provinces mentioned were densely peopled, and the cultivated regions extended to the mouth of the lake, as is shown by groups of tumuli still to be seen in the immediate neighborhood of the present city. Still Stockholm does not rank among the oldest cities of Sweden; the exceedingly eligible site had long been neglected owing to its exposure to the incursions of pirates.[1]

Environs of Stockholm.

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[1] Before the rise of Stockholm Björkö, Sigtuna, and Upsala were places of great importance. Björkö ("the isle of birches"), by foreign authors called Birca, was a kind of capital where the king lived occasionally at least; history speaks of its relations with Dorestad in the Netherlands, and the extensive refuse heaps of the old city, as well as the numerous sepulchral monuments, show that the population must have been large. But, though situated at a central point on the Mälar Lake, it was destroyed,

Stockholm was first founded by Birger Jarl, it is said, in the middle of the 13th century, at a time when pirate fleets were less common than they had been, and the Government was anxious to establish commercial relations with the towns which were now beginning to flourish on the southern coast of the Baltic. The city was originally founded as a fortress on an island at the mouth of Lake Mälar; this island, which is not large, consists of a hill of gravel resting upon rocky ground, having its highest side towards the north, and sloping in the other directions. The castle was erected on the northeastern corner, and the city was surrounded with walls having fortified towers on the north and south. It came to be called Stockholm ("the isle of the log," Lat. *Holmia*, Germ. *Holm*); the true explanation of the name is not known. Soon the space which had been inclosed was found to be insufficient, and houses were built outside the walls, which thus lost their defensive character. The castle, two towers belonging to the older works, and some newer walls nearer the water became the sole fortifications. The citizens began also to build on the neighboring shores, though there, in the event of a siege, all houses had to be destroyed, so as not to give shelter to the enemy. A tendency to increased development has steadily showed itself throughout the Middle Ages and in modern times. On an islet in the stream, between the original Stockholm and the northern shore, was founded, in the 14th century, a hospital of the Holy Ghost, and a new tower was erected to defend the approach to the city. On another islet closely adjoining the original Stockholm on the west, a Franciscan monastery was founded towards the end of the 13th century.

The present city has an area of 12.6 square miles (.44 being water); its extreme length from north to south is about 3.8 miles and its circumference 14¼. The different parts of the actual city are the following: (1) *Staden* is the old "city"; its ancient origin is apparent in the narrow and winding streets. The individual houses are not very old, owing to the ravages of frequent fires; still, some are to be seen with very narrow frontage and gables turned towards the street, as in North Germany. The old market, still called Stortorget ("the great market"), is now one of the smallest in Stockholm. The royal palace, dating from the Middle Ages, but enlarged and partly rebuilt at a later period, was destroyed by fire in 1697, the body of Charles XI. being with difficulty rescued from the flames. A new palace, after plans by Nicodemus Tessin, was not completed (owing to wars and the general distress) until 1754; it is a quadrangular structure on the summit of the hill, with two wings towards the east and four towards the west (two straight and two in a semicircle). The style of the building is noble and refined, the royal apartments rich in treasures of art. In the immediate vicinity of the palace is the church of St. Nicholas, the oldest in Stockholm, but in many parts changed from what it was; the chancel was demolished in the 16th century to give more room for the palace. Staden is the commercial centre of the city, containing the exchange, the bank of Sweden, and the custom-house, as well as the offices of many merchants. On the eastern side a very large quay, called the Skeppsbro ("the bridge of ships"), extends from the statue of Gustavus III. opposite the palace to where the traffic between Lake Mälar and the Baltic is carried on through a sluice or lock. The Skeppsbro is the landing-place for steamers to the northern provinces of Sweden and foreign ports. On the other side of the palace is the Kanslihus, containing the offices of most of the ministries; and a little farther on is a market, named from the palace on its northern side, the Riddarhus, belonging to the Swedish nobility. The principal hall of the Riddarhus has its walls adorned with the armorial bearings of the noble families of Sweden. The representatives of these families meet here every third year for consultation as to their common interests. In front of the building stands the statue of Gustavus I. The town-hall stands in the same square. (2) *Riddarholmen* contains the old Franciscan church, which, however, is not now used for divine service. Since the time of Gustavus Adolphus it has been the burial-place of the royal family; it also contains many trophies from the European wars of Sweden. On one side of the church stand the houses of parliament; on the other is the statue of Birger Jarl, the founder of Stockholm. A large part of the island is occupied by Government offices, including the record office. Along the shore most of the steamers for different parts of Lake Mälar and farther on through the canal of Södertelge, for the Baltic, have their landing-places. (3) *Helgeandsholmen* ("the isle of the Holy Ghost") is at present occupied by the royal stables. The Norrbro ("north bridge"), connecting the old town with the northern shore, passes the eastern extremity of the island. (4) *Norrmalmen* ("the northern suburb") begins at the Norrbro with the market of Gustavus Adolphus, where his statue stands between the theatre royal and the crown prince's palace. Norrmalmen is one of the best built parts of the city, with broad straight streets; it contains four parish churches and also the English church, the Roman Catholic church, and the Jewish synagogue. In the southeastern corner is a large open space, Kungsträdgården ("the royal garden"), with the statues of Charles XII. and Charles XIII. and a fountain, one of the principal playgrounds for children. Near it is another park, with the statue of Berzelius. Norrmalmen has several public buildings, such as the post-office, the principal railway station, the academy of art, the academy of sciences, the high technical school, and the school of metallurgy, the technical school, the observatory, etc. On the northern side of Norrmalmen lies the principal cemetery. (5) *Blasieholmen*, united with Norrmalmen since the filling up of the canal which formerly separated them, contains the national museum, the academy of music, etc. (6) *Skeppsholmen* ("the isle of ships") and (7) *Castellholmen* both belong to the admiralty. (8) *Kungsholmen* ("the isle of the king"), to the west of Norrmalmen, contains a parish church, the mint, the high school of medicine, several hospitals, and many factories. (9) *Ladugardslandet* takes its name from the farm yard (*ladugård*) of the royal castle, which formerly occupied a great part of its area. It became a part of the city in the middle of the 17th century, but until recently played a very subordinate part, owing to want of water. Since the introduction of the new water-supply this part of Stockholm has grown wonderfully, and is now the finest part of the city, with more than 40,000 inhabitants. It has a fine park, Humlegården ("hop garden"), with the royal library and the statue of Linnæus. Most of the barracks of Stockholm, as well as the high military school, are situated in this quarter of the town. (10) *Djurgården* ("deer garden") is a royal park, with villas, restaurants, shipbuilding yards, etc. (11) *Södermalmen* ("the southern suburb") is separated from Staden by the sluice already mentioned. On an open space at the side of the channel stands the statue of Charles XIV. (Bernadotte). The larger part of this suburb, with its two parish churches, chapels, hospitals, etc., stands at a considerable elevation, and communication has been facilitated by the construction of two elevators. On the outskirts are factories, foundries, etc.

A glance at the map at once shows how important have been its water-facilities in forming the character of Stockholm. From all sides the water permeates the different

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apparently before the beginning of the 11th century, we do not exactly know when nor by whom; and, once destroyed, it never recovered. Sigtuna, lying on the shore of a far-reaching northern arm of Lake Mälar, also a royal residence and the seat of the first mint in Sweden, where English workmen were employed by King Olaf at the beginning of the 11th century, was, though much more sheltered than Björkö, destroyed in the course of the 12th century.

parts of the city, separating them, yet at the same time helping to unite them. Stretching far away to east and to west between shores and islands sometimes open and cultivated, sometimes rocky and covered with trees, the water entices the inhabitants to make excursions and to reside for a part of the year in the country; in the summer the city is largely deserted. The site is universally recognized as extremely picturesque. The great water-surface has also a beneficent influence upon the climate. In 1884 the mean temperature was 42.47° Fahr., the highest temperature of the year being 72.4° Fahr. (2d and 5th July), the lowest —0.4° Fahr. (30th November). The year's rainfall amounted to 18.3 inches, the number of rainy days being 129. The best time for visiting Stockholm is the latter half of June, when the evening and morning lights, reflected from the water and seen through the young and luxuriant verdure, produce singularly beautiful and varied effects.

In Sweden the cities formerly played a comparatively subordinate part. During the Swedish Middle Ages the prominent classes were the nobility, the clergy, and the peasantry. The anti-aristocratic revolution of the 14th and the 15th centuries had in Sweden its principal supporters among the peasants. But the importance of the cities has gradually increased, and recent times have witnessed an accelerated development, which is best exemplified by the history of Stockholm. The number of inhabitants was, in 1800, 75,517; in 1825, 79,473; in 1850, 93,070; in 1860, 112,391; in 1870, 136,016; in 1880, 168,775; in 1884, 205,123; and in December, 1885, 215,688. In 1884 11,916 were qualified to take part in the election of members of the lower house of parliament. Along with the rapid increase of population went a correspondingly increased industrial activity and a considerable development in the means of communication. The number of mechanics in 1884 was 11,064 (8716 of the wage-earning class), the corresponding numbers for 1880 being 9664 and 7483. The number of factories in 1884 was 275, employing 9810 work-people (including 2638 women), and producing to the value of 32,355,565 Swedish crowns (£1,797,531 [$8,736,000.66]). The merchants in 1884 numbered 3828, with 6554 assistants. In the same year 37,561 vessels entered (21,460 steamers), while 37,699 (21,565 steamers) cleared. Of these 1688 entered from and 1159 cleared for foreign ports. In former times Stockholm had the command of all the foreign commerce for the country round Lake Mälar, and for the whole of northern Sweden; but more recently the northern cities have made themselves to a certain extent independent of the capital.

For communication between the different parts of Stockholm omnibuses and small rowing boats have now given place to small steamers; in 1884 sixty-three of these were in use in the city and its immediate vicinity. In 1880 tramways were constructed for Staden, Norrmalmen, Kungsholmen, and Ladugårdslandet.

The city forms a separate administrative district under a governor (*öfverståthållare*). In ecclesiastical matters it belongs to the archbishopric of Upsala, and the archbishop has the right to preside in its consistory, of which the president generally is the *pastor primarius*, the rector of St. Nicholas. The members of this consistory are the rectors of the other seven territorial parishes and the rectors of the Finnish and German congregations. There is also a court consistory, presided over by the chief court preacher.

It was not until modern times that Stockholm became the capital of Sweden. The mediæval kings visited year by year different parts of the kingdom, where they lived for a shorter or longer time. When, from the development of state affairs, the need of a capital came to be felt, no city could compete with the claims of Stockholm. It is the usual residence of the king: in the summer he lives generally in one of the palaces in the neighborhood; some part of every year he passes in his Norwegian capital. The supreme court of justice has its seat in Stockholm, as well as the *Svea Hofrätt*, the next highest tribunal for central and northern Sweden. It is also the seat of all the other central governmental boards.

Stockholm is also the seat of seven academies. (1) The Swedish Academy, with eighteen members, founded in 1786, deals with the language and literature of Sweden. It is engaged upon a Swedish dictionary, and celebrates every year the memory of some renowned Swede. (2) The academy of sciences, founded in 1739, with 100 ordinary members, distributed into nine classes, and 75 foreign members, has charge of the royal museum of natural history, the physical, astronomical, and meteorological institutes, and the botanical garden. (3) The academy of belles lettres, history, and antiquities, founded in 1753, reformed in 1786, now occupies itself only with history and antiquities; it has 14 honorary members, 20 ordinary members, 16 foreign members and correspondents. The secretary of this academy is, at the same time, as royal antiquary of Sweden and garde des médailles, director of the archæological, historical, and numismatical state collections, and inspector of the antiquities of the kingdom. (4) The academy of agriculture, founded in 1811, with 24 honorary members, 136 ordinary and 75 foreign members, occupies itself with agriculture and fisheries. It has an experimental institution for agricultural chemistry, physiology of plants, gardening, and practical agriculture. (5) The academy of fine arts, founded in 1735, has charge of the official school of art. (6) The academy of music, founded in 1771, has the care of the state conservatory of music. (7) The academy of military sciences was founded in 1796. Each of these academies is a distinct body; most of them publish their transactions, and each has its own library.

There are several private societies of a scientific character, such as the society for publication of historical documents, the historical society, the society of anthropology and geography, the society of national antiquities, the geological society, the society of natural sciences, the entomological society, etc.

Stockholm has no state university, but there is a high school of medicine (*Carolinska Institute*), which has several professors of mathematics and natural science. The city has also a high technical school, a technical school, a high military school, and a military school (in the palace of Carlberg, outside of the city), a veterinary school, a school of pharmacy, seven more or less complete secondary schools, and two seminaries for female teachers, besides private schools. The number of pupils in the secondary schools in 1884 was 2294 and in the primary schools 14,351.

The following are the principal public collections. (1) The royal historical museum (in the national museum) contains a remarkably rich series of the prehistoric antiquities of the country. Founded in the 17th century, it has made greatest progress since 1837. (2) The royal numismatical collection (in the national museum) contains about 90,000 coins and medals. The series of Anglo-Saxon coins found in Sweden is very important. (3) the numismatical collection of the Bank of Sweden (in the bank offices) contains very good series of Swedish coins and medals. (4) The royal collection of armor and royal dresses (in the royal palace) is very rich in specimens of the 17th and 18th centuries. (5) The royal museum of fine and industrial arts (in the national museum) contains sculptures, pictures, engravings, drawings, etc. The collection of Swedish art is, of course, very rich. Of foreign schools that of the Netherlands is best represented. The collection illustrating the development of industrial arts consists principally of gifts of Charles XV. and Count A. Bjelke. (6) The royal museum of natural history (in the palace of the academy of sciences), with very rich zoological, botanical, palæontological, and mineral series, is exceedingly rich in objects from the arctic regions. Other collections deserving mention are (7) the museum of the geological survey of Sweden; (8) the museum of the school of medicine; (9) the northern museum, a private institution, a very rich collection representing the life of all social classes of the north; (10) the royal library, very rich in books and manuscripts; and (11) the royal archives.

See Elers, *Stockholm*, 4 vols., 1800–1801; Ferlin, *Stockholms Stad*; *Berättelser angående Stockholms Kommunalförvaltning*. (H. HI.)

STOCKINGS. See Hosiery.

STOCKPORT, a market-town and municipal and parliamentary borough of England, in Cheshire and partly in Lancashire, is situated on an elevation above the Mersey at the junction of the Tame and Goyt, and of a number of railway lines, 46 miles east-northeast of Chester, 37 east of Liverpool, and 6 south-southeast of Manchester. Owing to the lie of the ground the streets are very irregular and uneven, and occasionally precipitous, while in the south they rise above the river in tiers. The Mersey is crossed by a number of bridges, including one of eleven arches opened in 1826 at a cost of £40,000 [$194,400]. None of the ecclesiastical buildings are of special interest, the principal being the church of St. Mary, erected in 1817, at a cost of £30,000 [$145,800] on the site of one of the 15th century, of which the chancel and vestry remain. The free grammar school was founded and endowed in 1487 by Sir Edward Shaa or Shaw, knight. The present building was erected in 1831 by the Goldsmiths' Company, who further endowed it with £290 [$1409.40] a year, and handed it over to the corporation. The Stockport Sunday school, erected in 1805, has accommodation for 4000 scholars. There is a free public library, established in 1875. The principal public buildings are the court-house, the market-house, the union workhouse, the mechanics' institute, the infirmary, the institution for the blind and deaf and dumb, and the fine new public baths. In St. Peter's Square there is a statue, unveiled 27th November, 1886, of Richard Cobden, who was elected member for the borough in 1841 and 1847. Vernon Park, finely situated about a mile from the town, contains a free museum, built in 1858 at the expense of the members for the borough, and since enlarged by the corporation. The staple industries are the spinning and weaving of cotton and felt-hat making. There are also breweries, foundries, machine-works, and flour-mills. The limits of the municipal and parliamentary boroughs are co-extensive. The area is 2200 acres, with a population in 1871 of 53,014 and in 1881 of 59,553.

Though not referred to in any of the Roman itineraries, and possessing neither Roman nor Saxon remains, Stockport is supposed to have been a Roman camp or outpost, which occupied the hill on which the Normans afterwards built a baronial castle. It is not mentioned in Domesday. The castle was held in 1173 by Geoffrey de Costentyn against Henry II., but whether in his own right or not is uncertain. In the beginning of the 13th century it was possessed by the first Baron Ranulf de Dapifer, progenitor of the Despensers, from whom it passed to Robert de Stockeport, who in the reign of Henry III. made the town a free borough, and in 1260 received for it from the earl of Chester the grant of a market. The town was visited by the plague in 1605–6. It was of some importance during the Civil War, and was taken by the Royalists under Prince Rupert in May, 1644. During the insurrection of 1745 Prince Charles Edward rested at the town on the 28th November. The town was enfranchised in 1832, with the right, which it still retains, of returning two members, and was incorporated under the Corporations Act in 1835.

STOCKS, as a form of punishment, are now quite obsolete. They were originally established in England after the passing of the Statute of Laborers, 23 Edw. III. c. 1. That Act enjoined that stocks (*ceppes*) should be made in every town between the passing of the Act and Pentecost of that year (1350). By numerous other statutes, until comparatively modern times, the punishment of the stocks was inflicted for offences of a less heinous kind, *e.g.*, breaches of the Sunday Observance Acts of Charles I. and Charles II. In the United States the stocks were formerly used as a means of punishing slaves.

STOCKTON, a city of the United States, county seat of San Joaquin county, California, at the head of the Stockton navigable channel which joins the San Joaquin river, and 48 miles south-southeast of Sacramento, by the western division of the Central Pacific Railroad. It is the business centre of the San Joaquin valley, a great wheat market, and the seat of the State lunatic asylum (founded in 1853). Artesian wells 80 to 1000 feet deep provide the city with a perennial supply of water. Two public libraries, several public schools, and a convent may be mentioned among its important institutions; and it manufactures leather, agricultural implements, paper, flour, etc. The population was 10,066 in 1870 and 10,282 in 1880. Stockton was laid out in 1849, and was incorporated as a city in 1850.

STOCKTON-ON-TEES, a market town and municipal and parliamentary borough and seaport of Durham, on the borders of the North Riding of Yorkshire, into which the parliamentary borough extends, is situated on the Tees, which is crossed by an iron bridge (completed in 1887 at a cost over £80,000 [$388,800], to supersede the stone bridge of 1769) leading to South Stockton, and on the Stockton and Darlington and the Sunderland and West Hartlepool branches of the North-Eastern Railway, 20 miles south-southeast of Durham, and 4 miles west-southwest of Middlesborough. The principal street is about a mile in length. Of the ancient castle commanding the Tees, which was destroyed in 1652, the last remains were removed in 1865. Among the principal public buildings are the town-hall, with a clock-tower and spire, the borough hall (erected in 1852 at a cost of £32,000 [$155,520]; the freemasons' hall, the temperance hall, the theatre, the exchange hall, the literary institute, the hospital, the dispensary, the free library, and the blue-coat school. Stockton is a seaport of considerable importance. The management of the Tees, vested in 1808 in the Tees Navigation Company, was in 1852 vested in the Tees Conservancy Commissioners, incorporated by Act of Parliament, under whose auspices the river has been greatly improved. The trade of the port is chiefly with Holland and the ports of the Baltic, and there is a considerable coasting trade with the Tyne ports and with Hull and London. Its chief exports are iron manufactures, coal, coke, and agricultural produce, the average annual value for the five years 1880–84 being about £72,000 [$349,920]. The principal imports are timber, iron, grain and provisions, the average annual value for the five years 1880–84 being about £240,000 [$1,166,400]. In 1885 the number of vessels that entered the port was 649, of 149,628 tons, the number that cleared 700, of 175,647 tons. The rapid increase of the town within the last quarter of a century is largely owing to the development of the iron and and steel trade in the district. There are extensive steel works, blast-furnaces, iron and brass foundries, and rolling-mills, and iron-shipbuilding is also an important industry. There are also-sailcloth works, potteries, breweries, and brick and tile works. The population of the municipal borough (area 1189 acres) in 1871 was 27,738, and in 1881 it was 41,015. The population of the parliamentary borough (area 7157 acres) in the same years was 37,612 and 55,457. The parliamentary borough includes the suburb of South Stockton on the opposite side of the river, forming a separate urban sanitary district (area 1052 acres), with a population in 1871 of 6794 and in 1881 of 10,665. It has a temperance hall, a mechanics' institute, and a national school, and its manufactures are similar to those of Stockton.

The place is of great antiquity, and is supposed to have been occupied by the Romans. Before the Conquest the manor belonged to the see of Durham. It was probably first incorporated by Bishop Hugh de Pudsey, who in the reign of Richard I. occupied the castle. The castle, which was for a long time the residence of the bishops, stood on the north bank of the Tees. The town was destroyed by the Scots in 1322, but the castle seems to have escaped. During the Civil War it was garrisoned for the king, but was afterwards delivered up to the Parliamentary party, and in 1645 was held by the Scots. The town suffered severely from inundations of the Tees in 1771, 1783, and 1822. Though Stockton was placed under the Municipal Act of 1835, it remained divided into two parts, the one called the "borough," where the land was freehold, governed by the corporation and the other called the "town," where the land was copyhold or leasehold, held under the vicar and vestrymen, and outside the corporate jurisdiction. To remedy this state of matters an "Extension and Improvement Act" was passed in 1852. The town was enfranchised in 1867, and returns one member.

STOICS, a school of philosophers founded at the close of the 4th century B.C. by Zeno of Citium, and so called from the Stoa or painted corridor (*στοὰ ποικίλη*) on the north side of the market-place at Athens, which, after its restoration by Cimon, the celebrated painter Polygnotus had adorned with frescos representing scenes from the Trojan War. But, though it arose on Hellenic soil, from lectures delivered in a public place at Athens, the school is scarcely to be considered a product of purely Greek intellect, but rather as the first fruits of that interaction between West and East which followed the conquests of Alexander. Hardly a single Stoic of eminence was a citizen of any city in the heart of Greece, unless we make Aristo of Chios, Cleanthes of Assus, and Panætius of Rhodes exceptions. Such lands as Cyprus, Cilicia, and Syria, such cities as Citium, Soli, Heraclea in Pontus, Sidon, Carthage, Seleucia on the Tigris, Apamea by the Orontes, furnished the school with its scholars and presidents; Tarsus, Rhodes, and Alexandria became famous as its university towns. As the first founder was of Phœnician descent, so he drew most of his adherents from the countries which were the seat of Hellenistic (as distinct from Hellenic) civilization; nor did Stoicism achieve its crowning triumph until it was brought to Rome, where the grave earnestness of the national character could appreciate its doctrine, and where for two centuries or more it was the creed, if not the philosophy, of all the best of the Romans. Properly therefore it stands in marked antithesis to that fairest growth of old Hellas, the Academy, which saw the Stoa rise and fall,—the one the typical school of Greece and Greek intellect, the other of the Hellenized East, and, under the early Roman empire, of the whole civilized world. The transcendent genius of its author, the vitality and romantic fortunes of his doctrine, claim our warmest sympathies for Platonism. But it should not be forgotten that for more than four centuries the tide ran all the other way. It was Stoicism, not Platonism, that filled men's imaginations, and exerted the wider and more active influence upon the ancient world at some of the busiest and most important times in all history. And this was chiefly because before all things it was a practical philosophy, a rallying point for strong and noble spirits contending against odds. Nevertheless, in some departments of theory, too, and notably in ethics and jurisprudence, Stoicism has dominated the thought of after ages to a degree not easy to exaggerate.

The history of the Stoic school may conveniently be divided in the usual threefold manner: the old Stoa, the middle or transition period (Diogenes of Seleucia, Boethus of Sidon, Panætius, Posidonius), and the later Stoicism of Roman times. By the old Stoa is meant the period (*c.* 304–205 B.C.) down to the death of Chrysippus, the second founder; then was laid the foundation of theory, to which hardly anything of importance was afterwards added. Confined almost to Athens, the school made its way slowly among many rivals. Aristo of Chios and Herillus of Carthage, Zeno's heterodox pupils, Persæus, his favorite disciple and housemate, the poet Aratus, and Sphærus, the adviser of the Spartan king Cleomenes, are noteworthy minor names; but the chief interest centres about Zeno, Cleanthes, Chrysippus, who in succession built up the wondrous system. What originality it had—at first sight it would seem not much—belongs to these thinkers; but the loss of all their works except the hymn of Cleanthes, and the inconsistencies in such scraps of information as can be gleaned from unintelligent witnesses, for the most part of many centuries later, have rendered it a peculiarly difficult task to distinguish with certainty the work of each of the three. The common standpoint, the relation to contemporary or earlier systems, with all that goes to make up the character and spirit of Stoicism, can, fortunately, be more certainly established, and may with reason be attributed to the founder.

Zeno.

Zeno's residence at Athens fell at a time when the great movement which Socrates originated had spent itself in the second generation of his spiritual descendants. Neither Theophrastus at the Lyceum, nor Xenocrates and Polemo at the Academy, nor Stilpo, who was drawing crowds to hear him at Megara, could be said to have inherited much of the great reformer's intellectual vigor, to say nothing of his moral earnestness. Zeno visited all the schools in turn, but seems to have attached himself definitely to the Cynics; as a Cynic he composed at least one of his more important works, "the much admired *Republic*," which we know to have been later on a stumbling-block to the school. In the Cynic school he found the practical spirit which he divined to be the great need of that stirring troublous age. For a while his motto must have been "back to Socrates," or at least "back to Antisthenes." The Stoics always counted themselves amongst the Socratic schools, and canonized Antisthenes and Diogenes; while reverence for Socrates was the tie which united to them such an accomplished writer upon lighter ethical topics as the versatile Persæus, who, at the capital of Antigonus Gonatas, with hardly anything of the professional philosopher about him, reminds us of Xenophon, or even Prodicus. Zeno commenced, then, as a Cynic; and in the developed system we can point to a kernel of Cynic doctrine to which various philosophemes of other thinkers (more especially Heraclitus and Aristotle, but also Diogenes of Apollonia, the Pythagoreans, and the medical school of Hippocrates in a lesser degree) were added. Thus, quite apart from the general similarity of their ethical doctrine, the Cynics were materialists; they were also nominalists, and combated the Platonic ideas; in their theory of knowlege they made use of "reason" (λόγος), which was also one of their leading ethical conceptions. In all these particulars Zeno followed them, and the last is the more important, because Chrysippus having adopted a new criterion of truth,—a clear and distinct perception of sense,—it is only from casual notices we learn that the elder Stoics had approximated to Cynicism in making right reason the standard. At the same time, it is certain that the main outlines of the characteristic physical doctrine, which is after all the foundation of their ethics and logic, were the work of Zeno. The Logos, which had been an ethical or pyschological principle to the Cynics, received at his hands an extension throughout the natural world, in which Heraclitean influence is unmistakable. Reading the Ephesian doctrine with the eyes of a Cynic, and the Cynic ethics in the light of Heracliteanism, he came to formulate his distinctive theory of the universe far in the advance of either. In taking this immense stride and identifying the Cynic "reason," which is a law for man, with the "reason" which is the law of the universe, Zeno has been compared with Plato, who similarly extended to the Socratic "general notion" from the region of morals,—of justice, temperance, virtue,—to embrace all objects of all thought, the verity of all things that are.

Cleanthes.

If the recognition of physics and logic as two studies co-ordinate with ethics is sufficient to differentiate the mature Zeno from the Cynic author of the *Republic*, no less than from his own hetorodox disciple Aristo, the elaboration on all sides of Stoic natural philosophy belongs to Cleanthes, who certainly was not the merely docile and receptive intelligence he is sometimes represented as being. He carried on and completed the assimilation of Heraclitean doctrine; but his own contributions were more distinctive and original than those of any other Stoic. Zeno's seeming dualism of God (or force) and formless matter he was able to transform into the lofty pantheism which breathes in every line of the famous hymn to Zeus. Heraclitus had indeed declared all to be in flux, but we ask in vain what is the cause for the unceasing process of his ever-living fire. It was left for Cleanthes to discover this motive cause in a conception familiar to Zeno, as to the Cynics before him, but restricted to the region of ethics,—the conception of tension or effort. The soul of the sage, thought the Cynics, should be strained and braced for judgment and action; his first need is firmness (εὐτονία) and Socratic strength. But the mind is a corporeal thing. Then followed the flash of genius: this varying tension of the one substance everywhere present, a purely physical fact, accounts for the diverse destinies of all innumerable particular things; it is the veritable cause of the flux and process of the universe. Herein lies the key to the entire system of the Stoics, as Cleanthes's epoch-making discovery continually received fresh applications to physics, ethics, and epistemology. Other of his innovations, the outcome of his crude materialism, found less favor with his successor, who declined to follow him in identifying the primary substance with fire, or in tracing all vitality to its ultimate source in the sun, the "ruling power" of the world,—a curious anticipation of scientific truth. Yet under this poetical Heraclitean mystic the school was far from flourishing. The eminent teachers of the time are said to have been Aristo, Zeno's heterodox pupil, and Arcesilas, who in Plato's name brought Megarian subtleties and Pyrrhonian agnosticism to bear upon the intruding doctrine; and after a vigorous upgrowth it seemed not unlikely to die out. From all danger of such a fate it was rescued by its third great teacher, Chrysippus; "but for Chrysippus there had been no Porch." Zeno had caught the practical spirit of his age,—the desire for a popular philosophy to meet individual needs. But there was another tendency in post-Aristotelian thought,—to lean upon authority and substitute learning for independent research,—which grew stronger just in proportion as the fresh interest in the problems of the universe and the zeal for discovery declined,—a shadow, we may call it, of the coming Scholasticism thrown a thousand years in advance.

Chrysippus.

The representative of this tendency, Chrysippus addressed himself to the congenial task of assimilating, developing, systematizing the doctrines bequeathed to him, and, above all, securing them in their stereotyped and final form, not simply from the assaults of the past, but, as after a long and successful career of controversy and polemical authorship he fondly hoped, from all possible attack in the future. To his personal characteristics can be traced the hair-splitting and formal pedantry which ever afterwards marked the activity of the school, the dry repellent technical procedure of the Dialecticians *par excellence*, as they were called. He created their formal logic and contributed much that was of value to their psychology and epistemology; but in the main his work was to new-label and new-arrange in every department, and to lavish most care and attention on the least important parts,—the logical terminology and the refutation of fallacies, or as his opponents declared, the excogitation of fallacies which even he could not refute. In his *Republic* Zeno had gone so far as to declare the routine education of the day (*e.g.*, mathematics, grammar, etc.) to be of no use. Such Cynic crudity Chrysippus rightly judged to be out of keeping with the requirements of a great dogmatic school, and he labored on all sides after thoroughness, erudition, and scientific completeness. In short, Chrysippus made the Stoic system what it was, and as he left it we proceed to describe it.

Conception of philosophy.

And first we will inquire, What is philosophy? No idle gratification of curiosity, as Aristotle fabled of his life intellectual (which would be but a disguise for refined pleasure), no theory divorced from practice, no pursuit of science for its own sake, but knowledge so far forth as it can be realized in virtuous action, the learning of virtue by exercise and effort and training. So absolutely is the "rare and priceless wisdom" for which we strive identical with virtue itself that the three main divisions of philosophy current at the time and accepted by Zeno,—logic, physics, and ethics,—are defined as the most generic or comprehensive *virtues*. How otherwise could they claim our attention? Accordingly Aristo, holding to Cynicism when Zeno himself had got beyond it, rejected two of these parts of philosophy as useless and out of reach,—a divergence which excluded him from the school, but strictly consistent with his view that ethics alone is scientific knowledge. Of the three divisions logic is the least important; ethics is the outcome of the whole, and historically the all-important vital element; but the foundations of the whole system are best discerned in the science of nature, which deals pre-eminently with the macrocosm and the microcosm, the universe and man, including natural theology and an anthropology or psychology, the latter forming the direct introduction to ethics.

Physics.

The Stoic system is in brief—(*a*) materialism, (*b*) dynamic materialism, lastly (*c*) monism or pantheism. (*a*) The first of these characters is described by anticipation in Plato's *Sophist* (246 C *sq.*), where, arguing with those "who drag everything down to the corporeal" (σῶμα), the Eleatic stranger would fain prove to them the existence of something incorporeal, as follows: "They admit the existence of an animate body. Is soul then something existent (οὐσία)? Yes. And the qualities of soul, as justice and wisdom—are they visible and tangible? No. Do they then exist? They are in a dilemma." Now, however effective against Plato's contemporary Cynics or Atomists, the reasoning is thrown away upon the Stoics, who take boldly the one horn of this dilemma. That qualities of bodies (and therefore of the corporeal soul) exist they do not deny; but they assert most uncompromisingly that they are one and all (wisdom, justice, etc.) corporeal. And they strengthen their position by taking Plato's own definition (247 D), namely, "being is that which has the power to act or be acted upon," and turning it against him.

Materialism.

For this is only true of Body; action, except by contact, is inconceivable; and they reduce every form of causation to the efficient cause, which implies the communication of motion from one body to another. Again and again, therefore, only Body exists. The most real realities to Plato and Aristotle had been thought and the objects of thought, νοῦς and νοητά, whether abstracted from sensibles or inherent in "matter," as the incognizable basis of all concrete existence. But this was too great an effort to last long. Such spiritualistic theories were nowhere really maintained after Aristotle and outside the circle of his immediate followers. The reaction came and left nothing of it all; for five centuries the dominant tone of the older and the newer schools alike was frankly materialistic. "If," says Aristotle, "there is no other substance but the organic substances of nature, physics will be the highest of the sciences," a conclusion which passed for axiomatic until the rise of Neoplatonism. The analogues therefore of metaphysical problems must be sought in physics; particularly that problem of the causes of things for which the Platonic idea and the Peripatetic "constitutive form" had been in turn received solutions.

Tension.

(*b*) But the doctrine that all existence is confined within the limits of the sensible universe,—that there is no being save corporeal being or body,—does not suffice to characterize the Stoic system; it is no less a doctrine of the Epicureans. It is the idea of tension as the essential attribute of body, in contradistinction to passive inert matter, which is distinctively Stoic. The Epicureans leave unexplained the primary constitution and first movements of their atoms or elemental solids; chance or declination may account for them. Now, to the Stoics nothing passes unexplained; there is a reason (λόγος) for everything in nature. Everything which exists is at once capable of acting and being acted upon. In everything that exists, therefore, even the smallest particle, there are these two principles. By virtue of the passive principle the thing is susceptible of motion and modification; it is matter which determines substance (οὐσία). The active principle makes the matter a given determinate thing, characterizing and qualifying it, whence it is termed quality (ποιότης). For all that is or happens there is an immediate cause or antecedent; and as "cause" means "cause of motion," and only body can act upon body, it follows that this antecedent cause is itself as truly corporeal as the matter upon which it acts. Thus we are led to regard the active principle "force" as everywhere co-extensive with "matter," as pervading and permeating it, and together with it occupying and filling space. This is that famous doctrine of universal

Matter and force.

Monism

permeation (*κρᾶσις δι᾽ ὅλου*), by which the axiom that two bodies cannot occupy the same space is practically denied. Thus that harmony of separate doctrines which contributes to the impressive simplicity of the Stoic physics is only attained at the cost of offending healthy common sense, for Body itself is robbed of a characteristic attribute. A thing is no longer, as Plato once thought, hot or hard or bright by partaking in abstract heat or hardness or brightness, but by containing within its own substance the material of these qualities, conceived as air-currents in various degrees of tension. We hear, too, of corporeal days and years, corporeal virtues, and actions (like walking) which are bodies (*σώματα*). Obviously, again, the Stoic quality corresponds to Aristotle's essential form; in both systems the active principle, "the cause of all that matter becomes," is that which accounts for the existence of a given concrete thing (*λόγος τῆς οὐσίας*). Only here, instead of assuming something immaterial (and therefore unverifiable), we fall back upon a current of air or gas (*πνεῦμα*); the essential reason of the thing is itself material, standing to it in the relation of a gaseous to a solid body. Here, too, the reason of things—that which accounts for them—is no longer some external end to which they are tending; it is something acting within them, "a spirit deeply interfused," germinating and developing as from a seed in the heart of each separate thing that exists (*λόγος σπερματικός*). By its prompting the thing grows, develops, and decays, while this "germinal reason," the element of quality in the thing, remains constant through all its changes. (*c*) What then, we ask, is the relation between the active and the passive principles? Is there, or is there not, an essential distinction between substance or matter and pervading force or cause or quality? Here the Stoa shows signs of a development of doctrine. Zeno began, perhaps, by adopting the formulas of the Peripatetics, though no doubt with a conscious difference, postulating that form was always attached to matter, no less than matter, as known to us, is everywhere shaped or informed. Whether he ever overcame the dualism which the sources, such as they are, unanimously ascribe to him is not clearly ascertained. It seems probable that he did not. But we can answer authoritatively that to Cleanthes and Chrysippus, if not to Zeno, there was no real difference between matter and its cause, which is always a corporeal current, and therefore matter, although the finest and subtlest matter. In fact they have reached the final result of unveiled hylozoism, from which the distinction of the active and passive principles is discerned to be a merely formal concession to Aristotle, a legacy from his dualistic doctrine. His technical term Form (*εἶδος*) they never use, but always Reason or God. This was not the first time that approaches had been made to such a doctrine, and Diogenes of Apollonia in particular was led to oppose Anaxagoras, who distinguished Nous or Thought from every other agent within the cosmos which is its work, by postulating as his first principle something which should be at once physical substratum and thinking being. But until dualism had been thought out, as in the Peripatetic school, it was impossible that monism (or at any rate materialistic monism) should be definitely and consciously maintained. One thing is certain: the Stoics provided no loophole of escape by entrenching upon the "purely material" nature of matter; they laid down with rigid accuracy its two chief properties,—extension in three dimensions, and resistance, both being traced back to force. There were, it is true, certain inconsistent conceptions, creations of thought to which nothing real and external corresponded, namely, time, space, void, and the idea expressed in language (*λεκτόν*). But this inconsistency was covered by another: though each of these might be said to be something, they could not be said to exist.

Cosmogony.

The distinction of force and matter is then something transitory and relative. Its history will serve as a sketch of the cosmogony of the Stoics, for they too, like earlier philosophers, have their "fairy tale of science." Before there was heaven or earth, there was primitive substance or Pneuma, the everlasting presupposition of particular things. This is the totality of all existence; out of it the whole visible universe proceeds, hereafter to be again resolved into it. Not the less is it the creative force, or deity, which develops and shapes this universal order or cosmos. To the question, What is God? Stoicism rejoins, What is God not? In this original state of Pneuma God and the world are absolutely identical. But even then tension, the essential attribute of matter, is at work. Though the force working everywhere is one, there are diversities of its operation, corresponding to various degrees of tension. In this primitive Pneuma there must reside the utmost tension and heat; for it is a fact of observation that most bodies expand when heated, whence we infer that there is a pressure in heat, an expansive and dispersive tendency. The Pneuma cannot long withstand this intense pressure. Motion backwards and forwards once set up goes to cool the glowing mass of fiery vapor and to weaken the tension. Hereupon follows the first differentiation of primitive substance,—the separation of force from matter the emanation of the world from God. The germinal world-making powers (*σπερματικοὶ λόγοι*), which, in virtue of its tension, slumbered in Pneuma, now proceed upon their creative task. The primitive substance, be it remembered, is not Heraclitus's fire (though Cleanthes also called it flame of fire, *φλόξ*) any more than it is the air or "breath" of Anaximenes or Diogenes of Apollonia. Chrysippus determined it, following Zeno, to be fiery breath or ether, a spiritualized sublimed intermediate element. The cycle of its transformations and successive condensations constitutes the life of the universe, the mode of existence proper to finite and particular being. For the universe and all its parts are only different embodiments and stages in that metamorphosis of primitive being which Heraclitus had called a progress up and down (*ὁδὸς ἄνω κάτω*). Out of it is separated, first, elemental fire, the fire which we know, which burns and destroys; and this, again, condenses into air or aerial vapor; a further step in the downward path derives water and earth from the solidification of air. At every stage the degree of tension requisite for existence is slackened, and the resulting element approaches more and more to "inert" matter. But, just as one element does not wholly pass over into another (*e.g.*, only a part of air is transmuted into water or earth), so the Pneuma itself does not wholly pass over into the elements. The residue that remains in original purity with its tension yet undiminished is the ether in the highest sphere of the visible heavens, encircling the world of which it is lord and head. From the elements the one substance is transformed into the multitude of individual things in the orderly universe, which again is itself a living thing or being, and the Pneuma pervading it, and conditioning life and growth everywhere, is its soul. But this process of differentiation is not eternal; it continues only until the times of the restoration of all things. For the world which has grown up will in turn decay. The tension which has been relaxed will again be tightened; there will be a gradual resolution of things into elements, and of elements into the primary substance, to be consummated in a general conflagration when once more the world will be absorbed in God. Then in due order a new cycle of development begins, reproducing the last in every minutest detail, and so on for ever.

Pneuma.

The doctrine of Pneuma, vital breath or "spirit," arose in the medical schools. The simplest reflection among savages and half-civilized men connects vitality with the air inhaled in respiration; the disciples of Hippocrates, without much modifying this primitive belief, explained the maintenance of vital warmth to be the function of the breath within the organism. In the time of Alexander the Great Praxagoras discovered the distinction between the arteries and the veins. Now in the corpse the former are empty; hence in the light of these preconceptions they were declared to be vessels for conveying Pneuma to the different parts of the body. A generation afterwards Erasistratus made this the basis of a new theory of diseases and their treatment. Vital spirit, inhaled from the outside air, rushes through the arteries till it reaches the various centres, especially the brain and the heart, and there causes thought and organic movement. But long before this the peculiar character of air had been recognised as something intermediate to the corporeal and the incorporeal: when Diogenes of Apollonia revived the old Ionian hylozoism in opposition to the dualism of Anaxagoras, he made this, the typical example of matter in the gaseous state, his one element. In Stoicism, for the moment the two conceptions are united, soon, however, to diverge,—the medical conception to receive its final development under Galen, while the philosophical conception, passing over to Philo and others, was shaped and modified at Alexandria under the influence of Judaism, whence it played a great part in the developments of Jewish and Christian theology.

Contrast to Heraclitus.

The influence upon Stoicism of Heraclitus has been differently conceived. Siebeck would reduce it within very small dimensions, but this is not borne out by the concise history found at Herculaneum (*Index Herc.*, ed. Comparetti, col. 4 *sq.*). They substituted primitive Pneuma for his primitive fire, but so far as they are hylozoists at all they stand upon the same ground with him. Moreover, the commentaries of Cleanthes, Aristo, and Sphærus on Heraclitean writings (Diog. L., vii. 174, ix. 5, 15) point to common study of these writings under Zeno. Others again (*e.g.*, Lassalle) represent the Stoics as merely diluting and distorting Heracliteanism. But this is altogether wrong, and the proofs offered, when rightly sifted, are often seen to rest upon the distortion of Heraclitean doctrine in the reports of later writers, to assimilate it to the better known but essentially distinct innovations of the Stoics. In Heraclitus the constant flux is a metaphysical notion replaced by the interchange of material elements which Chrysippus stated as a simple proposition of physics. Heraclitus offers no analogy to the doctrine of four (not three) elements as different grades of tension; to the conception of fire and air as the "form," in Aristotelian terminology, of particulars; nor to the function of organizing fire which works by methodic plan to produce and preserve the world (*πῦρ τεχνικὸν ὁδῷ βαδίζον ἐπὶ γένεσιν κόσμου*). Nor, again, is there any analogy to the peculiar Stoic doctrine of universal intermingling (*κρᾶσις δι' ὅλου*). The two active elements interpenetrate the two lower or more relaxed, winding through all parts of matter and so pervading the greater masses that there is no mechanical mixture, nor yet a chemical combination, since both "force" and "matter" retain their relative characters as before. Even the distinction between "force" and "matter"—so alien to the spirit of Heraclitus—is seen to be a necessary consequence. Once assume that every character and property of a particular thing is determined solely by the tension in it of a current of Pneuma, and (since that which causes currents in the thing cannot be absolutely the same with the thing itself) Pneuma, though present in all things, must be asserted to vary indefinitely in quantity and intensity. So condensed and coarsened is the indwelling air-current of inorganic bodies that no trace of elasticity or life remains; it cannot even afford them the power of motion; all it can do is to hold them together (*συνεκτικὴ δύναμις*), and, in technical language, Pneuma is present in stone or metal as a retaining principle (*ἕξις* = hold), explaining the attributes of continuity and numerical identity (*συνεχῆ καὶ ἡνωμένα*) which even these natural substances possess. In plants again and all the vegetable kingdom it is manifest as something far purer and possessing greater tension, called a "nature," or principle of growth (*φύσις*). Further, a distinction was drawn between irrational animals, or the brute creation, and the rational, *i.e.*, gods and men, leaving room for a divergence, or rather development, of Stoic opinion. The older authorities conceded a vital principle, but denied a soul, to the brutes; animals, they say, are *ζῷα* but not *ἔμψυχα*. Later on much evidence goes to show that (by a divergence from the orthodox standard perhaps due to Platonic influence) it was a Stoic tenet to concede a soul, though not a rational soul, throughout the animal kingdom. To this higher manifestation of Pneuma can be traced back the "esprits animaux" of Descartes and Leibnitz, which continue to play so great a part even in Locke. The universal presence of Pneuma was confirmed by observation. A certain warmth, akin to the vital heat of organic being, seems to be found in inorganic nature: vapors from the earth, hot springs, sparks from the flint, were claimed as the last remnant of Pneuma not yet utterly slackened and cold. They appealed also to the velocity and dilatation of aeriform bodies, to whirlwinds and inflated balloons. The Logos is quick and powerful, and sharper than any two-edged sword, piercing even to the dividing asunder of the joints and marrow. Tension itself Cleanthes defined as a fiery flash (*πληγὴ πυρός*). Take the fundamental properties of body—extension and resistance. The former results from distance; but distances, or dimensions, are straight lines, *i.e.*, lines of greatest tension (*εἰς ἄκρον τεταμένη*). Tension produces dilatation, or increase in distance. Resistance, again, is explained by cohesion, which implies binding force. Again, the primary substance has rectilinear motion in two directions, backwards and forwards, at once a condensation, which produces cohesion and substance, and a dilatation, the cause of extension and qualities. How near this comes to the scientific truth of attraction and repulsion need hardly be noted. From the astronomers the Stoics borrowed their picture of the universe,—a *plenum* in the form of a series of layers or concentric rings, first the elements, then the planetary and stellar spheres, massed round the earth as centre,—a picture which dominated the imagination of men from the days of Eudoxus down to those of Dante or even Copernicus. As to the physical constitution of bodies, they were content to reproduce the Peripatetic doctrine with slight modifications in detail, of hardly any importance when compared with the change of spirit in the doctrine taught. But they rarely prosecuted researches in physics or astronomy, and the newly created sciences of biology and comparative anatomy received no adequate recognition from them.

Psychology.

Theory of knowledge.

If, however, in the science of nature the Stoics can lay claim to no striking originality, the case is different when we come to the science of man. In the rational creatures—man and the gods—Pneuma is manifested in a high degree of purity and intensity as an emanation from the world-soul, itself an emanation from the primary substance of purest ether,—a spark of the celestial fire, or, more accurately, fiery breath, which is a mean between fire and air, characterized by vital warmth more than by dryness. The physical basis of Stoic psychology deserves the closest attention. On the one hand, soul is corporeal, else it would have no real existence, would be incapable of extension in three dimensions (and therefore of equable diffusion all over the body), incapable of holding the body together, as the Stoics contended that it does, herein presenting a sharp contrast to the Epicurean tenet that it is the body which confines and shelters the light vagrant atoms of soul. On the other hand, this corporeal thing is veritably and identically reason, mind, and ruling principle (*λόγος, νοῦς, ἡγεμονικόν*); in virture of its divine origin Cleanthes can say to Zeus, "We too are thy offspring," and a Seneca can calmly insist that, if man and God are not on perfect equality, the superiority rests rather on our side. What God is for the world that the soul is for man. The Cosmos must be conceived as a single whole, its variety being referred to varying stages of condensation in Pneuma. So, too, the human soul must possess absolute simplicity, its varying functions being conditioned by the degrees or species of its tension. It follows that of "parts" of the soul, as previous thinkers imagined, there can be no question; all that can consistently be maintained is that from the centre of the body—the heart—seven distinct air-currents are discharged to various organs, which are so many modes of the one soul's activity.[1] The ethical consequences of this position will be seen at a later stage. With this psychology is intimately connected the Stoic theory of knowledge. From the unity of soul it follows that all psychical processes,—sensation, assent, impulse,— proceed from reason, the ruling part; that is to say, there is no strife or division; the one rational soul alone has sensations, assents to judgments, is impelled towards objects of desire just as much as it thinks or reasons. Not that all these powers at once reach full maturity. The soul at first is void of content; in the embryo it has not developed beyond the nutritive principle of a plant (*φύσις*); at birth the "ruling part" is a blank tablet, although ready prepared to receive writing. This excludes all possibility of innate ideas or any faculty akin to intuitive reason. The source of all our knowledge is experience and discursive thought, which manipulates the materials of sense. Our ideas are copied from stored-up sensations. No other theory was possible upon the foundation of the Stoic physics.

Note the parallel between the macrocosm and the microcosm. The soul of the world fills and penetrates it; in like manner, the human soul prevades and breathes through all the body, informing and guiding it, stamping the man with his essential character of rational. There is in both alike a ruling part, though this is situate in the human heart at the centre,—not in the brain, as the analogy of the celestial ether would suggest. Finally, the same cause, a relaxation of tension, accounts for sleep, decay, and death of man and for the dissolution of the world; after death the disembodied soul can only maintain its separate existence, even for a limited time, by mounting to that region of the universe which is akin to its nature. It was a moot point whether all souls so survive, as Cleanthes thought, or the souls of the wise and good alone, which was the opinion of Chrysippus; in any case, sooner or later individual souls are merged in the soul of the universe, from which they proceeded. The relation of the soul of the universe to God is quite clear; it is an inherent property, a mode of His activity, an effluence or emanation from the fiery ether which surrounds the universe, penetrating and permeating it. A Stoic might consistently maintain that World-Soul, Providence, Destiny, and Germinal Reason are not mere synomyms, for they express different aspects of God, different relations of God to things. We find ourselves on the verge of a system of abstractions, or "attributes turned into entities," as barren as any excogitated in mediæval times. In a certain sense, Scholasticism began with Chrysippus. To postulate different substances as underlying the different forces of nature would have been to surrender the fundamental thought of the system. What really *is*—the Pneuma—neither increases nor diminishes; but its modes of working, its different currents, can be conveniently distinguished and enumerated as evidence of so many distinct attributes.

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[1] These derivative powers include the five senses, speech, and the reproductive faculty, and they bear to the soul the relation of qualities to a substance. The ingenious essay of Mr. R. D. Archer Hind on the Platonic psychology (*Jour. of Phil.*, vol. x. p. 120) aims at establishing a parallel unification on the spiritualistic side; comp. *Rep.*, x. 612 A.

Perception.

One inevitable consequence of materialism is that subject and object can no longer be regarded as one in the act of perception, as Platò and Aristotle tended to assume, however imperfectly the assumption was carried out. The presumption of some merely external connection, as between any other two corporeal things, is alone admissible, and some form of the representative hypothesis is most easily called in to account for perception. The Stoics explained it as a transmission of the perceived quality of the object, by means of the sense organ, into the percipient's mind, the quality transmitted appearing as a disturbance or impression upon the corporeal surface of that "thinking thing," the soul. Sight is taken as the typical sense. A conical pencil of rays diverges from the pupil of the eye, so that its base covers the object seen. In sensation a presentation is conveyed, by an air-current, from the sense organ, here the eye, to the mind, *i.e.*, the soul's "ruling part" in the breast; the presentation, besides attesting its own existence, gives further information of its object,—visible color or size, or whatever be the quality in the thing seen. That Zeno and Cleanthes crudely compared this presentation to the impression which a seal bears upon wax, with protuberances and indentations, while Chrysippus more prudently determined it vaguely as an occult modification or "mode" of mind, is an interesting but not intrinsically important detail. But the mind is no mere passive recipient of impressions from without, in the view of the Stoics. Their analysis of sensation supposes it to react, by a variation in tension, against the current from the sense-organ; and this is the mind's assent or dissent, which is inseparable from the sense presentation. The contents of experience are not all alike true or valid; hallucination is possible; here the Stoics join issue with Epicurus. It is necessary, therefore, that assent should not be given indiscriminately; we must determine a criterion of truth, a special formal test whereby reason may recognize the merely plausible and hold fast the true. In an earlier age such an inquiry would have seemed superfluous. To Plato and Aristotle the nature and operation of thought and reason constitute a sufficient criterion. Since their day not only had the opposition between sense and reason broken down, but the reasoned skepticism of Pyrrho and Arcesilaus had made the impossibility of attaining truth the primary condition of wellbeing. Yet the standard which ultimately found acceptance in the Stoic school was not put forward, in that form, by its founder. Zeno, we have reason to believe, adopted the Cynic Logos for his guidance to truth as well as to morality. As a disciple of the Cynics he must have started with a theory of knowledge somewhat like that developed in the third part of Plato's *Theætetus* (201 C *sq.*),—that simple ideas are given by sense, whereas "opinion," which is a complex of simple ideas, only becomes knowledge when joined with Logos. We may further suppose that the more obvious of Plato's objections had led to the correction of "reason" into "right reason." However that may be, it is certain from Aristotle (*Nic. Eth.*, vi. 13, 1144b, 17) that virtue was defined as a "habit" in accordance with right reason, and (Diog. Laer., vii. 54) from that the earlier Stoics made right reason the standard of truth. The law which regulates our action is thus the ultimate criterion of what we know,—practical knowledge being understood to be of paramount importance. But this criterion was open to the persistent attacks of Epicureans and Academics, who made clear (1) that reason is dependent upon, if not derived from, sense, and (2) that the utterances of reason lack consistency. Chrysippus, therefore, conceded something to his opponents when he substituted for the Logos the new standards of sensation (αἴσθησις) and general conception (πρόληψις = anticipation, *i.e.*, the generic type formed in the mind unconsciously and spontaneously). At the same time he was more clearly defining and safeguarding his predecessors' position. For reason is consistent in the general conceptions wherein all men agree, because in all alike they are of spontaneous growth. Nor was the term sensation sufficiently definite. The same Chrysippus fixed upon a certain characteristic of true presentations, which he denoted by the much disputed term "apprehensive" (καταληπτικὴ φαντασία). Provided the sense organ and the mind be healthy, provided an external object be really seen or heard, the presentation, in virtue of its clearness and distinctness, has the power to extort the assent which it always lies in our power to give or to withhold.

Criterion of truth.

Formerly this technical phrase was explained to mean "the perception which irresistibly compels the subject to assent to it as true." But this, though apparently supported by Sextus Empiricus (*Adv. Math.*, vii. 257), is quite erroneous; for the presentation is called καταληπτόν, as well as καταληπτικὴ φαντασία, so that beyond all doubt it is something which the percipient subject grasps, and not that which grasps or "lays hold of" the percipient. Nor, again, is it wholly satisfactory to explain καταληπτική as virtually passive, "apprehensible," like its opposite ἀκατάληπτος; for we find ἀντιληπτικὴ τῶν ὑποκειμένων used as an alternative phrase (*ib.*, vii. 248). It would seem that the perception intended to constitute the standard of truth is one which, by producing a mental counterpart of a really existent external thing, enables the percipient, in the very act of sense, to "lay hold of" or apprehend an object in virtue of the presentation or sense impression of it excited in his own mind. The reality of the external object is a necessary condition, to exclude hallucinations of the senses; the exact correspondence between the external object and the internal precept is also necessary, but naturally hard to secure, for how can we compare the two? The external object is known only in perception. However, the younger Stoics endeavored to meet the assaults of their persistent critic Carneades by suggesting various modes of testing a single presentation, to see whether it were consistent with others, especially such as occurred in groups, etc.; indeed, some went so far as to add to the definition "coming from a real object and exactly corresponding with it" the clause "provided it encounter no obstacle."

Degrees of knowledge.

The same criterion was available for knowledge derived more directly from the intellect. Like all materialists, the Stoics can only distinguish the sensible from the intelligible as thinking when the external object is present (αἰσθάνεσθαι) and thinking when it is absent (ἐννοεῖν). The product of the latter kind includes memory (though this is, upon a strict analysis, something intermediate) and conceptions or general notions, under which were confusedly classed the products of the imaginative faculty. The work of the mind is seen first in "assent"; if to a true presentation the result is "simple apprehension" (κατάληψις: this stands in close relation to the καταληπτικὴ φαντασία, of which it is the necessary complement); if to a false or unapprehensive presentation the result is "opinion" (δόξα), always deprecated as akin to error and ignorance, unworthy of a wise man. These processes are conceivable only as "modes" of mind, changes in the soul's substance, and the same is true of the higher conceptions, the products of generalization. But the Stoics were not slow to exalt the part of reason, which seizes upon the generic qualities, the essential nature of things. Where sense and reason conflict, it is the latter that must decide. One isolated "apprehension," however firm its grasp, does not constitute knowledge or science (ἐπιστήμη); it must be of the firmest, such as reason cannot shake, and, further, it must be worked into a system of such apprehensions, which can only be by the mind's exercising the "habit" (ἕξις) of attaining truth by continuous tension. Here the work of reason is assimilated to the force which binds together the parts of an inorganic body and resists their separation. There is nothing more in the order of the universe than extended mobile bodies and forces in tension in these bodies. So, too, in the order of knowledge there is nothing but sense and the force of reason maintaining its tension and connecting sensations and ideas in their proper sequence. Zeno compared sensation to the outstretched hand, flat and open; bending the fingers was assent; the clenched fist was "simple apprehension," the mental grasp of an object; knowledge was the clenched fist tightly held in the other hand. The illustration is valuable for the light it throws on the essential unity of diverse intellectual operations, as well as for enforcing once more the Stoic doctrine that different grades of knowledge are different grades of tension. Good and evil, virtues and vices, remarks Plutarch, are all capable of being "perceived"; sense, this common basis of all mental activity, is a sort of touch by which the ethereal Pneuma which is the soul's substance recognizes and measures tension.

Logic.

With this exposition we have already invaded the province of logic. To this the Stoics assigned a miscellany of studies—rhetoric, dialectic, including grammar, in addition to formal logic,—to all of which their industry made contributions. Some of their innovations in grammatical terminology have lasted until now; we still speak of oblique cases, genitive, dative, accusative, of verbs active (ὀρθά), passive (ὕπτια), neuter (οὐδέτερα), by the names they gave. Their corrections and fancied improvements of the Aristotelian logic are mostly useless and pedantic. Judgment (ἀξίωμα) they defined as a complete idea capable of expression in language (λεκτὸν αὐτοτελές), and to distinguish it from other enunciations, as a wish or a command, they added "which is either true or false." From simple judgments they proceeded to compound judgments, and declared the hypothetical syllogism to be the normal type of reason, of which the categorical syllogism is an abbreviation. Perhaps it is worth while to quote their treatment of the categories. Aristotle made ten, all co-ordinate, to serve as "heads of predication" under which to collect distinct scraps of information respecting a subject, probably a man. For this the Stoics substituted four *summa genera*, all subordinate, so that each in turn is more precisely determined by the next. They are Something, or Being, determined as (1) substance or subject matter, (2) essential quality, *i.e.*, substance qualified, (3) mode or chance attribute, *i.e.*, qualified substance in a certain condition (πως ἔχον), and, lastly, (4) relation or relative mode (in full ὑποκείμενον ποιὸν πρός τί πως ἔχον). The zeal with which the school prosecuted logical inquiries had one practical result,—they could use to perfection the unrivalled weapon of analysis. Its chief employment was to lay things bare and sever them from their surroundings, in order that they might be contemplated in their simplicity, with rigid exactness, as objects of thought, apart from the illusion and exaggeration that attends them when presented to sense and imagination. The very perfection and precision of this method constantly tempted the later Stoics to abuse it for the systematic depreciation of the objects analyzed.

Ethics.

The practical philosophy of the Stoics stands in the closest connection with their physics and psychology. Holding that man is a being who acts as well as thinks, and that this is the all-important side of his life, they find the link between the two in the mind's assent; for, when impelled towards certain objects by a prompting or "impulse" (ὁρμή = movement of the soul seeking to possess itself of certain external things), whether of nature or reason, a man must needs judge the objects to be desirable; the subsequent movement, as it were, translates this judgment into action. Against the skeptical position it was necessary to maintain—(1) that motion, and therefore moral action, cannot follow upon the mere presentment of an idea, unless the idea so suggested receive assent, and (2) that assent alone does not suffice without the motive faculty which is found in all animals.[1] Of our various impulses, some in the mature man are (α) rational; some, as in the child, are (β) non-rational, because anterior to reason; while (γ) the impulse of the man may be contrary to reason, under the influence of the affections or passions.

Rational impulse.

(α) Now reason, as a spring of action, has for its aim harmony or self-consistency, a life proceeding upon a single plan (τὸ ὁμολογουμένως ζῆν, τοῦτο δ' ἐστὶ καθ' ἕνα λόγον καὶ συμφώνως ζῆν): in this there is a certain symmetry or beauty, the attraction which excites rational impulse towards it. Clearly this definition of the end of action comes from the Cynics, who pithily expressed it by saying that in order to live man needs either reason or a halter (δεῖν λόγον ἢ βρόχον). But during Zeno's early studies another conception had been current, that of agreement with nature. Apparently it had been started by the Old Academy, where probably the technical phrase "first objects according to nature," τὰ πρῶτα κατὰ φύσιν, had its origin. Now the slightest acquaintance with Stoic physics shows that reason and nature are at one; we may therefore well believe that Zeno himself had explained his harmonious or self-consistent life to mean a life in harmony with nature (Diog. Laer., vii. 87, quoting Zeno, "On the Nature of Man"). At all events that was the orthodox formula adopted and interpreted by Cleanthes and Chrysippus—the former, as we might have expected from his Heraclitean tendencies, representing it to mean "harmony with the universal nature," the latter emphasizing that not only is it the nature of the universe, but the particular nature of man, that is meant. Cleanthes's interpretation is at once novel and fruitful: reason being the true self or nature of man, and being essentially the same in him with the reason in the All, its procedure in him should correspond to and reproduce its procedure in the All. It is reasonable, therefore, for the individual to submit to and co-operate with the indwelling reason, or law of the universe, and in obedience to this universal law (κοινὸς νόμος) imitate the uniform methodic march of the divine creative fire. Here we note the conception of morality as obedience to an objective law, though, as reason attains to consciousness of itself only in man, it is a law of which he himself, *qua* rational, is lawgiver. But Chrysippus, in his reading of the formula, had no intention of relaxing the close dependence of ethics upon physics. A new light is thrown upon the study of external nature by the essential unity of reason in the macrocosm and in the microcosm: what we learn of its operations there is profitable for instruction here, and life should be directed in accordance with the experience we have acquired of the course of nature (ζῆν κατ' ἐμπειρίαν τῶν φύσει συμβαινόντων, Chrysippus ap. Stob., *Ecl.*, ii. 134). Whether man will comply with the commands of the universal law or not, whether therefore the ethical end is realized in him, must depend upon himself. The whole tendency of the physical theory is towards a system of rigid determinism, nay, almost of fatalism; but, so soon as we reach the ethical region, the problem of indeterminism is forced upon us in all its perplexity.

Instinct.

(β) Having determined the end of rational action, we must now give a glance at the earlier, instinctive activity of beings properly without reason (*i.e.*, of children and the brute creation); this too has its importance, since before reason is developed the agent follows the "uncorrupted impulses" of nature. Here we come upon a controversy which still has an interest for the psychologist, for Epicurus had declared pleasure to be the end of all instinctive activity, while the Stoics combated his position and sought to prove that not pleasure but self-preservation is really sought. According to them, the child or the animal would speedily be crushed out of existence if it did not move at all or if its movements were not governed by some plan; a vague consciousness of itself and a love for its own constitution must be postulated to account for the impulse which, together with sensation, distinguishes animal life from the life of the plant.[1] That all motion is excited by pleasure in prospect, or the hope of cessation from pain, is (they argue) contrary to fact. Efforts to move are made perseveringly even where they occasion pain. The whole life of unreasoning infancy and of the brutes can be satisfactorily explained on the assumption of sense and impulse acting mechanically, somewhat after the fashion indicated rather than worked out in detail in the Peripatetic application of the practical syllogism to the motion of animals.

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[1] πάσας δὲ τὰς ὁρμὰς συγκαταθέσεις εἶναι, τὰς δὲ πρακτικὰς καὶ τὸ κινητικὸν περιέχειν.—Stobæus, *Ecl. Eth.*, ii. 164.

[1] πρῶτον οἰκεῖον εἶναι παντὶ ζῴῳ τὴν αὐτοῦ σύστασιν καὶ τὴν ταύτης συνείδησιν. The σύστασις of an organic being is an outcome of internal forces, a mutual relation of varying elements,—in man, a relation of the ruling part of the soul, *i.e.*, the rational soul, to the rest. By οἰκείωσις is meant that nature inspires this self-love, "for it is improbable that nature should estrange the living thing from itself, or that she should leave the creature she had made without either estrangement from, or affection for, its own constitution."

Pleasure.

In their theory of pleasure itself the Stoics approximate very decidedly to Aristotle. It is, as he said, a concomitant (ἐπιγέννημα), but not of all activities; on the contrary, the highest are without it, and it is invariably of no significance where it is found. Moreover, while Aristotle had asserted that it adds a certain zest or finish to natural activity, the Stoics declared that it never appears at all except as a mark of the decline or relaxation of vital energy, the bloom which is indeed a mark of ripeness but also the certain precursor of decay.

The affections.

(γ) To return to impulse,—there remains the case of action against reason under the influence of the passions. Although nature may guide man towards the right objects, she does not control the impetus or velocity of the soul's movement. If this be in excess, the rational soul is hurried into an inflamed disorderly condition, the source of which is an erroneous judgment or false opinion, though its effects are seen in the evident elation or depression, and the stings of excitement, which are the symptoms of mental disorder. Anxious to uphold individual responsibility, the Stoics pronounced the false opinion to be voluntary; that once granted, the subsequent reaction of the mind (*i.e.*, the emotional effects on which Zeno especially dwelt), the compulsion and extravagance which are characteristic of the passions, may be said to follow inevitably, so that under the sway of blind impulses the man is still acting voluntarily. This sets in a striking light the close dependence of ethics upon psychology. The Peripatetics had made the intellectual soul with virtues of its own something altogether distinct from the lower nature, the seat of the emotions and of the moral virtues which consist in their regulation. The Stoic doctrine of the essential unity of soul is a vehement protest against all this: the soul's unity is shown in a unity of activity, whether it be in a healthy or a disordered state. As all virtues are essentially one, though they differ according to the different relations to which the knowledge of good and evil is applied, so, too, emotion is not something antagonistic to reason, but perverted reason. There is no such struggle of vicious inclinations against virtue, a contest waged by two separate powers, as Aristotle had imagined in his account of moral weakness; the proper simile is a mutiny or revolt in one and the same city, Mansoul now in allegiance to the rightful authority and now in open rebellion. The lower animals and children are incapable of emotion; it is only found where reason is fully developed. The analysis and classification of these affections start with the false opinion or judgment or imagination, which may relate to the present or the future, to fancied good or fancied ill. Hence there are four types of the affections: all are grouped around pleasure, an impulse towards present fancied good; desire, an impulse towards future fancied good; grief, an impulse to shun fancied evil in the present; fear, an impulse to shun fancied evil in the future. On the analogy of bodily disease, these disorders of the mind are further divided into (1) chronic ailments (νοσήματα), such as avarice, where the belief that money is a good is persistent and deep-seated, leading to a habit of feeling and acting, or ambition, a similar erroneous judgment in respect of public honors, and (2) infirmities (ἀρρωστήματα), sudden attacks of error to which the patient momentarily succumbs. This remarkable development of Stoic principles leads to the demand for the entire suppression of the affections (ἀπάθεια), in contradistinction to that regulation and governance of them for which Plato and the Old Academy contended (μετριοπάθεια). Further, it explains the incessant war which the later Stoics waged with imagination.

Right reason.

The end of action has then been explained to be a consistent life, a rational life, and, lastly, a life according to nature. Now the Cynics had already traced back consistency to a certain Herculean strength or force of will, which again is an effect of the bracing or tension of the soul's substance, so that this ever-recurring attribute is as available to explain will as intelligence. Herein we discover, as it were, an internal source of the external harmony and regularity of a consistent life. Our will should be directed to this source rather than to its manifestations,—to "right" (*i.e.*, inflexible and straight) "reason," which has attained a character of intense rigidity, an intensive energy raised to an impassable degree. For this infallible firmness of the reason the technical term is διάθεσις, a "disposition" which, like straightness or crookedness in a line, admits of no degrees of less or more; thence comes harmony, regularity, and consistency in all our acts, which alone is truly beautiful (καλόν = fair or noble; for which the Romans characteristically said *honestum* = honorable). Not even Christianity laid more stress upon inwardness, or taught more explicitly that motive counts for everything and external performance for very little. Once let the reason become "right" and it imparts this same character to all that it affects. First the soul is made strong, healthy, beautiful; when, therefore, it thus fulfils all the conditions of its being, it is absolutely perfect.

Virtue.

Now the perfection of anything is called its virtue; the virtue of man, then, is the perfection of his soul, *i.e.*, of the ruling part or rational soul. But "out of the heart are the issues of life": make the soul perfect and you make the life perfect. From such a "disposition" must proceed a life which flows on smoothly and uniformly, like a gentle river (εὔροια βίου). No longer is there anything to hope or fear; this harmonious accord between impulses and acts is itself man's well-being or welfare (εὐδαιμονία). Cleanthes scouts the notion of adding to such perfection that occasional result of a decaying activity entitled pleasure; Chrysippus remonstrates indignantly with Plato for appealing to the "moral bugbears" of future rewards or punishments. There is no "wages of virtue," not even the continuance of her activity; for lapse of time can add nothing to perfect well-being; it is complete, whole, and indivisible now.

Virtue, then, as right reason, is at once knowledge and strength of will; for a right comprehension of Stoic psychology shows that these two are identical. The unity of all virtue is sufficiently apparent, but the Stoics also acknowledged a plurality of specific virtues grouped round the four cardinal virtues of Plato. Wisdom (φρόνησις) was, according to Zeno and Cleanthes, the common element; according to Aristo, it should rather be termed knowledge (ἐπιστήμη); and this view was adopted in the school to avoid the awkwardness of using the same term (φρόνησις) both for a special virtue and for the generic attribute of them all. Wisdom or knowledge in distributing to others is justice, in endeavor it is temperance, in endurance it is courage or fortitude; but in every virtuous act all four of the virtues are implicit. Virtue is thus the unconditional good; it is at once the absolute end and the means to the end.

Goodness must be interpreted, as Socrates used to interpret it, that which furnishes some advantage or true utility; its opposite, evil, as that which produces harm or disadvantage. Obviously only virtue, and that which comes from virtue, confers any real advantage; only vice can really do harm. Goodness is a wider genus than virtue; all virtue is good, but not all goods are virtues. There are goods of soul, such as habits and happy aptitudes which may be acquired in varying degrees (*i.e.*, they are ἕξεις not διαθέσεις); others are only single actions (ἐνέργειαι). A friend again may be a means to good (ποιητικὸν τέλους). All these goods are utilities (ὠφελήματα), and therefore deserve to be sought (αἱρετά). Similarly evils may be classified as—(1) vices, settled dispositions contrary to right reason, proceeding from that ignorance which infallibly attends on a slackening of the soul's fibre; (2) evil habits or inclinations (εὐκαταφορίαι); (3) isolated vicious actions. All these evils alike are to be shunned (φευκτά); all alike are harmful (βλάμματα): the moral responsibility rests with the individual, in so far as he is ignorant or has his soul relaxed.

Things indifferent.

Good and evil, however, is not an exhaustive classification. There is a large class of things which are neither the one nor the other; which do not conduce to our attainment of the end, nor hinder us therefrom; which are neither to be pursued nor shunned, but are simply indifferent (ἀδιάφορα). To all these objects the attitude of the Cynics was complete indifference, wherein they were followed by Aristo; that of the skeptics professedly utter insensibility. Now the most original feature of the Stoic ethics is the classification of things indifferent and their arrangement in a certain scale in accordance with the value, positive or negative (ἀξία, ἀπαξία), to be assigned to them either intrinsically or in certain circumstances (κατὰ περίστασιν). Some objects are so unimportant that in regard to them Aristo's attitude of complete indifference is justified. Placing them at the zero point, we may advance in both directions, assigning to all the objects of instinctive natural impulses a positive value, in virtue of which they are to be picked out (ληπτά) in preference to other indifferent things not of this description. Thus bodily health, though not a good, is entitled to a certain value; disease, though not an evil, has a certain negative value. The former class is according to nature, the latter contrary to nature; the former are instinctively sought by children as tending to maintain their "constitution" or nature; the latter their "uncorrupted impulses" (ἀδιάστροφοι ἀφορμαί) lead them to shun as tending to mar, cripple, or destroy life. Similarly, actions may be classified: all virtuous actions are right actions (κατορθώματα); all vicious actions are wrong actions or "sins" (ἁμαρτήματα). The attainment of any one of the objects in the class of things indifferent, looked at in itself, is neither right nor wrong. But, if the object picked out be that object out of all at the moment present to us which has the highest value, then the action of selecting it admits of being defended on probable grounds, and as such is entitled to be called (quite apart from the agent's disposition, whether virtuous or vicious), *materialiter*, an act "meet and fit" to do (καθῆκον). Such an act need not be preceded by any reasoning at all; in the case of the brutes and of children it is always instinctive, yet in all cases it is capable of being justified on grounds of probability (ὃ πραχθὲν εὔλογον ἔχει ἀπολογίαν). Similarly with the selection of an object which has less value in preference to one of higher value: such a blunder is not, taken in itself, a wrong action, but it violates fitness (παρὰ τὸ καθῆκον). Amongst fitting actions, some are always fitting, others only at times, under given circumstances; some indifferent objects we select for their own sakes, others merely as means. The range of such human functions is wide enough to include the acquisition of information, the exercise of temperance and courage, even altruistic conduct. And yet some actions in man are on a level with the nutritive functions of the plant (Diog. Laer., vii. 86). Again, our human functions compose our whole conscious life; even life, then, considered in itself, has in it no moral good; we may, if need be, under certain circumstances, voluntarily withdraw from it.

Fitness, or external duty.

The Stoics maintain that the variety of things indifferent is essential to virtue, because it is the field upon which reason is exercised. Virtue is a body, therefore it is corporeal; therefore its active principle needs a passive material to act upon. Things indifferent are capable of being put to a good or a bad use, though some lend themselves to use more easily than others. Nor does virtue merely avail itself, now and then, of things indifferent,—it can do nothing else than avail itself of them. Though they are not goods, and though their attainment does not confer well-being, yet all virtue is the selection or choice of them. For how is a virtuous life manifested? In a series of external acts, each one of which is the choice of some natural end, some object according to nature, as possessing at the moment the highest value. The same external act may be done by an irrational agent, and in his case the act is not virtuous. For there is as great a gulf fixed between fitting and virtuous actions as between things indifferent having positive value and the good. No increase of value can raise a thing indifferent to the class of good; no degree of fitness in the external act done can render it virtuous. As right actions consist in following reason in the selection of things according to nature, it follows that such right actions (as distinct from the fitting actions of which all living things are capable) are the exclusive privilege of rational beings. So, too, with wrong actions: only rational beings can perform them; although children or the brutes may run counter to fitness, and pursue objects contrary to nature, they cannot be said to sin or do wrong. All actions, then, of rational beings must be either virtuous or vicious; there is no mean between the two. But what of fitting actions? Are not they also done by rational agents? Is not the distinction between right conduct and mere external fitness continually drawn when the Stoics are referring to the activity of rational human beings? Unquestionably so; but in examining a given act it is necessary to view it on the formal as well as on the material side,—as proceeding from a virtuous or vicious disposition, and again as tending, when taken in itself and apart from this disposition, to promote or destroy the agent's nature or constitution, *i.e.*, as something "meet and fit" to do, or as contrary to fitness (or, in rare cases, as having no tendency in either direction). Lastly, the analysis of conduct is incomplete unless the external object which the agent aims at attaining by the act is also taken into account: it may be natural, and may therefore excite desire; or it may be contrary to nature, and excite aversion; or it may be absolutely indifferent. Now the Stoic classifications of (*a*) external objects and (*b*) actions (as they have come down to us from not very discriminating sources) are hampered by the inclusion of right actions and wrong actions, which are made species of the wider genera. Under objects according to nature come (α) fitting actions, (β) right actions, (γ) virtues; *i.e.*, conduct which is perfect contains all that in the imperfect imitates perfection: a right action has *ipso facto* all the fitness of a fitting action, and all the accord with nature of a thing according to nature. So with the opposite class: the vicious man by the very fact of not having the tension of soul which is virtue, commits a sin in his every action; all that he does, therefore, is on this ground contrary to fitness and contrary to nature. Any defect in external conduct proves it to be a sin; the mere absence of defect does not establish its claim to be right conduct. It is as easy to prove a given person is unwise (and therefore a sinner) as it is hard to prove him a sage. Virtue is one, vice is manifold.

No act in itself is either noble or base; even the grossest violation of fitness, if it could be done with the right intention, would count as virtue, and the most fitting deeds without that intention are naught (see Orig., *C. Cels.*, iv. 45; Sext. Emp., *Adv. Math.*, xi. 190; *Pyrrh. Hyp.*, iii. 245, is therefore wrong). It does not appear, then, that there is any divergence in principle between the doctrine of the end of action and the doctrine of fitness or relative duty; nor should the latter be regarded (as is done by Cicero and some modern expositors) as an afterthought, intended to soften the too rigorous demands of the Stoic ideal. For from the first it was an integral part of the system: Zeno wrote a treatise περὶ τοῦ καθήκοντος; indeed he adopted it as a technical term. That this doctrine was a stumbling-block to the small band of his early disciples seems not unlikely; for Aristo and Herillus, who left him, as is believed, on independent grounds, modified it in their own ethical theories afterwards put forth. According to Hirzel (*Untersuch*, ii. p. 54), however, the views of these two heterodox Stoics more closely approximated than at first sight appears: Herillus, as well as Aristo, maintained that all actions intermediate to vice and virtue are absolutely indifferent (Diog. Laer., vii. 155); and Aristo, like Herillus, defined virtue as knowledge, and held that the wise man will never form opinions, *i.e.*, will not act upon anything short of knowledge.

Cosmopolitanism.

In their view of man's social relations the Stoics are greatly in advance of preceding schools. We saw that virtue is a law which governs the universe: that which Reason and God ordain must be accepted as binding upon the particle of reason which is in each one of us. Human law comes into existence when men recognize this obligation; justice is therefore natural, and not something merely conventional. The opposite tendencies, to allow to the individual responsibility and freedom, and to demand of him obedience to law, are both features of the system; but in virtue even of the freedom which belongs to him *qua* rational, he must recognize the society of rational beings of which he is a member, and subordinate his own ends to the ends and needs of this society. Those who own one law are citizens of one state, the city of Zeus, in which men and gods have their dwelling. In that city all is ordained by reason working intelligently, and the members exist for the sake of one another; there is an intimate connection (συμπάθεια) between them which makes all the wise and virtuous friends, even if personally unknown, and leads them to contribute to one another's good. Their intercourse should find expression in justice, in friendship, in family and political life. But practically the Stoic philosopher always had some good excuse for withdrawing from the narrow political life of the city in which he found himself. The circumstances of the time, such as the decay of Greek city-life, the foundation of large territorial states under absolute Greek rulers which followed upon Alexander's conquests, and afterwards the rise of the world-empire of Rome, aided to develop the leading idea of Zeno's *Republic*. There he had anticipated a state without family life, without law courts or coins, without schools or temples, in which all differences of nationality would be merged in the common brotherhood of man. This cosmopolitan citizenship remained all through a distinctive Stoic dogma; when first announced it must have had a powerful influence upon the minds of men, diverting them from the distractions of almost parochial politics to a boundless vista. There was, then, no longer any difference between Greek and barbarian, between male and female, bond and free. All are members of one body as partaking in reason, all are equally men. Not that this led to any movement for the abolition of slavery. For the Stoics attached but slight importance to external circumstances, since only the wise man is really free, and all the unwise are slaves. Yet, while they accepted slavery as a permanent institution, philosophers as wide apart as Chrysippus and Seneca sought to mitigate its evils in practice, and urged upon masters humanity in the treatment of their slaves.

Religion.

The religious problem had peculiar interest for the school which discerned God everywhere as the ruler and upholder, and at the same time the law, of the world that He had evolved from Himself. The physical groundwork lends a religious sanction to all moral duties, and Cleanthes's noble hymn is evidence how far a system of natural religion could go in providing satisfaction for the cravings of the religious temper:

> "Most glorious of immortals, O Zeus of many names, almighty and everlasting, sovereign of nature, directing all in accordance with law, thee it is fitting that all mortals should address. . . Thee all this universe, as it rolls circling round the earth, obeys wheresoever thou dost guide, and gladly owns thy sway. Such a minister thou holdest in thy invincible hands,—the two-edged, fiery, ever-living thunderbolt, under whose stroke all nature shudders. No work upon earth is wrought apart from thee, lord, nor through the divine ethereal sphere, nor upon the sea; save only whatsoever deeds wicked men do in their own foolishness. Nay, thou knowest how to make even the rough smooth, and to bring order out of disorder; and things not friendly are friendly in thy sight. For so hast thou fitted all things together, the good with the evil, that there might be one eternal law over all. . . Deliver men from fell ignorance. Banish it, father, from their soul, and grant them to obtain wisdom, whereon relying thou rulest all things with justice."

To the orthodox theology of Greece and Rome the system stood in a twofold relation, as criticism and rationalism. That the popular religion contained gross errors hardly needed to be pointed out. The forms of worship were known to be trivial or mischievous, the myths unworthy or immoral. But Zeno declared images, shrines, temples, sacrifices, prayers, and worship to be of no avail. A really acceptable prayer, he taught, can only have reference to a virtuous and devout mind: God is best worshipped in the shrine of the heart by the desire to know and obey Him. At the same time the Stoics felt at liberty to defend and uphold the truth in polytheism. Not only is the primitive substance God, the one supreme being, but divinity must be ascribed to His manifestations,—to the heavenly bodies, which are conceived, like Plato's created gods, as the highest of rational beings, to the forces of nature, even to deified men; and thus the world was peopled with divine agencies. Moreover, the myths were rationalized and allegorized, which was not in either case an original procedure. The search for a deeper hidden meaning beside the literal one had been begun by Democritus, Empedocles, the Sophists, and the Cynics. It remained for Zeno to carry this to a much greater extent, and to seek out or invent "natural principles" (λόγοι φυσικοί) and moral ideas in all the legends and in the poetry of Homer and Hesiod. In this sense he was the pattern if not the "father" of all such as allegorize and reconcile. Etymology was pressed into the service, and the wildest conjectures as to the meaning of names did duty as a basis for mythological explanations. The two favorite Stoic heroes were Hercules and Ulysses, and nearly every scene in their adventures was made to disclose some moral significance. Lastly, the practice of divination and the consultation of oracles afforded a means of communication between God and man,—a concession to popular beliefs which may be explained when we reflect that to the faithful divination was something as essential as confession and spiritual direction to a devout Catholic now, or the study and interpretation of Scripture texts to a Protestant. Chrysippus did his best to reconcile the superstition with his own rational doctine of strict causation. Omens and portents, he explained, are the natural symptoms of certain occurrences. There must be countless indications of the course of Providence, for the most part unobserved, the meaning of only a few having become known to men. His opponents argued, "if all events are foreordained, divination is superfluous;" he replied that both divination and our behavior under the warnings which it affords are included in the chain of causation. Even here, however, the bent of the system is apparent. They were at pains to insist upon purity of heart and life as an indispensable condition for success in prophesying and to enlist piety in the service of morality.

Divination.

Middle Stoa.

When Chrysippus died (Ol. 143 = 208–204 B.C.) the structure of Stoic doctrine was complete. With the Middle Stoa we enter upon a period at first of comparative inaction, afterwards of internal reform. Chrysippus's immediate successors were Zeno of Tarsus, Diogenes of Seleucia (often called the Babylonian), and Antipater of Tarsus, men of no originality, though not without ability; the two last-named, however, had all their energies taxed to sustain the conflict with CARNEADES (*q.v.*). This was the most formidable assault the school ever encountered; that it survived was due more to the foresight and elaborate precautions of Chrysippus than to any efforts of that "pen-doughty" pamphleteer, Antipater (καλαμοβόας), who shrank from opposing himself in person to the eloquence of Carneades. The subsequent history testified to the importance of this controversy. The special objects of attack were the Stoic theory of knowledge, their theology, and their ethics. The physical basis of the system remained unchanged but neglected; all creative force or even original research in the departments of physics and metaphysics vanished. Yet problems of interest bearing upon psychology and natural theology continued to be discussed. Thus the cycles of the world's existence, and the universal conflagration which terminates each of them, excited some doubt. Diogenes of Seleucia is said to have wavered in his belief at last; Boethus, one of his pupils, flatly denied it. He regarded the Deity as the guide and upholder of the world, watching over it from the outside, not as the immanent soul within it, for according to him the world was as soulless as a plant. We have here a compromise between Zeno's and Aristotle's doctrines. But in the end the universal conflagration was handed down without question as an article of belief. It is clear that the activity of these teachers was chiefly directed to ethics: they elaborated fresh definitions of the chief good, designed either to make yet clearer the sense of the formulas of Chrysippus or else to meet the more urgent objections of the New Academy. Carneades had emphasized one striking apparent inconsistency: it had been laid down that to choose what is natural is man's highest good, and yet the things chosen, the "first objects according to nature," had no place amongst goods. Antipater may have met this by distinguishing "the attainment" of primary natural ends from the activity directed to their attainment (Plut., *De Comm. Not.*, 27, 14, p. 1072 F); but, earlier still, Diogenes had put forward his gloss, viz., "The end is to calculate rightly in the selection and rejection of things according to nature." Archedemus, a contemporary of Diogenes, put this in plainer terms still: "The end is to live in the performance of all fitting actions" (πάντα τὰ καθήκοντα ἐπιτελοῦντας ζῆν). Now it is highly improbable that the earlier Stoics would have sanctioned such interpretations of their dogmas. The mere performance of relative or imperfect duties, they would have said, is something neither good nor evil; the essential constituent of human good is ignored. And similar criticism is actually passed by Posidonius: "This is not the end, but only its necessary concomitant; such a mode of expression may be useful for the refutation of objections put forward by the Sophists" (Carneades and the New Academy?), "but it contains nothing of morality or well-being" (Galen, *De Plac. Hipp. et Plat.*, p. 470 K). There is every ground, then, for concluding that we have here one concession extorted by the assaults of Carneades. For a similar compromise there is express testimony: "good repute" (εὐδοξία) had been regarded as a thing wholly indifferent in the school down to and including Diogenes. Antipater was forced to assign to it "positive value," and to give it a place amongst "things preferred" (Cic., *De Fin.*, iii. 57). These modifications were retained by Antipater's successors. Hence come the increased importance and fuller treatment which from this time forward fall to the lot of the "external duties" (καθήκοντα). The rigor and consistency of the older system became sensibly modified.

To this result another important factor contributed.

The sage.

In all that the older Stoics taught there breathes that enthusiasm for righteousness in which has been traced the earnestness of the Semitic spirit; but nothing presents more forcibly the pitch of their moral idealism than the doctrine of the Wise Man. All mankind fall into two classes,—the wise or virtuous, the unwise or wicked,—the distinction being absolute. He who possesses virtue possesses it whole and entire; he who lacks it lacks it altogether. To be but a hand's-breadth below the surface of the sea ensures drowning as infallibly as to be five hundred fathoms deep. Now the wise man is drawn as perfect. All he does is right, all his opinions are true; he alone is free, rich, beautiful, skilled to govern, capable of giving or receiving a benefit. And his happiness, since length of time cannot increase it, falls in nothing short of that of Zeus. In contrast with all this, we have a picture of universal depravity. Now, who could claim to have attained to the sage's wisdom? Doubtless, at the first founding of the school Zeno himself and Zeno's pupils were inspired with this hope; they emulated the Cynics Antisthenes and Diogenes, who never shrank out of modesty from the name and its responsibilities. But the development of the system led them gradually and reluctantly to renounce this hope, as they came to realize the arduous conditions involved. Zeno indeed could hardly have been denied the title conferred upon Epicurus. Cleanthes, the "second Herculus," held it possible for man to attain to virtue. From anecdotes recorded of the tricks played upon Aristo and Sphærus (Diog. Laer., vii. 162, 117) it may be inferred that the former deemed himself infallible in his opinions, *i.e.*, set up for a sage; Persæus himself, who had exposed the pretensions of Aristo, is twitted with having failed to conform with the perfect generalship which was one trait of the wise man, when he allowed the citadel of Corinth to be taken by Aratus (Athen., iv. 102 D). The trait of infallibility especially proved hard to establish when successive heads of the school seriously differed in their doctrine. The prospect became daily more distant, and at length faded away. Chrysippus declined to call himself or any of his contemporaries a sage. One or two such manifestations there may have been—Socrates and Diogenes? but the wise man was rarer, he thought, than the phœnix. If his successors allowed one or two more exceptions, to Diogenes of Seleucia at any rate the sage was an unrealized ideal, as we learn from Plutarch (*De Comm. Not.*, 33, 1076 B), who does not fail to seize upon this extreme view. Posidonius left even Socrates, Diogenes, and Antisthenes in the state of progress towards virtue.

Modifications in practice.

Although there was in the end a reaction from this extreme, yet it is impossible to mistake the bearing of all this upon a practical system of morals. So long as dialectic subtleties and exciting polemics afforded food for the intellect, the gulf between theory and practice might be ignored. But once let this system be presented to men in earnest about right living, and eager to profit by what they are taught, and an ethical reform is inevitable. Conduct for us will be separated from conduct for the sage. We shall be told not always to imitate him. There will be a new law, dwelling specially upon the "external duties" required of all men, wise or unwise; and even the sufficiency of virtue for our happiness may be questioned. The introducer and expositor of such a twofold morality was a remarkable man. Born at Rhodes *c.* 185 B.C., a citizen of the most flourishing of Greek states and almost the only one which yet retained vigor and freedom, Panætius lived for years in the house of Scipio Africanus the younger at Rome, accompanied him on embassies and campaigns, and was perhaps the first Greek who in a private capacity had any insight into the working of the Roman state or the character of its citizens. Later in life, as head of the Stoic school at Athens, he achieved a reputation second only to that of Chrysippus. He is the earliest Stoic author from whom we have, even indirectly, any considerable piece of work, as books i. and ii. of the *De Officiis* are a *réchauffé*, in Cicero's fashion, of Panætius "Upon External Duty" (περὶ τοῦ καθήκοντος).

Stoicism in Rome.

The introduction of Stoicism at Rome was the most momentous of the many changes that it saw. After the first sharp collision with the jealousy of the national authorities it found a ready acceptance, and made rapid progress amongst the noblest families. It has been well said that the old heroes of the republic were unconscious Stoics, fitted by their narrowness, their stern simplicity, and devotion to duty for the almost Semitic earnestness of the new doctrine. In Greece its insensibility to art and the cultivation of life was a fatal defect; not so with the shrewd men of the world, desirous of qualifying as advocates or jurists. It supplied them with an incentive to scientific research in archæology and grammar; it penetrated jurisprudence until the belief in the ultimate identity of the *jus gentium* with the

Panætius.

law of nature modified the prætor's edicts for centuries. Even to the prosaic religion of old Rome, with its narrow original conception and multitude of burdensome rites, it became in some sort a support. Scævola, following Panætius, explained that the prudence of statesmen had established this public institution in the service of order midway between the errors of popular superstition and the barren truths of enlightened philosophy. Soon the influence of the pupils reacted upon the doctrines taught. Of speculative interest the ordinary Roman had as little as may be; for abstract discussion and controversy he cared nothing. Indifferent to the scientific basis or logical development of doctrines, he selected from various writers and from different schools what he found most serviceable. All had to be simplified and disengaged from technical subtleties. To attract his Roman pupils Panætius would naturally choose simple topics susceptible of rhetorical treatment or of application to individual details. He was the representative, not merely of Stoicism, but of Greece and Greek literature, and would feel pride in introducing its greatest masterpieces: amongst all that he studied, he valued most the writings of Plato. He admired the classic style, the exquisite purity of language, the flights of imagination, but he admired above all the philosophy. He marks a reaction of the genuine Hellenic spirit against the narrow austerity of the first Stoics. Zeno and Chrysippus had introduced a repellent technical terminology; their writings lacked every grace of style. With Panætius the Stoa became eloquent: he did his best to improve upon the uncouth words in vogue, even at some slight cost of accuracy, *e.g.*, to discard *προηγμένον* for *εὐχρηστον*, or else designate it "so-called good," or even simply "good," if the context allowed.

The part Panætius took in philological and historical studies is characteristic of the man. We know much of the results of these studies; of his philosophy technically we know very little. He wrote only upon ethics, where historical knowledge would be of use. Crates of Mallus, one of his teachers, aimed at fulfilling the high functions of a "critic" according to his own definition,—that the critic must acquaint himself with all rational knowledge. Panætius was competent to pass judgment upon the critical "divination" of an Aristarchus (who was perhaps himself also a Stoic), and took an interest in the restoration of Old Attic forms to the text of Plato. Just then there had been a movement towards a wider and more liberal education, by which even contemporary Epicureans were affected. Diogenes the Babylonian had written a treatise on language and one entitled *The Laws*. Along with grammar, which had been a prominent branch of study under Chrysippus, philosophy, history, geography, chronology, and kindred subjects came to be recognized as fields of activity no less than philology proper. It has been recently established that Polybius the historian was a Stoic, and it is clear that he was greatly influenced by the form of the system which he learned to know, in the society of Scipio and his friends, from Panætius.[1] Nor is it improbable that works of the latter served Cicero as the originals of his *De Republica* and *De Legibus*.[2] Thus the gulf between Stoicism and the later Cynics, who were persistently hostile to culture, could not fail to be widened.

Eclecticism.

A wave of eclecticism passed over all the Greek schools in the 1st century B.C. Platonism and skepticism had left undoubted traces upon the doctrine of such a reformer as Panætius. He had doubts about a general conflagration; possibly (he thought) Aristotle was right in affirming the eternity of the present order of the world. He doubted the entire system of divination. On these points his disciples Posidonius and Hecato seem to have reverted to orthodoxy. But in ethics his innovations were more suggestive and fertile. He separated wisdom as a theoretic virtue from the other three which he called practical. Hecato slightly modified this: showing that precepts (*θεωρήματα*) are needed for justice and temperance also, he made them scientific virtues, reserving for his second class the unscientific virtue (*ἀθεώρητος ἀρετή*) of courage, together with health, strength, and such like "excellencies." Further, Panætius had maintained that pleasure is not altogether a thing indifferent: there is a natural as well as an unnatural pleasure. But, if so, it would follow that, since pleasure is an emotion, apathy or eradication of all emotions cannot be unconditionally required. The gloss he put upon the definition of the end was "a life in accordance with the promptings given us by nature;" the terms are all used by older Stoics, but the individual nature (*ἡμῖν*) seems to be emphasized. From Posidonius, the last representative of a comprehensive study of nature and a subtle erudition, it is not surprising that we get the following definition; the end is to live in contemplation of the reality and order of the universe, promoting it to the best of our power, and never led astray by the irrational part of the soul. The heterodox phrase with which this definition ends points to innovations in psychology which were undoubtedly real and important, suggested by the difficulty of maintaining the essential unity of the soul. Panætius had referred two faculties (those of speech and of reproduction) to animal impulse and to the vegetative "nature" (*φύσις*) respectively. Yet the older Stoics held that this *φύσις* was changed to a true soul (*ψυχή*) at birth. Posidonius, unable to explain the emotions as "judgments" or the effects of judgments, postulated, like Plato, an irrational principle (including a concupiscent and a spirited element) to account for them, although he subordinated all these as faculties to the one substance of the soul lodged in the heart This was a serious departure from the principles of the system, facilitating a return of later Stoicism to the dualism of God and the world, reason and the irrational part in man, which Chrysippus had striven to surmount.[3]

Posidonius.

Yet in the general approximation and fusion of opposing views which had set in, the Stoics fared far better than rival schools. Their system became best known and most widely used by individual eclectics. All the assaults of the skeptical Academy had failed, and within fifty years of the death of Carneades his degenerate successors, unable to hold their ground on the question of the criterion, had capitulated to the enemy. Antiochus of Ascalon, the professed restorer of the Old Academy, taught a medley of Stoic and Peripatetic dogmas, which he boldly asserted Zeno had first borrowed from his school. The wide diffusion of Stoic phraseology and Stoic modes of thought may be seen on all hands,—in the language of the New Testament writers, in the compendious "histories of philosophy" industriously circulated by a host of writers about this time (*cf.* H. Diels, *Doxographi Græci*).

The later Stoics.

The writings of the later Stoics have come down to us, if not entire, in great part, so that Seneca, Cornutus, Persius, Lucan, Epictetus, Marcus Aurelius are known at first hand. They do not profess to give a scientific exposition of doctrine, and may therefore be dismissed somewhat briefly (see EPICTETUS and AURELIUS). We learn much more about the Stoic system from the scanty fragments of the first founders,[4] or even from the epitomes of Diogenes Laertius and Stobæus, than from these writers. They testify to the restriction of philosophy to the practical side, and to the increasing tendency, ever since Panætius, towards a relaxation of the rigorous ethical doctrine and its approximation to the form of religious conviction. This finds most marked expression in the doctrines of submission to Providence and universal philanthropy. Only in this way could they hold their ground, however insecurely, in face of the religious reaction of the first century. In passing to Rome, Stoicism quitted the school for actual life. The fall of the republic was a gain, for it released so much intellectual activity from civic duties. The life and death of Cato fired the imagination of a degenerate age in which he stood out both as a Roman and a Stoic. To a long line of illustrious successors, men like Pætus Thrasea and Helvidius Priscus, Cato bequeathed his resolute opposition to the dominant power of the times; unsympathetic, impracticable, but fearless in demeanor, they were a standing reproach to the corruption and tyranny of their age. But when at first, under Augustus, the empire restored order, philosophy became bolder and addressed every class in society, public lectures and spiritual direction being the two forms in which it mainly showed activity. Books of direction were written by Sextius in Greek (as afterwards by Seneca in Latin), almost the only Roman who had the ambition to found a sect, though in ethics he mainly followed Stoicism. His contemporary, Papirius Fabianus was the popular lecturer of that day, producing a powerful effect by his denunciations of the manners of the time. Under Tiberius, Sotion and Attalus were attended by crowds of hearers. In Seneca's time there was a professor, badly attended it is true, even in a provincial town like Naples. At the same time the antiquarian study of Stoic writings went on apace, especially those of the earliest teachers,—Zeno and Aristo and Cleanthes.

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[1] Hirzel, *Untersuch.*, ii. p. 841 *sq.* Polybius's rejection of divination is decisive. See, *e.g.*, his explanation upon natural causes of Scipio the elder's capture of New Carthage, "by the aid of Neptune," x. 11 (*cf.* x. 2). P. Voigt holds that in vi. 5, 1, *τισιν ἑτέροις τῶν φιλοσόφων* is an allusion to Panætius.

[2] This, at least, is maintained by Schmekel.

[3] Works of Posidonius and Hecato have served as the basis of extant Latin treatises. Cicero, *De Divinatione*, perhaps *De Natura Deorum*, i., ii., comes in part from Posidonius; Cicero, *De Finibus*, iii., and Seneca, *De Beneficiis*, i.-iv., from Hecato, who is also the source of Stobæus, *Ecl. Eth.*, ii. 110. *Cf.* H. H. Fowler, *Panætii et Hecatonis Fragmenta*, Bonn, 1885.

[4] *Cf.* C. Wachsmuth, *Commentationes II. de Zenone Citiensi et Cleanthe Assio*, Göttingen, 1874. Baguet's *Chrysippus*, Louvain, 1822, is unfortunately very incomplete.

Seneca.

Seneca is the most prominent leader in the direction which Roman Stoicism now took. His penetrating intellect had mastered the subtleties of the system of Chrysippus, but they seldom appear in his works, at least without apology. Incidentally we meet there with the doctrines of Pneuma and of tension, of the corporeal nature of the virtues and the affections, and much more to the same effect. But his attention is claimed for physics chiefly as a means of elevating the mind, and as making known the wisdom of Providence and the moral government of the world. To reconcile the ways of God to man had been the ambition of Chrysippus, as we know from Plutarch's criticisms. He argued plausibly that natural evil was a thing indifferent,—that even moral evil was required in the divine economy as a foil to set off good. The really difficult problem why the prosperity of the wicked and the calamity of the just were permitted under the divine government he met in various ways: sometimes he alleged the forgetfulness of higher powers; sometimes he fell back upon the necessity of these contrasts and grotesque passages in the comedy of human life. Seneca gives the true Stoic answer in his treatise *On Providence:* the wise man cannot really meet with misfortune; all outward calamity is a divine instrument of training, designed to exercise his powers and teach the world the indifference of external conditions. In the soul Seneca recognizes an effluence of the divine spirit, a god in the human frame; in virtue of this he maintains the essential dignity and internal freedom of man in every human being. Yet, in striking contrast to this orthodox tenet is his vivid conception of the weakness and misery of men, the hopelessness of the struggle with evil, whether in society or in the individual. Thus he describes the body (which, after Epicurus, he calls the flesh) as a mere husk or fetter or prison of the soul; with its departure begins the soul's true life. Sometimes, too, he writes as if he accepted an irrational as well as a rational part of the soul. In ethics, if there is no novelty of doctrine, there is a surprising change in the mode of its application. The ideal sage has receded; philosophy comes as a physician, not to the whole but to the sick. We learn that there are various classes of patients in "progress" (προκοπή), *i.e.*, on their way to virtue, making painful efforts towards it. The first stage is the eradication of vicious habits: evil tendencies are to be corrected, and a guard kept on the corrupt propensities of the reason. Suppose this achieved, we have yet to struggle with single attacks of the passions; irascibility may be cured, but we may succumb to a fit of rage. To achieve this second stage the impulses must be trained in such a way that the fitness of things indifferent may be the guide of conduct. Even then it remains to give the will that property of rigid infallibility without which we are always liable to err, and this must be effected by the training of the judgment. Other peculiarities of the later Stoic ethics are due to the condition of the times. In a time of moral corruption and oppressive rule, as the early empire repeatedly became to the privileged classes of Roman society, a general feeling of insecurity led the student of philosophy to seek in it a refuge against the vicissitudes of fortune which he daily beheld. The less any one man could do to interfere in the government, or even to safeguard his own life and property, the more heavily the common fate pressed upon all, leveling the ordinary distinctions of class and character. Driven inwards upon themselves, they employed their energy in severe self-examination, or they cultivated resignation to the will of the universe, and towards their fellow-men forbearance and forgiveness and humility, the virtues of the philanthropic disposition. With Seneca this resignation took the form of a constant meditation upon death. Timid by nature, aware of his impending doom, and at times justly dissatisfied with himself, he tries all means of reconciling himself to the idea of suicide. The act had always been accounted allowable in the school, if circumstances should call for it: indeed, the first three teachers had found such circumstances in the infirmity of old age. But their attitude towards the "way out" (ἐξαγωγή), of incurable discomforts is quite unlike the anxious sentimentalism with which Seneca dwells upon death.

Musonius.

From Seneca we turn, not without satisfaction, to men of sterner mould, such as Musonius Rufus, who certainly deserves a place beside his more illustrious disciple, Epictetus. As a teacher he commanded universal respect, and wherever we catch a glimpse of his activity in these perilous times—whether banished by Nero, or excepted from banishment by Vespasian, as the judicial prosecutor of that foul traitor Egnatius Celer, or as thrusting himself between the ranks of Vespasianists and Vitellianists, to preach conciliation on the eve of a battle—he appears to advantage. His philosophy, however, is yet more concentrated upon practice than Seneca's, and in ethics he is almost at the position of Aristo. Virtue is the sole end, but virtue may be gained without many doctrines, mainly by habit and training. Epictetus testifies to the powerful hold he acquired upon his pupils, each of whom felt as if Musonius spoke to his heart. Amongst a mass of his practical precepts, we come across an original thought, the famous distinction between "things in our power," *i.e.*, our ideas and imaginations, and "things beyond our power," *i.e.*, the course of events and external advantages. The practical lesson drawn from it is, that we must school ourselves to accept willingly the inevitable.

Epictetus.

In the life and teaching of Epictetus this thought bore abundant fruit. The beautiful character which rose superior to weakness, poverty, and slave's estate is also presented to us in the *Discourses* of his disciple Arrian as a model of religious resignation, of forbearance and love towards our brethren, that is, towards all men, since God is our common father. With him even the "physical basis" of ethics takes the form of a religious dogma,—the providence of God, and the perfection of the world. We learn that he regards the δαίμων or "guardian angel" as the divine part in each man; sometimes it is more nearly conscience, at other times reason. His ethics, too, has a religious character. He begins with human weakness and man's need of God: whoso would become good must first be convinced that he is evil. Submission is enforced by an argument which almost amounts to a retractation of the difference between things natural and things contrary to nature, as understood by Zeno. Would you be cut off from the universe? he asks. Go to, grow healthy, and rich. But if not, if you are a part of it, then become resigned to your lot. Towards this goal of approximation to

Cynicism the later Stoics had all along been tending. Withdrawal from the active duty of the world must lead to passive endurance, and, ere long, complete indifference. Musonius had recommended marriage and condemned unsparingly the exposure of infants. Epictetus, however, would have the sage hold aloof from domestic cares, another Cynic trait. So, too, in his great maxim "bear and *forbear*," the last is a command to refrain from the external advantages which nature offers.

Aurelius.

Epictetus is marked out amongst Stoics by his renunciation of the world. He is followed by a Stoic emperor, M. Aurelius Antoninus, who, though in the world, was not of it. The *Meditations* give no systematic exposition of belief, but there are many indications of the religious spirit we have already observed, together with an almost Platonic psychology. Following Epictetus, he speaks of man as a corpse bearing about a soul; at another time he has a threefold division—(1) body, (2) soul, the seat of impulse (*πνευμα-ίον*), and (3) *νοῦς* or intelligence, the proper *ego*. In all he writes there is a vein of sadness; the flux of all things, the vanity of life, are thoughts which perpetually recur, along with resignation to the will of God and forbearance towards others, and the religious longing to be rid of the burden and to depart to God. These peculiarities in M. Antoninus may perhaps be explained in harmony with the older Stoic teaching; but, when taken in connection with the rise of Neoplatonism and the revival of superstition, they are certainly significant. None of the ancient systems fell so rapidly as the Stoa. It had just touched the highest point of practical morality, and in a generation after M. Antoninus there is hardly a professor to be named. Its most valuable lessons to the world were preserved in Christianity; but the grand simplicity of its monism slumbered for fifteen centuries before it was revivėd by Spinoza.

Literature.—The best modern authority is Zeller, *Phil. d. Griech.*, iii. pt. i. (3d ed., 1880),—Eng. transl. *Stoics*, by Reichel (1879), and *Eclectics*, by S. F. Alleyne (1883). Of the 214 numbers to which the bibliography of Stoicism extends in Ueberweg-Heinze, *Grundriss der Gesch. der Phil.* (7th ed., 1886), may be cited F. Ravaisson, *Essai sur le Stoicisme*, Paris, 1856; M. Heinze, *Die Lehre vom Logos*, Oldenburg, 1872; H. Siebeck, *Untersuchungen zur Phil. d. Griechen*, Halle, 1873, and *Gesch. d. Psychologie*, i. 2, Gotha, 1884; R. Hirzel, "Die Entwicklung der stoisch. Phil.," in *Untersuchungen zu Ciceros Schriften*, ii. pp. 1–566, Leipsic, 1882; Ogereau, *Essai sur le Système des Stoiciens*, Paris, 1885; L. Stein, *Die Psychologie der Stoa*, i., Berlin, 1886. (R. D. H.)

STOKE-UPON-TRENT, a market-town and municipal and parliamentary borough of Staffordshire, is situated on the Trent, on the Trent and Mersey Canal, where it unites with the Cauldon Canal, and on the London and North-Western and North Staffordshire railway lines, 2 miles east of Newcastle-under-Lyme, and 15 north of Stafford. It is connected with Burslem and other places by steam tramway. The principal public buildings are the town-hall (1835), with assembly rooms, the new market-hall (1883), the Minton memorial building (1858), containing rooms for art and science classes, the free library and museum (1878), and the North Staffordshire infirmary, founded in 1815 and removed to its present site in 1868. A cemetery 21 acres in extent was laid out in 1883. There are statues of Josiah Wedgewood (1863) and of Colin Minton Campbell (1886). The head offices of the North Staffordshire Railway Company are in the town. Stoke has no antiquarian interest, and owes its importance to the porcelain and earthenware manufactures. It may be regarded as the centre of the "Potteries" district. Stoke was created a parliamentary borough in 1832, with two members, but by the Act of 1885 a large part of this went to form the new borough of Hanley. The population of the municipal borough (formed in 1874, with an area of 1660 acres) was 19,261 in 1881; the area has since been increased to 1720 acres. The population of the parliamentary borough (area 9081 acres) in 1871 was 130,985, and in 1881 it was 152,394; the population of the borough as adjusted in 1885, which returns only one member, is estimated at 65,000.

STOLBERG, or **Stollberg**, an industrial and mining town in Rhenish Prussia, is situated on the Vicht, 7 miles east of Aix-la-Chapelle. It is the centre of a very active and varied industry, exporting its produce to all parts of the world. The leading branch is metal-working, which is here carried on in important zinc, brass, and iron foundries, smelting-works of various kinds, puddling and rolling works, and manufactories of needles, pins, and other metal goods. The ore is mostly found in the mines around the town, but some is imported from a considerable distance. In or near the town there are also large chemical works, glass-works, a mirror-factory, and various minor establishments. Extensive coal-mines in the neighborhood provide the enormous supply of fuel demanded by the various industries. The population in 1885 was 11,841.

The industrial prosperity of the town was founded in the middle of the 17th century by French religious refugees, who introduced the art of brass-founding. An ancient castle in the town is popularly believed to have been a hunting-lodge of Charlemagne.

STOLBERG, Count Christian (1748–1821), German poet, was born at Hamburg on the 15th October, 1748. His father, Count Christian Günther, was a privy councillor in Denmark. Stolberg studied at Göttingen, where he formed one of a "Dichterbund," which afterwards became famous. It included, besides Stolberg and his brother, Boie, Bürger, Miller, Voss, Hölty, and Leisewitz. In 1777 he became an official in the civil service at Tremsbüttel in Holstein, and married Louise, the countess of Reventlow, whose beauty he had often celebrated in his verses. He resigned his office in 1800, and afterwards lived upon his estate in Schleswig. He died January 18, 1821.

Stolberg was not a poet of high originality, but in some of his poems he gave vigorous expression to sincere and ardent feeling. He excelled, too, in the utterance of gentle and delicate sentiment. Much of his work appeared in association with that of his brother, whose genius was bolder and more impressive than his own. They published together a volume of poems in 1779, and *Schauspiele mit Chören* in 1787, their object in the latter work being to revive a love for the Greek drama. The dramas contributed to this volume by Christian Stolberg are *Balthasar* and *Otanes*. In 1815 the brothers issued a volume of *Vaterländische Gedichte*. Christian Stolberg was the sole author of *Gedichte aus dem Griechischen* (1782) and of a translation of the works of Sophocles (1787). All his poetical works are included in the *Werke der Brüder Stolberg* (20 vols, 1820–25).

STOLBERG, Count Frederick Leopold (1750–1819), the brother of the preceding, was born on the 7th November, 1750, at Bramstedt in Holstein. Like his brother he studied at Göttingen, and was a member of the "Dichterbund." In 1776 he went to Copenhagen as ambassador of the prince-bishop of Lübeck, and in 1789 he was sent to Berlin as the ambassador of the king of Denmark. His first wife, whom he had married in 1782, having died, he married the Countess Sophia von Redern in 1790, and in the following year he was appointed president of the government of the prince-bishop at Eutin. In 1800 he resigned his office, and at Münster joined the Church of Rome, taking with him all the members of his family except his eldest daughter Agnes, who had married Count Ferdinand von Stolberg-Wernigerode. Stolberg's friends and admirers were astonished by his conversion to the Roman Church, and he was hotly attacked by Voss, whose intervention gave rise to a bitter controversy. After his change of faith Stolberg issued an elaborate *Geschichte der Religion Jesu Christi*, in which he hardly even attempted to write with impartial judgment. He died near Osnabrück on the 5th December, 1819.

In association with his brother he published *Gedichte; Schauspiele mit Chören;* and *Vaterländische Gedichte.* He also wrote *Iamben* (1784), a series of satires on the vices and prejudices of his time; and he translated the *Iliad*, some of Plato's dialogues, four tragedies of Æschylus, and Ossian's poems. Among his prose writings may be mentioned *Die Insel*, a romance (1788); *Eine Reise in Deutschland, der Schweiz, Italien, und Sicilien* (1794); and his *Leben Alfred's des Grossen* (1815). He was a master of many forms of poetical expression, and in his best period he produced a strong impression on his contemporaries by his passion for nature and freedom.

Biographies of Stolberg have been written by Nicolovius, Menge, Wiedel, Hennes, and Janssen.

STOLP, or **Stolpe**, an ancient trading-town in the bleak coast-plain of Eastern Pomerania, Prussia, is situated on the Stolpe, 10 miles from the Baltic Sea and 64 miles to the west of Dantzic. The large church of St. Mary, with a lofty tower, dating from the 14th century, the Renaissance castle of the 16th century, now used as a prison, and one of the ancient town-gates restored in 1872 are memorials of the time when Stolp was a prosperous member of the Hanseatic League. The manufacture of amber articles, tobacco and cigars, cigar-boxes, etc., with some iron-founding, linen-weaving, and salmon-fishing in the Stolpe, are the chief industrial occupations of the inhabitants, who also carry on trade in grain, cattle, spirits, fish, and geese. Stolpmünde, a fishing-village and summer resort, at the mouth of the river, is the port of Stolp. The population of Stolp in 1885 was 22,431 (in 1816 5260), about 600 being Roman Catholics and about 1000 Jews.

Stolp, mentioned in the 11th century, received town-rights in 1273. From the 14th to the 16th century it was a member of the Hanseatic League. Until 1637, when it passed to Brandenburg, the town was generally in the possession of the dukes of Pomerania.

STOMACH. See Digestive Organs.

STOMACH, Diseases of the. Only the more common and serious varieties of gastric disease can be here referred to. The majority of them exhibit, as their most marked and sometimes their only feature, the symptoms of Dyspepsia (*q.v.*). Hence the diagnosis of the forms of stomach disease is frequently a matter of much difficulty. Nevertheless a careful consideration of the history and the manifested phenomena of a given case may often lead to a correct identification of its nature. The present notice refers in general terms to the most prominent symptoms which usually characterize the chief gastric disorders.

The stomach is liable to inflammatory affections, of which the condition of catarrh, or irritation of its mucous membrane, is the most frequent and most readily recognized. This may exist in an acute or a chronic form, and depends upon some condition, either local or general, which produces a congested state of the circulation in the walls of the stomach.

Acute Gastric Catarrh may arise from various causes, of which the most important are: (1) constitutional conditions, such as the gouty or rheumatic, or an inherited tendency to irritability of the digestive organs; (2) errors in diet, particularly excessive quantity, indigestible quality, imperfect mastication, extremes of temperature of the food, toxic agents, especially alcohol, in excess, or food in a state of decomposition; (3) atmospheric influences, as appears evident from its tendency to occur in very warm or very cold weather or in the case of sudden temperature alternations.

The chief change the stomach undergoes affects its mucous membrane, which is in a state of congestion, either throughout or in parts. It is more than probable that this condition produces an alteration in the secreting function of the organ, and that its peptic juices become less potent, the effect of which will be to retard the process of digestion and favor the occurrence of decomposition and fermentation in its contents, thus aggravating the original evil. The symptoms are those well known as characterizing an acute "bilious attack," consisting in loss of appetite, sickness or nausea, and headache, frontal or occipital, often accompanied with giddiness. The tongue is furred, the breath fetid, and there is pain or discomfort in the region of the stomach, with sour eructations, and frequently vomiting, first of food and then of bilious matter. An attack of this kind tends to subside in a few days, especially if the exciting cause be removed. Sometimes, however, the symptoms recur with such frequency as to lead to the more serious chronic form of the disease.

The treatment bears reference, in the first place, to any known source of irritation, which, if it exist, may be expelled by an emetic or purgative. This, however, is seldom necessary, since vomiting is usually present. For the relief of sickness and pain, the sucking of ice and counter-irritation over the region of the stomach are of service. Further, remedies which exercise a soothing effect upon an irritable mucous membrane, such as bismuth or weak alkaline fluids, and along with these the use of a light milk diet, are usually sufficient to remove the symptoms.

Chronic Gastric Catarrh may result from the acute or may arise independently. It is not unfrequently connected with antecedent disease in other organs, such as the lungs, heart, liver, or kidneys, and it is specially common in persons addicted to alcoholic excess. In this form the texture of the stomach is more seriously affected than in the acute. It is permanently in a state of congestion, and its mucous membrane and muscular coat undergo thickening and other changes, which, besides markedly affecting the function of digestion, may lead to stricture of the pyloric orifice of the stomach and its results, to be subsequently referred to. The symptoms are those of dyspepsia in an aggravated form (see Dyspepsia), of which discomfort and pain after food, with distension and frequently vomiting, are the chief; and the treatment must be conducted in reference to the causes giving rise to it. The careful regulation of the diet (see Dietetics), both as to the amount, the quality, and the intervals between meals, demands special attention. Of medicinal agents, bismuth, arsenic, nux vomica, and the mineral acids are all of acknowledged efficacy, as are also preparations of pepsin.

Ulcer of the Stomach (gastric ulcer, perforating ulcer) is of not unfrequent occurrence, and is a disease of much gravity. Its causes are probably not fully understood, yet the following points may be regarded as generally admitted: (1) that the disease is twice as common in females as in males, and that it is found to affect domestic servants more frequently than any other class; (2) that it occurs for the most part in early life, the period from twenty to thirty including the great majority of the cases; (3) that it appears to be connected in many instances with impairment of the circulation in the stomach and the formation of a clot in a small bloodvessel (thrombosis); (4) that such an occurrence may arise in connection with an impoverished state of the blood (anæmia), which is actually the condition present in many of the cases, but that it may also arise from diseased bloodvessels, the result of long-continued catarrh, or from the irritation and debilitating effects of hot or cold substances.

It is held that when any such obstruction takes place in a bloodvessel the nutrition of a limited area of the stomach is cut off, and the part is apt to undergo disintegration all the more readily from the unresisted action of the gastric juices upon it. Hence an ulcer is formed. This ulcer is usually of small size (¼ to 1 inch in diameter), of round or oval form, and tends to advance, not superficially, but to penetrate through the coats of the stomach. Its most usual site is upon the posterior wall of the upper or lesser curvature of the stomach and near to the pyloric orifice. It may undergo a healing process at any stage, in which case it may leave but little trace of its existence; while, on the other hand, it may in the course of cicatrizing produce such an amount of contraction as to lead to stricture of the pylorus. But, again, perforation may take place, which in most cases is quickly fatal, unless previously the stomach has become, as it may, adherent to another organ, by which the dangerous effects of this occurrence may be averted. Usually there is but one ulcer, but sometimes there are more.

The symptoms to which this disease gives rise are often exceedingly indefinite and obscure, and in some cases the diagnosis has been first made out by the sudden occurrence of a fatal perforation. Generally, however, there are certain evidences more or less distinct which tend to indicate the probable presence of a gastric ulcer. First among these is *pain*, which is in some measure present at all times, but is markedly increased after food. This pain is situated either in front, at the lower end of the sternum, or fully more commonly behind, about the middle of the back. Sometimes it is felt at one or both sides. It is often extremely severe, and is usually accompanied with much tenderness to touch, and also with a sense of oppression and inability to wear tight clothing. The pain is probably largely due to the active movements of the stomach set up by the presence of the food. Accompanying the pain there is frequently *vomiting*, either very soon after the food is swallowed or at a later period. This tends in some measure to relieve the pain and discomfort, and in many instances the patient rather encourages this act. Vomiting of blood (hæmatemesis) is a frequent symptom, and is most important diagnostically. It may show itself either to a slight extent, and in the form of a brown or coffee-like mixture, or as an enormous discharge of pure blood of dark color and containing clots. The source of the blood is some vessel or vessels which the ulcerative process has ruptured. Blood is also found mixed with the discharges from the bowels, rendering them dark and tarry looking. The general condition of a patient with gastric ulcer is as a rule that of ill-health, showing pallor, more or less emaciation, and debility. The tongue presents a red irritable appearance, and there is usually constipation of the bowels.

The course of a case of gastric ulcer is very variable. In some instances it would appear to be acute, making rapid progress to a favorable or unfavcrable termination. In most, however, the disease is chronic, lasting for months or years; and in those cases where the ulcers are multiple or of extensive size incomplete healing may take place and relapses of the symptoms occur from time to time. Ulcers are sometimes present and give rise to no marked symptoms; and it has occurred to the writer to see more than one instance of this kind where fatal perforation suddenly took place, and where *post-mortem* examination revealed the existence of long-standing ulcers which could not possibly have been made out by any evidences furnished during life. While gastric ulcer is always to be regarded as a dangerous disease, its termination, in the great majority of cases, is in recovery. It frequently, however, leaves the stomach in a delicate condition, necessitating the utmost care as regards diet. Occasionally, though rarely, the disease proves fatal by sudden hæmorrhage, but a fatal result is more frequently due to perforation and the extrusion of the contents of the stomach into the peritoneal cavity, in which case death usually occurs in from twelve to forty-eight hours, either from shock or from peritonitis. Should the stomach become adherent to another organ, and fatal perforation be thus prevented, there may remain as the result of this a permanent condition of dyspepsia, owing to interference with the natural movements of the stomach during digestion; while again stricture of the pylorus and consequent dilatation of the stomach is an occasional result of the cicatrization of an ulcer in its neighborhood.

Of prime importance in the treatment of this disease is the careful adjustment of the diet, the conditions existing in the stomach obviously requiring that the food administered should be of as bland and soft a character as possible. Of all substances milk forms the most suitable aliment, and, while there may be instances in which it fails to agree, even when mixed with lime water or previously boiled, these are comparatively few. The peptonized foods originally suggested by Sir Wm. Roberts of Manchester are frequently found of much service in this disease. Light soups as well as milk may sometimes be administered in this way with benefit. The quantity, the intervals between the times of administration, and the temperature, as well as the quantity, of the food demand careful attention. In severe cases, where the presence of food in the stomach gives rise to much suffering, nourishment by the bowel may be given for a time with great advantage. Of medicinal remedies the most serviceable are large doses of bismuth, with which it may be necessary to conjoin small doses of opium or of hydrocyanic acid for the relief of pain. The careful administration of nitrate of silver has been recommended as a means of promoting the healing of the ulcers, but this end is probably more readily accomplished by the remedies and especially by the method of diet already referred to, combined with rest. When hæmorrhage occurs it is relieved by ice and by such styptics as gallic acid, ergot of rye, lead, alum, etc., while in the dread event of perforation the only means of affording relief is opium.

Cancer of the Stomach is one of the most common forms of internal cancerous disease. It occurs for the most part in persons at or after middle life, and in both sexes equally. Hereditary tendency may not unfrequently be traced.

The most common varieties of cancer affecting the stomach are scirrhus, medullary, and colloid, and the parts affected are usually the inlet or outlet orifices; but the morbid process may spread widely in the stomach wall. When in the neighborhood of the pylorus a stricture is frequently produced as the disease advances. The cancerous growth usually commences in the submucous tissue, but as it progresses it tends to ulcerate through the mucous membrane, and in this process hæmorrhage and hæmatemesis may occur. The symptoms of this disease are in many instances so indefinite as to render the diagnosis for a long time conjectural. They are mostly those of dyspepsia, with more or less pain, discomfort, and vomiting, particularly after meals. The vomited matters are often of coffee-ground appearance, due to admixture with blood, but copious hæmatemesis is less frequent than in cases of gastric ulcer. The patient loses flesh and strength and soon comes to acquire the cachectic aspect commonly associated with cancer. The diagnosis is rendered all the more certain when, as is frequently the case, a tumor can be detected on examination over the region of the stomach, but there are many instances where no such evidence is obtained and where the nature of the disease is left to be made out by the age of the patient and by the intractable and progressive character of the symptoms. Cases of cancer of the stomach advance with more or less rapidity to a fatal termination, which is usually quickest in the medullary form. In most instances death takes place in from six to twelve months. The treatment can only be palliative, but much relief may often be afforded by a careful attention to diet, by the treatment applicable to dilatation of the stomach, and by the use of opium.

Stricture of the Pylorus may, as has been already indicated, result from the various morbid conditions affecting the stomach to which reference has been made, namely, catarrh, ulcer, and cancer. By whatever means produced, the effect is an obstruction to the transmission through the pyloric orifice into the intestines of the contents of the stomach, the occurrence of dilatation of the organ, with weakening of its walls, and the consequent accumulation and fermentation of partially digested food. This condition gives rise to much discomfort, heartburn, and pain, and to the occurrence every few days of a copious vomiting of fermenting material, in which may be found on microscopic examination the fungoid growths of *Sarcina* and *Torulæ*. With the continuance of the disease the symptoms tend to increase and to wear out the patient's strength, since little or no assimilation is possible, and death sooner or later takes place from inanition. For a long time this condition was regarded as incurable in every case, till the method of treatment, originally suggested by Küssmaul, of washing out the stomach daily or less frequently was found to yield remarkably beneficial results in almost all cases, and, in many instances of non-cancerous disease, to accomplish an actual cure. This plan of treatment is now largely resorted to, and it has proved to be a valuable addition to the therapeutics of gastric diseases. (J. O. A.)

STONE, a market-town of Staffordshire, England, on the river Trent, and on the North Staffordshire Railway, 7 miles south of Stoke and 7 north of Stafford. Part of the walls remain of an abbey which dates from the foundation of a college of canons in 670. The present church was opened in 1750. The inhabitants are employed chiefly in shoemaking, but malting, brewing, and tanning are also carried on. The population of the urban sanitary district (estimated area 1000 acres) was 5669 in 1881.

STONE. See VESICAL DISEASES.

STONEHENGE, one of the most remarkable examples of the ancient stone circles, is situated in Salisbury Plain, Wiltshire, about 7 miles north of Salisbury. It consists of two circles and two ovals with a large stone in the centre. The outer circle, about 300 feet in circumference, is composed of upright stones about 16 feet in height and 18 feet in circumference, with others of similar size placed horizontally on their tops. Originally, there were thirty uprights and thirty imposts, but now only seventeen uprights and seven imposts retain their position. The inner circle, which is about 9 feet distant from the outer circle, consisted originally of forty single stones, much smaller in size, and, unlike those of the outer circle, showing no evidence of having been hewn. The larger of the ovals was composed of five pairs of trilithons standing separate from each other, and rising gradually in height from east to west. Only two of these now remain entire; one of the uprights of the grand central trilithon has fallen, and is broken in two pieces; the impost though fallen is entire, and the other impost is 9 feet out of the perpendicular; another trilithon fell outward on the 3d June, 1797; and of a third one of the uprights is still standing, the other upright and the impost having in their fall been broken into three pieces. The inner oval consisted originally of nineteen stones, of which there are remains of eleven, tapering in form and taller than those of the inner circle. In the centre of the smaller oval is the supposed altar stone, 15 feet in length. The whole is surrounded by a vallum and ditch about 370 yards in circumference. From the northeast an avenue, marked by a bank and ditch on each side, proceeds for a distance of 594 yards, after which it divides into two branches, one going eastwards up a hill between two groups of barrows, and the other northwestwards about 300 yards to the cursus or race-course. The cursus, which is inclosed between two parallel banks and ditches running east and west, is a mile and 176 yards in length, with a breadth of 110 yards. There is a smaller cursus a little to the north. In the avenue there is a cromlech or bowing-stone, 16 feet in length, called the Friar's Heel, and in a line with it, within the area of the work, there is a large prostrate stone on which it is supposed the victims were immolated. Barrows lie around on all sides.

Stonehenge is first mentioned by Nennius in the 9th century, who asserts that it was erected in commemoration of the 400 nobles who were treacherously slain near the spot by Hengist in 472. A similar account of its origin is given in the triads of the Welsh bards, where its erection is attributed to King Merlin, the successor of Vortigern. Inigo Jones, in his work on Stonehenge, published in 1655, endeavors to prove that it was a temple of the Romans, but later writers of authority are generally agreed that it is of Druidical origin, although there are differences of opinion as to its probable date, some placing it at 100 years before Christ, and others in the 5th century. It seems most probable that the inner circle and inner oval, constructed of smaller stones of granite, which must have been brought from a distance, is of earlier origin than the outer circle and oval.

Among numerous writings on Stonehenge may be mentioned *Stonehenge and Abury*, by Dr. William Stukeley, 1740, reprinted in 1840; Davies's *Celtic Researches*, 1804, and *Mythology of the Druids*, 1809; Hoare's *Ancient Wiltshire*, vol. i., 1812; Browne, *An Illustration of Stonehenge and Abury*, 1823; the article on Stonehenge in the *Quarterly Review* for July, 1860; Long's *Stonehenge and its Barrows*, 1876; Gidley, *Stonehenge, Viewed in the Light of Ancient History and Modern Observation*, 1877.

STONE MASONRY. See BUILDING, vol. iv. p. 418.

STONINGTON, a borough and seaport of the United States, in New London county, Connecticut, is situated on Long Island Sound, 139 miles from New York by the railway to Providence and Boston. It is built on a narrow rocky point, and is a quiet quaint-looking town, largely frequented as a summer watering-place. Its industries comprise silk-throwing and the manufacture of silk machinery, and it has a considerable interest in sealing. Here and there may still be seen traces of the bombardment by the British under Sir Thomas Hardy, in August, 1814. The harbor is protected by two breakwaters; it is the terminus of a daily line of steamers from New York. The population of the township was 6313 in 1870, and 7355 in 1880. Settled in 1649, the borough was incorporated in 1801.

STORACE, STEPHEN (1763–1796), dramatic composer, was born in London in 1763. His father, Stefano Storace, an Italian contrabassist, taught him the violin so well that at ten years old he played successfully the most difficult music of the day. After completing his education at the Conservatorio di Sant' Onofrio at Naples, he produced his first opera, *Gli Sposi Malcontenti*, at Vienna, in 1785. Here he made the acquaintance of Mozart, in whose *Nozze di Figaro* his sister, Anna Selina Storace, first sang the part of Susanna. Here also he produced a second opera, *Gli Equivoci*, founded on Shakespeare's *Comedy of Errors*, and a "Singspiel," entitled *Der Doctor und der Apotheker*. But his greatest triumphs were achieved in England, whither he returned in 1787. After creating a favorable impression by bringing out his "Singspiel" at Drury Lane, under the title of *The Doctor and the Apothecary*, Storace attained his first great success in 1789, in *The Haunted Tower*, a genuine English opera, which ran for fifty nights in succession, and retained its popularity long after the opening of the present century. *No Song No Supper* was equally successful in 1790; and *The Siege of Belgrade* scarcely less so in 1791. The music of *The Pirates*, produced in 1792, was partly adapted from *Gli Equivoci*, and is remarkable as affording one of the earliest instances of the introduction of a grand *finale* into an English opera. These works were followed by some less successful productions; but *The Cherokee* (1794) and *The Three and the Deuce* (1795) were very favorably received, and the music to Colman's play, *The Iron Chest*, first performed March 12, 1796, created even a greater sensation than *The Haunted Tower*. This was Storace's last work. He caught cold at the rehearsal, and died in consequence, March 19, 1796.

The character of Storace's music is pre-eminently English, but his early intercourse with Mozart gave him an immense advantage over his contemporaries in his management of the orchestra, while for the excellence of his method of writing for the voice he was no doubt largely indebted to the charming vocalization of his sister Anna. This lady, who has attained lasting honor as the original representative of Susanna in *Le Nozze di Figaro*, was born in London in 1766, completed her education at Venice under Sacchini, sang for Mozart at Vienna, and first appeared at the King's Theatre in London in 1787. After contributing greatly to the success of *The Haunted Tower*, and her brother's later operas, she crowned a long and brilliant career by winning great laurels at the Handel Commemoration at Westminster Abbey in 1791, retired from public life in 1808, and died August 24, 1817. During her stay in Vienna she married John Abraham Fisher, a celebrated violinist, but he used her so cruelly that she refused to bear his name, and in her will—bequeathing property to the amount of £50,000—styled herself "spinster."

STORAX. It has been explained in INCENSE (vol. xii. p. 757) and LIQUIDAMBAR (vol. xiv. p. 693) that the storax of commerce and the pharmacopœia (used as an emollient) is derived from the Oriental liquidambar tree. The storax of the ancients, on the other hand, a solid gum which does not now occur in commerce, appears to have been the product of the beautiful white-flowered shrub *Styrax officinalis*, which is still common on Carmel and elsewhere in Syria. It was much used as an incense, and formed an early and important article of Phœnician trade (see Movers, *Phönizier*, ii. 3, 101, 223 *sq.*). It is probable that the Greek work στύραξ is of Semitic origin, representing the Hebrew צרי, which the English version renders "balm" (Lagarde, *Mittheilungen*, p. 234 *sq.*).

STORK (A.S. *Storc*; Germ. *Storch*), the *Ciconia alba* of ornithology, and, through picture and story, one of the best known of foreign birds; for, though often visiting Britain, it has never been a native or even inhabitant of the country. It is a summer-visitant to most parts of the European continent,—the chief exceptions being France (where the native race has been destroyed), Italy, and Russia,—breeding from southern Sweden to Spain and Greece, and being especially common in Poland.[1] It reappears again in Asia Minor, the Caucasus, Persia, and Turkestan, but further to the eastward it is replaced by an allied species, *C. boyciana*, which reaches Japan. Though occasionally using trees (as was most likely its original habit) for the purpose, the Stork most generally places its nest on buildings,[2] a fact familiar to travellers in Denmark, Holland, and Germany, and it is nearly everywhere a cherished guest, popular belief ascribing good luck to the house to which it attaches itself.[3] Its food, consisting mainly of frogs and insects, is gathered in the neighboring pastures, across which it may be seen stalking with an air of quiet dignity; but in the season of love it indulges in gestures which can only be called grotesque,—leaping from the ground with extended wings in a kind of dance, and, absolutely voiceless as it is, making a loud noise by the clattering of its mandibles. At other times it may be seen gravely resting on one leg on an elevated place, thence to sweep aloft and circle with a slow and majestic flight. Apart from its considerable size,—and a Stork stands more than three feet in height,—its contrasted plumage of pure white and deep black, with its bright red bill and legs, makes it a conspicuous and beautiful object, especially when seen against the fresh green grass of a luxuriant meadow. In winter the Storks of Europe retire to Africa,—some of them, it would seem, reaching the Cape Colony,—while those of Asia visit India. A second species, with much the same range, but with none of its relative's domestic disposition, is the Black Stork, *C. nigra*, of which the upper parts are black, brilliantly glossed with purple, copper, and green, while it is white beneath,—the bill and legs, with a patch of bare skin round the eyes, being red. This bird breeds in lofty trees, generally those growing in a large forest. Two other dark-colored, but somewhat abnormal, species are the purely African *C. abdimii*, and the *C. episcopus*, which has a wider range, being found not only in Africa but in India, Java, and Sumatra. The New World has only one true Stork, *C. maguari*,[1] which inhabits South America, and resembles not a little the *C. boyciana* above mentioned, differing therefrom in its greenish-white bill and black tail. Both these species are very like *C. alba*, but are larger, and have a bare patch of red skin round the eyes.

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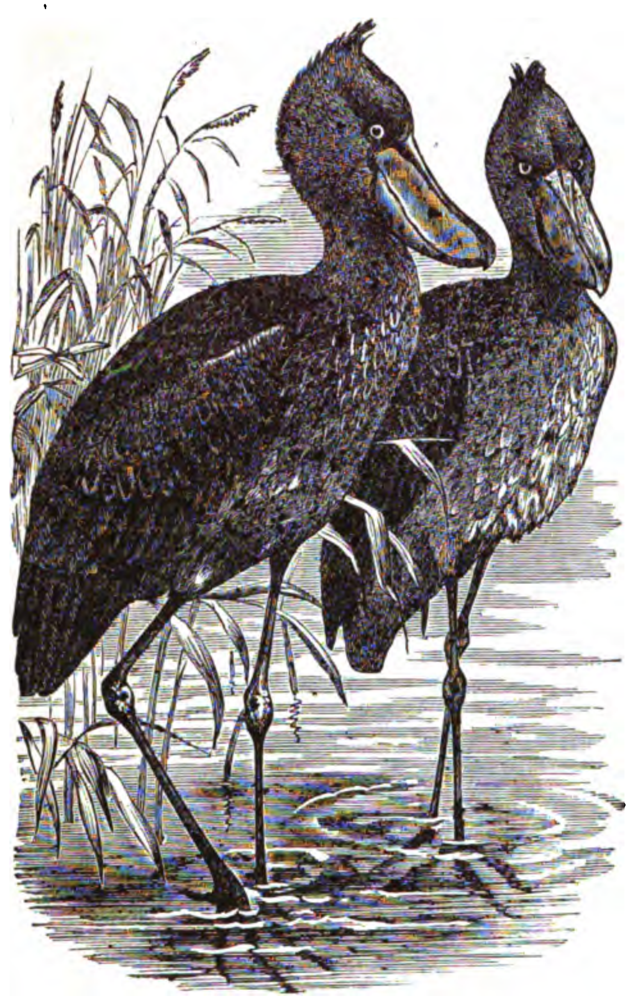
[1] In that country its numbers are said to have greatly diminished since about 1858, when a disastrous spring-storm overtook the homeward-bound birds. The like is to be said of Holland since about 1860.

[2] To consult its convenience a stage of some kind, often a cart-wheel, is in many places set up and generally occupied by successive generations of tenants.

[3] Its common Dutch name is *Ooijevaar*, which can be traced through many forms (Koolmann, *Wörterb. d. Ostfries. Sprache*, i. p. 8 *sub voce* "Adebar") to the old word *Odeboro* ("the bringer of good"). In countries where the Stork is abundant it enters largely into popular tales, songs, and proverbs, and from the days of Æsop has been a favorite in fable.



Shoe-Bill or Whale-Headed Stork. (After Wolf in *Trans. Zool. Soc.*)

The Storks form the *Pelargi* of Nitzsch, as separated by him from the Herons and the Ibises, but all three are united by Prof. Huxley in his group *Pelargomorphæ*. The relations of the Storks to the Herons may be doubtful; but there is no doubt that the former include the Jabiru (vol. xiii. p. 539) and its allies, as well as the curious genus *Anastomus* (with its lower mandible hollowed out so as only to meet the maxilla at the base and the tip), of which there are an African and an Asiatic species. Two other remarkable forms probably belong to the *Pelargi*. These are *Balæniceps rex* and *Scopus umbretta*, each the sole member of its own genus, and both from Africa. The former, first brought to Europe by Mr. M. Parkyns from the White Nile, was regarded by Gould, who described it in the Zoological *Proceedings* (1851, pp. 1, 2, pl. xxxv.), as an abnormal Pelican. This view was disputed by Reinhardt (*op. cit.*, 1860, p. 377), and wholly dispelled by Prof. Parker in the Zoological *Transactions* (iv. pp. 269–351), though these two authors disagreed as to its affinities, the first placing it with the Storks, the last assigning it to the Herons. In singularity of aspect few birds surpass *Balæniceps*, with its gaunt gray figure, some five feet in height, its large head surmounted by a little curled tuft, the scowling expression of its eyes, and its huge bill in form not unlike a whale's head—this last suggesting its generic name—but tipped with a formidable hook. The shape of the bill has also prompted the Arabs to call it, according to their idiom, the "Father of a Shoe," and it has been designated "Shoebill" in English.[2] The other form that remains to be noticed is the *Scopus umbretta* of ornithologists, called the "Umbre" by Pennant. This was discovered by Adanson the French traveller in Senegal about the middle of the last century, and was described by Brisson in 1760. It has since been found to inhabit nearly the whole of Africa and Madagascar, and is the "Hammerkop" (Hammerhead) of the Cape colonists. Though not larger than a Raven, it builds an enormous nest, some six feet in diameter, with a flat-topped roof and a small hole for entrance and exit, and placed either on a tree or a rocky ledge.[3] The bird, of an almost uniform brown color, slightly glossed with purple, and its tail barred with black, has a long occipital crest, generally borne horizontally, so as to give rise to its common name. It is somewhat sluggish by day, but displays much activity at dusk, when it will go through a series of strange performances. In all the Storks, so far as is known, the eggs are white, and in most forms distinguishable by the grain of their shell, which, without being rough, is closely pitted with pore-like depressions. (A. N.)

STORMS. See Meteorology, vol. xvi. pp. 159–161.

STORY, Joseph (1779–1845), was born at Marblehead, Massachusetts, September 18, 1779, graduated at Harvard in 1798, and was admitted to the bar in

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[1] This was formerly believed to have occurred in Europe, but erroneously, as was shown by Schlegel (*Rev. Critique*, p. 104).

[2] Under one or other of these names it is mentioned by many African travellers; but the best account of it is that given by Von Heuglin (*Orn. Nordost-Afrika's*, pp. 1095–1099). In 1860 two living birds were brought to England by Mr. Petherick and exibited in the Zoological Gardens.

[3] Two figures of the nest are given by Holub and Von Pelzeln (*Beitr. Orn. Südafrikas*, p. 279).

Massachusetts in 1801. He was a member of the Democratic party, then weak in New England but all-powerful in the rest of the Union; and his district made him its representative in Congress for 1808–9. In 1811 one of the associate-justiceships of the United States supreme court became vacant, and Story was appointed to it, retaining the office for life. Here he found his true sphere of work. The traditions of the American people, their strong prejudice for the local supremacy of the States and against a centralized government, had yielded reluctantly to the establishment of the federal legislative and executive in 1789. The federal judiciary had been organized at the same time, but had never grasped the full measure of its powers. Soon after Story's appointment the supreme court began to bring out into plain view the powers which the constitution had given it over State courts and State legislation. The leading place in this work belongs to Chief-Justice John Marshall, but Story has a very large share in that remarkable series of decisions and opinions, from 1812 until 1832, by which the work was accomplished. In addition to this he built up the department of admiralty law in the United States courts; and his *Commentaries on the American Constitution* are still the leading authority on the interpretation of that instrument. He died at Cambridge, Massachusetts, where he was the head of the Harvard law school, September 10, 1845.

See Story's *Life and Letters of Joseph Story;* Story's *Miscellaneous Works;* Story's *Commentaries on the Constitution of the United States*, and a great number of standard law-books of which he was the author. His supreme court decisions are in Cranch's, Wheaton's, and Peters's *Reports;* his circuit decisions in Gallison's, Mason's, Sumner's, and Story's *Reports.*

STOTHARD, Charles Alfred (1786–1821), antiquarian draughtsman, son of Thomas Stothard, noticed below, was born in London on July 5, 1786. After studying in the schools of the Royal Academy, he began, in 1810, his first historical piece, the Death of Richard II. in Pomfret Castle. Having taken a strong interest from an early period in the costumes of different ages and nations, he published in 1811 the first part of his valuable work, *The Monumental Effigies of Great Britain*. He was appointed historical draughtsman to the Society of Antiquaries, and was deputed by that body to visit Bayeux, to make drawings of the well-known tapestry. He was made a fellow of the society in 1819, and subsequently engaged in numerous journeys with the view of illustrating the works of D. Lysons. While engaged in tracing a portrait from one of the windows of the church of Beer-Ferrers, Devonshire, he fell and was killed on the spot (May 27, 1821). His widow (afterwards Mrs. Bray), along with her brother, completed his *Monumental Effigies*, left unfinished at his death. A biography, by his widow, was published in 1823.

STOTHARD, Thomas (1755–1834), subject painter, was born in London on August 17, 1755, the son of a well-to-do innkeeper in Long Acre. Being a delicate child, he was sent at the age of five to a relative in Yorkshire, and attended school at Acomb, and afterwards at Tadcastle and at Ilford in Essex. Showing a turn for drawing he was apprenticed to a draughtsman of patterns for brocaded silks in Spitalfields, and during his leisure hours he attempted illustrations to the works of his favorite poets. Some of these drawings were praised by Harrison, the editor of the *Novelist's Library*, and, Stothard's master having died, he resolved to devote himself to art. In 1778 he became a student of the Royal Academy, of which he was elected associate in 1791, full academician in 1794, and librarian in 1817. He married before he was thirty; and it is recorded that, after attending the wedding ceremony, he spent the afternoon in quietly drawing in the schools, and, on leaving, requested a fellow student to accompany him "to a family party." "Do come," he said, "for I have this day taken unto myself a wife." He died in London on the 27th of April, 1834.

Among his earliest book illustrations are plates engraved for *Ossian* and for *Bell's Poets;* and in 1780 he became a regular contributor to the *Novelist's Library*, for which he executed one hundred and forty-eight designs, including his eleven admirable illustrations to *Peregrine Pickle* and his graceful subjects from *Clarissa* and *Sir Charles Grandison.* Soon his hands were full of work, for all commissions were welcome to him. He contentedly designed plates for pocket-books, tickets for concerts, illustrations to almanacs, portraits of popular players,—and into even the slightest and most trivial sketches he infused a grace and distinction which render them of value to the collectors of the present time. Among his more important series are the two sets of illustrations to *Robinson Crusoe*, and the plates to *The Pilgrim's Progress* (1788), to *The Rape of the Lock* (1798), to the works of Gessner (1802), to Cowper's *Poems* (1825), and to *The Decameron;* while his figure-subjects in the superb editions of Roger's *Italy* (1830) and *Poems* (1834) prove that even in latest age his fancy was still unexhausted and his hand hardly at all enfeebled. He is at his best in subjects of a domestic or a gracefully ideal sort; the heroic and the tragic were beyond his powers. The designs by Stothard have been estimated by Mr. Wornum to number five thousand, and of these about three thousand have been engraved. His oil pictures are usually small in size, and rather sketchy in handling. Their coloring is often rich and glowing, being founded upon the practice of Rubens, of whom Stothard was a great admirer. He was a contributor to Boydell's *Shakespeare Gallery*, but his best-known painting is the Procession of the Canterbury Pilgrims, the engraving from which, begun by Schiavonetti and finished by Heath, attained an immense popularity. It was followed by a companion work, the Flitch of Bacon, which was drawn in sepia for the engraver, but was never carried out in color.

In addition to his easel pictures, Stothard adorned the grand staircase of Burleigh House with subjects of War, Intemperance, and the Descent of Orpheus in Hell (1799–1803); the mansion of Hafod, North Wales, with a series of scenes from Froissart and Monstrelet (1810), the cupola of the upper hall of the Advocate's Library, Edinburgh (now occupied by the Signet Library), with Apollo and the Muses, and figures of poets, orators, etc. (1822); and he prepared designs for a frieze and other decorations for St. James's Palace. He also designed the magnificent shield presented to the duke of Wellington by the merchants of London, and executed with his own hand a series of eight etchings from the various subjects which adorned it.

An interesting but most indiscriminately eulogistic biography of Stothard, by his daughter-in-law Mrs. Bray, was published in 1851.

STOURBRIDGE, a market-town of Worcestershire, England, stands on an eminence on the south bank of the Stour, and on the Great Western Railway, on the borders of Staffordshire, 4 miles southwest of Dudley and 10 west of Birmingham. A branch canal connects the town with the Staffordshire and Worcestershire Canal. The Stour is crossed by a railway viaduct erected in 1882 at a cost of £13,835 [$67,238.10]. The town possesses a corn exchange, a mechanics' institute, an Edward VI. grammar school, a Government school of art, and a blue-coat or hospital school. The manufacture of glass was established in 1556 by emigrants from Hungary, the place where they erected their manufactory being still known as Hungary Hill. Valuable fire-clay is obtained in the neighborhood, and a great variety of fine bricks are made. There are also large iron and leather works. The town was originally called Bedcote, a name which the manor still retains. The population of the urban sanitary district (area 450 acres) in 1871 was 9376, and in 1881 it was 9757.

STOVES and FIREPLACES are structures of iron and other materials in which fuel is burned for heating and ventilating apartments and for cooking food. Following the primitive open hearth, the first separate heating apparatus used by Egyptians, Greeks, and Romans was the brazier, an open basin of metal in which charcoal was consumed. The brazier is still in common use for industrial purposes, and in Continental countries it is widely employed both for cooking and for domestic heating. The Romans further were acquainted with the hypocaust, a separate chamber under the floor of the apartment to be heated (see Baths, vol. iii. p. 376). In an improved form of hypocaust, flues were provided which conveyed the heat and products of combustion to the floors of other apartments at some distance from the fire. In the remains of Roman villas found in Britain the hypocaust is an invariable feature. The introduction of chimneys into houses in the early part of the 14th century opened the way to all modern improvements in the heating arrangements of apartments, and the efforts of inventors have been devoted to the securing of the thorough combustion of the fuel used, and to the utilization of the maximum amount of heat therefrom in the most healthful and agreeable manner. Compare Smoke Abatement.

The stove or close range, as distinguished from the open fireplace, distributes the largest amount of heat from the fuel it burns. In its simplest form the common stove consists of a case of iron, closed above, with its sole raised from the floor on which it stands. It has two small openings in one side, one on the level of the fire-bars for draught, and the other above for supplying fuel; and on the opposite side the products of combustion are carried away by a flue-pipe passing into a chimney. In a more complex form the height of the case or body is increased, and a series of horizontal flues or spaces are formed inside, through which the heated air and smoke pass, thus extracting more thoroughly the heat before it enters the chimney, and giving a greatly increased heating surface. Such stoves overdry the air in rooms, and, when they are externally heated to a high degree, floating particles are burned by falling on their surfaces, whence arises the disagreeable stuffy smell almost inseparable from their use. To mitigate this evil of overheating, linings of tiles, firebricks, and other non-conducting materials are with great advantage introduced between the heated iron and the air of the apartment. In ventilating stoves the outside casing of iron is entirely protected from the direct action of fire by a lining of firebrick. The inside is divided into several spaces or flues, and air drawn from without enters by a separate flue, and passing through these spaces is heated and delivered into the apartment as a warm current. In another class, of which the gill stove is the type, there radiates from the fire-case a range of flanges or gills a few inches apart, which conduct the heat outwards and enormously extend the heating surface, counteracting at the same time the tendency to overheating. Cooking stoves or ranges have in their centre a fire space covered above with a removable top-plate, in which are circular openings whereby the cooking vessels can be brought into direct contact with the fire. At both sides there are one or more compartments which form ovens, and around these the heat from the fire is carried by flues; or at one side a water boiler may be placed, although generally a high-pressure boiler occupies a space immediately behind the fire. The flues which pass around all these spaces, and that also leading directly to the chimney, are controlled by dampers, so that the heat can be directed along any desired course.

Both as a heating and cooking agent coal gas is now being largely used, and many forms of stoves have been devised to meet its peculiar conditions as a gaseous fuel. Gas stoves present the obvious advantages of cleanliness, comparative freedom from smoke, and immediate readiness for use; and the flame and heat are under the most perfect control. Gas is used in open fireplaces as well as in stoves, a most efficient open heating arrangement being that devised by the late Sir Chas. W. Siemens, in which a combined fire of charcoal and coal gas is made. Small lamp stoves for burning mineral oils are also in use; but they share the serious disadvantage of certain simple gas stoves, from which the whole products of combustion pass into the room in which they are placed.

Fireplaces are entirely open in front; they radiate heat into the apartment; and flame, smoke, etc., pass direct into the chimney. The rapid passage of the heated air into the chimney carries away a large proportion of the heat, and this loss is particularly great in grates made entirely of iron. In modern grates of good quality the sides and back of the fire-basket are of fire-brick, which retains and throws out much heat. In slow-combustion grates the fire-basket is set low on the hearth, and air is admitted to the fuel only through the fire-bars in front. The back of the grate slopes in towards the hearth, where the fire space is comparatively narrow. By means of a door sliding down over the front from the upper part of the grate, the indraught of air can be modified at pleasure. In ventilating fireplaces the fire-basket is of iron lined with fire-brick, and in the space between the back of the grate and the wall flues are formed which are heated from the fire. Into these flues air from without is introduced, which, after being there warmed passes into the apartment at suitable openings.

STOW, John (1525–1605), historian and antiquary, was the son of Thomas Stow, a tailor, and was born in London, in the parish of St. Michael, Cornhill, in 1525. His parents do not appear to have been rich, for his father's whole rent for his house and garden was only 6s. 6d. [$1.58] a year, and Stow himself in his youth went every morning to fetch the milk for the family from a barn belonging to the nunnery of Minories. He learned the trade of his father, but possibly did not practice it much after he grew up to manhood. In 1549 he "kept house" near the well within Aldgate, but afterwards he removed to Lime Street ward, where he resided till his death. His first publication was *A Summary of Englische Chronicles* in 1561, which was frequently reprinted, with slight variations, during his lifetime. Of the first edition a copy was said to have been at one time in the Grenville library. In the British Museum there are at present copies of the editions of 1567, 1573, 1587, 1590, 1598, and 1604. Stow having in his dedication of 1567 referred to the rival publication of Richard Grafton in contemptuous terms, the dispute between them became extremely embittered. Stow's antiquarian tastes brought him under ecclesiastical suspicion as a person "with many dangerous and superstitious books in his possession," and in 1568 Grindal, bishop of London, caused his study to be searched. An inventory was taken of certain books he possessed "in defence of Papistry," but he was apparently able to satisfy his interrogators of the soundness of his Protestantism. A second attempt to incriminate him in 1570 was also without result. In 1580 Stow published his *Annales, or a Generale Chronicle of England from Brute until the present yeare of Christ* 1580; it was reprinted in 1592, 1601, and 1605, the last being continued to the 26th March, 1605, or within ten days of his death; editions "amended" by Howes appeared in 1615 and 1631. The work by which Stow is best known is his *Survey of London*, published in 1598, not only interesting from the quaint simplicity of its style and its amusing descriptions and anecdotes, but of unique value from its minute account of the buildings, social condition, and customs of London in the time of Elizabeth. A second edition appeared in his lifetime in 1603, a third with additions by Anthony Munday in 1618, a fourth by Munday and Dyson in 1633, a fifth with interpolated amendments by Strype in 1720, and a sixth by the same editor in 1754. The edition of 1598 was reprinted, edited by W. J. Thoms, in 1842, in 1846, and with illustrations in 1876. Through the patronage of Archbishop Parker Stow was enabled to print the *Flores Historiarum* of Matthew of Westminster in 1567, the *Chronicle* of Matthew Paris in 1571, and the *Historia Brevis* of Thomas Walsingham in 1574. At the request of Parker he had himself compiled a "farre larger volume," but circumstances were unfavorable to its publication and the manuscript is now lost. Additions to the previously published works of Chaucer were twice made through Stow's "own painful labours" in editions of 1561 and 1597. A number of Stow's manuscripts are in the Harleian collection in the British Museum. Some are in the Lambeth Library (No. 306); and from the volume which includes them were published by the Camden Society, edited by James Gairdner, *Three Fifteenth-Century Chronicles, with Historical Memoranda by John Stowe the Antiquary, and Contemporary Notes of Occurrences written by him* (1880). Stow's literary labors did not prove very remunerative, but he accepted poverty in a cheerful spirit. Ben Jonson relates that once when walking with him Stow jocularly asked two mendicant cripples "what they would have to take him to their order." This favor he, however, obtained from King James, who in

March, 1604, authorized him and his deputies to collect "amongst our loving subjects their voluntary contributions and kind gratuities," and himself began "the largesse for the example of others." If the royal appeal was successful Stow did not live long to enjoy the increased comfort resulting from it, as he died on the 6th April following. He was buried in the church of St. Andrew Undershaft, where the monument erected by his widow, exhibiting a terra-cotta figure of him, still remains.

STOWELL, William Scott, Baron (1745–1836), one of the ablest and most accomplished of English judges, especially in international law, was born at Heworth, a village about four miles from Newcastle, on 17th October, 1745. His father was a "coalfitter" (or tradesman engaged in the transport of coal); his mother was the daughter of a small tradesman, Atkinson by name; his younger brother John became the famous Lord Chancellor Eldon (*q.v*). Scott was educated at the Newcastle grammar school under the able tuition of the Rev. Hugh Moises. In February, 1761, he gained a Durham scholarship at Corpus Christi College, Oxford, and was immediately admitted as a student of the university. In 1764 he graduated as bachelor of arts, and became first a probationary fellow and then—as successor to William (afterwards the well-known Sir William) Jones—a tutor of University College. In 1767 he took his M.A. degree. In 1772 he graduated as bachelor of civil law. As Camden reader of ancient history he rivalled the reputation of Blackstone (1774). Although he had joined the Middle Temple in 1762 (June 24), it was not till 1776 that Scott devoted himself to a systematic study of law. In 1779 (June 23) he graduated as doctor of civil law, and, after the customary "year of silence," commenced practice in the ecclesiastical courts. His professional success was rapid. In 1783 he became registrar of the Court of Faculties, and in 1788 judge of the Consistory Court and advocate-general, in that year too receiving the honor of knighthood; and in 1798 he was made judge of the High Court of Admiralty. Sir William Scott twice contested the representation of Oxford university,—in 1780 without success, but successfully in 1801. He also sat for Downton in 1790. Upon the coronation of George IV. (1821) he was raised to the peerage as Baron Stowell. After a life of distinguished judicial service Lord Stowell retired from the bench,—from the Consistory Court in August, 1821, and from the High Court of Admiralty in December, 1827. His mental faculties became gradually feebler in his old age, and he died on January 28, 1836. Lord Stowell was twice married,—on April 7, 1781, to Anna Maria, eldest daughter and heiress of John Bagnall of Early Court, Berks, and on April 10, 1813, to the dowager marchioness of Sligo. By his first marriage he had four children, of whom two (a son and a daughter) died in infancy, a third (a son) died unmarried in middle life, while the eldest (a daughter) was twice married and survived her father.

Lord Stowell's judgments are models alike of literary execution and of judicial reasoning. His style is chaste yet not inornate, nervous without abruptness, and perfectly adjusted in every instance to the subject with which he deals. His decisions in the cases of Dalrymple *v.* Dalrymple (Dr. Dodson's *Report*) and Evans *v.* Evans (1 Hagg., 35)—from their combined force and grace, from the steadiness with which every collateral issue is set aside, from their subtle insight into human motives, and from the light which they cast on the philosophy and dark history of marriage law—deserve and will repay attentive perusal. Lord Stowell composed with great care, and some of the MSS. which he revised for Haggard and Phillimore's *Reports* were as full of interlineations as a bill of the Lower House corrected by the Lords. Stowell's mind was judicial rather than forensic,—reasoning, not as for a dialectic victory nor so as to convince the parties on whose suit he was deciding, but only with sufficient clearness, fulness, and force to justify the decision at which he had arrived.

The chief doctrines of international law with the assertion and illustration of which the name of Lord Stowell is identified are these: The perfect equality and entire independence of all states (Le Louis, 2 Dod., 243)—a logical deduction from the Austinian philosophy and still one of the fundamental principles of English jurisprudence; that the elementary rules of international law bind even semi-barbarous states (Hurtige Hans, 2 Rob., 325); that blockade to be binding must be effectual (The "Betsey," 1 Rob., 93); that there cannot be a legal where there is no actual blockade; and that contraband of war is to be determined by "probable destination" (The "Jonge Margaretha," 1 Rob., 189). In the famous Swedish convoy case (The "Maria," 1 Rob., 350; see too The "Recovery," 6 C. Rob., 348–9) Lord Stowell, in defiance of the complaints of those greedy merchants who, as Pufendorf, himself by choice a Swedish civilian, tells us, cared not how things went provided they could but satisfy their thirst of gain, asserted that "a prize court is a court not merely of the country in which it sits but of the law of nations." "The seat of judicial authority," he added, in words which have become classic, "is indeed locally here, in the belligerent country, but the law itself has no locality."

The judgments of Lord Stowell were, almost without exception, confirmed on appeal, are to this day the international law of England, and have become presumptive though not conclusive evidence of the international law of America. "I have taken care," wrote Justice Story, "that they shall form the basis of the maritime law of the United States, and I have no hesitation in saying that they ought to do so in that of every civilized country in the world."

See Townsend, *Lives of Twelve Eminent Judges*, vol. ii.; *Quarterly Review*, vol. lxxv.; W. E. Surtees, *Sketch of Lords Stowell and Eldon*; Creasy, *First Platform of International Law*; *Decisions*, by Dodson and Haggard.

STRABISMUS. See Ophthalmology, vol. xvii. p. 807.

STRABO, the famous geographer and historian, was born at Amasea in Pontus, a city which had been Hellenized to a great extent. Of his father's family we know nothing; but several of his mother's relations, who were probably Greeks, had held important posts under Mithradates Euergetes and his famous son Mithradates Eupator. Dorylaus, a distinguished general of Mithradates Euergetes, was the great grandfather of Strabo's mother. After the murder of that king, Dorylaus, who at that time was collecting mercenaries in Crete, where he had obtained the command in a successful war of the Cnossians against Gortyn, settled at Cnossus. By Sterope, a Macedonian, he had a daughter and two sons,—Lagetas and Stratarchus. Dorylaus had a brother Philetærus, whose son Dorylaus was brought up with Mithradates Eupator. This king, at the instance of his friend invited back to Pontus the family of Dorylaus, who was himself now dead, as was also his son Lagetas. Strabo saw Stratarchus in extreme old age. The daughter of Lagetas was the mother of Strabo's mother. Moaphernes, an uncle of Strabo's mother, probably on the father's side, was governor of Colchis under Mithradates Eupator. His mother's father must have held an important position, for, seeing the impending downfall of the king, and also in anger against him for having put to death his kinsmen Tibius and Theophilus, he handed over fifteen forts to Lucullus. In spite of this, with the ruin of the king the fortunes of the family fell. since Pompey refused to ratify the rewards promised by Lucullus.

Life.—Though the exact date of Strabo's birth is unknown, a close approximation is possible. Clinton places it not later than 54 B.C. The most probable date lies between 64 and 62, since he speaks of certain events occurring at the former as "a little before my time," whilst he describes an occurrence in the latter year as "in my own time," phrases which he uses elsewhere with great exactness in speaking of persons and events. He received a good education in the Greek poets, especially Homer; he studied at Nysa under the grammarian Aristodemus, under Tyrannio the grammarian at Rome, under the philosopher Xenarchus either at Rome or Alexandria, and he had studied Aristotle along with Boethus (possibly at

Rome under Tyrannio, who had access to the Aristotelian writings in Sulla's library). It is to be noted that from none of those teachers was he likely to learn mathematics or astronomy. He was at Corinth in 29 B.C., where he saw Octavian on his return from Egypt to celebrate his triumph for Actium. He was in Egypt in 24 B.C., and took the opportunity of ascending the Nile in company with the prefect Ælius Gallus. He was at Rome after 14 A.D., for he describes (v. 236) as an eyewitness the place where the body of Augustus was burnt in the Campus. He was still writing in 21 A.D. The date of his death is unknown. Strabo's statement that he saw P. Servilius Isauricus has caused some difficulty. This Servilius died at Rome in 44 B.C. at an advanced age. Some suppose that Strabo confused him with P. Servilius Casca, also called Isauricus, or some other distinguished Roman whom he had seen in Asia, but by his words he clearly means the conqueror of the Isaurians. This difficulty only arises from an entirely unwarranted assumption that Strabo was on his way to Rome for the first time in 29 B.C. We have seen that he studied under Tyrannio in that city; if he did so after 29 B.C. Tyrannio must have been very old, which Strabo would probably have mentioned, as he does in the case of Aristodemus. Although he had seen a comparatively small portion of the regions which he describes, he had travelled much, as he states himself: "Westward I have journeyed to the parts of Etruria opposite Sardinia; towards the south from the Euxine to the borders of Ethiopia; and perhaps not one of those who have written geographies has visited more places than I have between those limits. For those who have gone farther west have not gone so far eastward, and the case is the same with the regions between the northern and southern limits." The fulness of his description in certain places, contrasted with the meagreness and inaccuracy in others, seems to indicate that in the former cases he had actually visited the places, but that he is dependent on second-hand information for the latter. He tells us that he had seen Egypt as far south as Syene and Philæ, Comana in Cappadocia, Ephesus, Mylasa, Nysa and Hierapolis in Phrygia, Gyarus, and Populonia. Of Greece proper he saw but little; he visited Corinth, Athens, Megara, and places in their vicinity, and perhaps Argos, although he was not aware that the ruins of Mycenæ still existed; he had seen Cyrene from the sea, probably on his voyage from Puteoli to Alexandria. He remained at the latter place a long time, probably amassing materials, and studying astronomy and mathematics. For nowhere could he have had a better means of consulting the works of historians, geographers, and astronomers, such as Eratosthenes, Posidonius, Hipparchus, and Apollodorus. When and where he went from Egypt we know not. It has been commonly assumed that he returned home to Amasea. For this there are no grounds. Probabilities are in favor of his having returned to Rome, where he undoubtedly resided in his old age. The place of his death is unknown; but, since we find him at Rome in what must in the course of nature have been the closing years of his life, it is not unreasonable to suppose that there he died. Various passages in his work indicate that he held by the Stoic rule.

Works.—His earliest writings were two (not one, as commonly stated) historical works now lost, which he himself describes (xi. 515) as his *Historical Memoirs* and his *Continuation of Polybius*. There can be no doubt but that these were two distinct works; for he speaks (ii. 70) of having treated of the exploits of Alexander in his *Memoirs*, a topic which could not have found a place in a work which began where that of Polybius ended (146 B.C.) According to Suidas, the continuation of Polybius was in forty-three books. Plutarch, who calls him "the Philosopher," quotes Strabo's *Memoirs* (*Luc.*, 28), and cites him as an historian (*Sulla*, 26.) Josephus, who constantly calls him "the Cappadocian," often quotes from him, but does not mention the title of the work.

The *Geography* is the most important work on that science which antiquity has left us. It was, as far as we know, the first attempt to collect all the geographical knowledge at the time attainable, and to compose a general treatise on geography. It must not be regarded as nothing more than a new edition of Eratosthenes. In general outline it follows necessarily the work of the last-named geographer, who had first laid down a scientific basis for geography on which his successors could not help building. Strabo made considerable alterations, but not always for the better. The three books of the older work formed a strictly technical geographical treatise. Its small size prevented it from containing any such general description of separate countries as Strabo rightly conceived to fall within the scope of the geographer. "Strabo indeed appears to be the first who conceived a complete geographical treatise as comprising the four divisions of mathematical, physical, political, and historical geography, and he endeavored, however imperfectly, to keep all these objects in view." Moreover, the incidental historical notices, which are often of great value and interest, are all his own. These digressions at times interrupt the symmetry of his plan; but Strabo had all the Greek love of legendary lore, and he discusses questions relating to the journeyings of Heracles as earnestly as if they were events within recent history. He regarded Homer as the source of all wisdom and knowledge, and consequently accepted the Homeric geography in its entirety, as needing only proper explanation for the removal of all difficulties. On the other hand, he treats the work of Herodotus with undeserved contempt, and classes him with Ctesias and other "marvel-mongers"; and yet in some respects Herodotus had better information—for instance, in regard to the Caspian—than that possessed by Strabo himself. Again, Strabo may be censured for discarding the statements of Pytheas respecting the west and north of Europe, accepted as they had been by Eratosthenes. But in this he relied on Polybius, whom he might justly consider as having from his position at Rome far better means of gaining accurate information about those regions. A critical sagacity far stronger than that of Strabo might well have erred at a time when the data for forming accurate judgments on such questions were so meagre and chaotic. It must be admitted that the statements of Pytheas did not accord with the theory of Strabo just in those very points where he was at variance with Eratosthenes. He showed likewise an unwarranted skepticism in reference to the island of Cerne on the west coast of Africa, which without doubt the Carthaginians had long used as an emporium. Strabo has been censured for not making a greater use of Roman authorities. Although the Roman arms had opened up much of the north and west, he follows the Greek writers almost exclusively in his description of Spain, Gaul, Britain, Germany, and even Italy. For although he refers to Cæsar's *Commentaries* once by name, and has evidently made use of them in other passages, he but imperfectly availed himself of that work. He designed his geography as a sequel to his historical writings, and it had as it were grown out of his historical materials. Such materials were chiefly Greek. We cannot wonder if a man who at an advanced age has commenced a new work utilizes his old material, and has not the energy to undertake fresh researches. Again, if Strabo amassed his material in the library of Alexandria, Greek authorities would naturally furnish the great bulk of his collections. This involves the questions—When and where did he compose the work? He began it probably later than 9 B.C. For he says that, just as Alexander had opened up knowledge of the East, so the Roman arms had now opened up the geography of the West as far as the Elbe. This

Drusus accomplished in 9 B.C. Strabo was still engaged on the work, or certain parts of it, in 19 A.D., for he mentions in the fourth book the conquest of the Taurisci as having taken place thirty-three years before; he also speaks, in the sixth book, of Germanicus, who died in 20 A.D., as still alive, and in the seventeenth book he speaks of the death of Juba II. (21 A.D.) as a recent event. As it is not probable that he wrote for the first time all of his work except the first three books between 19 and 21 A.D., we must not make use of these passages as data for determining the date of composition of the whole work, or even of particular books, but rather ought we to regard them as insertions. Strabo, as already pointed out, was at Rome, after the death of Augustus (14 A.D.); in book vii. 290 and in book xiii. 609 he uses the terms "here" and "hither" in reference to Rome. It may be inferred from these passages that Strabo certainly revised, if he did not write, the entire work at Rome. If he returned to Rome after a long sojourn in Alexandria, this explains the defectiveness of his information about the countries to the east of his native land, and renders it possible for him to have made use of the chorography of Agrippa, and to have obtained the few incidents from Roman sources which here and there appear in his work.

He designed the work for the statesman rather than for the student. He therefore endeavors to give a general sketch of the character, physical peculiarities, and natural productions of each country, and consequently gives us much valuable information respecting ethnology, trade, and metallurgy. It was almost necessary that in such an attempt he should select what he thought most important for description, and at times omit what we deem of more importance. With respect to physical geography, his work is a great advance on all preceding ones. Judged by modern standards, his description of the direction of rivers and mountain-chains seems defective, but allowance must be made for difficulties in procuring information, and for want of accurate instruments. In respect of mathematical geography, his want of high scientific training was of no great hindrance. He had before him the results of Eratosthenes, Hipparchus, and Posidonius. The chief conclusions of astronomers concerning the spherical figure and dimensions of the earth, its relation to the heavenly bodies, and the great circles of the globe—the equator, the ecliptic, and the tropics—were considered as well established. He accepted also the division into five zones; he quotes approvingly the assertion of Hipparchus that it was impossible to make real advances in geography without astronomical observations for determining latitudes and longitudes.

The work consists of seventeen books, of which the seventh is imperfect. The first two books form a general introduction; the next ten deal with Europe, the four following with Asia, and the last with Africa. The first two books are meant to comprise a general survey of the progress of geography from the earliest times down to his own day. Unmethodical though they are, we owe to these books almost all we know of the geographical systems of his predecessors, especially that of Eratosthenes. Unfortunately he contents himself with disjointed criticism of detail instead of giving us an orderly statement of the previous systems. The first book begins with his claim to have geography regarded as a branch of philosophy, and he supports this claim by enumerating the philosophers who have studied it, beginning from Homer, as proofs of whose knowledge he adduces his acquaintance with the Ocean, the Ethiopians, and the Scythians. This discussion of Homer's geography takes up more than half the book. Passing over the early geographers, not even mentioning Herodotus, he censures Eratosthenes for using unreliable authorities, and for casting doubts on the voyages of Jason and other early navigators. He next criticizes the physical views of Eratosthenes concerning the changes in the earth's surface, and especially the hypothesis, adopted from Strato, that by sudden disruptions of land the Euxine and Mediterranean had become united to the ocean, and had sunk to their present level, which theory they supported by pointing to sea-shells at places high above the sea. This doctrine Strabo rightly rejected, and referred such phenomena to those changes which with constant operation produce subsidences and elevations of the land; and he quotes many instances of places engulfed by earthquakes, the disappearance of some islands, and the appearing of others. Hence he thinks it possible that even Sicily has been thrown up by the fires of Etna. Sir C. Lyell eulogizes Strabo's geological speculations for a soundness of view very unusual on such subjects amongst the ancients. Examining the second book of Eratosthenes, he discusses the length and breadth of the inhabited world, and its division into three continents. He blames Eratosthenes for believing Pytheas and denies the existence of Thule, consequently rejecting the latitude assigned to it by Eratosthenes, who had taken it as the northernmost limit of the inhabited world. Strabo holds Ierne (Ireland), which lies north of Britain, to be the farthest land in that direction, and brings the northern limit much farther south. As he adopts Eratosthenes's southern limit,—that through the Cinnamon Region and Taprobane (Ceylon),—it follows that in his view Eratosthenes had made the inhabited world too broad. As the Greeks assumed that the world was twice as long as it was broad, Eratosthenes accordingly had made it too long likewise; but, though Strabo shortens it on the west, there is no material difference between him and Eratosthenes. In this connection he gives his remarkable speculation that as the inhabited world was only one-third of the globe's circumference, there might be two or more inhabited worlds besides. In the second book he discusses the changes introduced by Eratosthenes, and rightly defends him from the attacks of Hipparchus. He adopts for Asia the map of Eratosthenes as a whole, for little additional knowledge had been gained in the interval. He even still regards the Caspian as opening into the Northern Ocean, as stated by Patrocles. In the general outline of Africa he makes no change, but he rejects the statement of Eratosthenes about Cerne. It is with respect to western and northern Europe that Strabo had knowledge denied to Eratosthenes. Roman conquest had opened up many places and peoples, yet his general map of Europe is inferior to that of his predecessor. After discussing the "seals" of Eratosthenes, he considers the views of Posidonius and Polybius, and recounts the voyages of Eudoxus of Cyzicus. Then having dealt with the division into zones, due to Parmenides, he states his own views, discussing briefly the mathematical geography; the earth is spherical and placed in the centre of the universe; he assumes five zones, and the circles on the sphere—the equator, the ecliptic or zodiac, the tropics, and the arctic circles; he assumes the earth's circumference as given by Eratosthenes, 252,000 stades (= 25,200 geographical miles), and his division of the great circle into sixtieth parts; the habitable world, the geographer's proper province, shaped like a chlamys, occupies a quadrilateral space in the northern hemisphere, filling little more than one-third of the north temperate zone; its maximum length is 70,000 stades, its breadth less than 30,000 stades. Whilst correcting the error by which his predecessors placed Massilia and Byzantium in the same latitude, he falls into an equal mistake by placing the former city two degrees south, instead of two degrees north of Byzantium. As Massilia is his cardinal point for measurements, this error distorts his whole map of the Mediterranean and western Europe, the mouths of the Rhine and Danube being in the same latitude. He next gives directions for making a plane map of the world, as a globe of sufficient size, like that of Crates, is too cumbrous. All lines that are circles on a globe must be straight lines on the map. Before describing each country in detail, he gives a general sketch of the habitable world with reference to seas, continents, and peoples, and explains the doctrine of climate and of the shadows projected by objects in consequence of the sun's varying position with respect to them. In the third book, starting from the Straits, he begins his description with Iberia, which he likens in shape to a bull's hide. His chief authorities were Artemidorus, whom he uses for the coasts of the Mediterranean and ocean generally, Eratosthenes, Posidonius, Polybius, Pherecydes, Timosthenes, Asclepiades, Myrleanus, and Dicæarchus. He gives a valuable account of the Roman administrative system, probably gained from his own inquiries, also of the native tribes, of the mines and methods of mining, and of the remains of the Greek and Phœnician settlements; he describes the Balearic Isles, following Artemidorus, and at the end of the book mentions the Cassiterides, which he seems to have identified with the Scilly Isles, probably erroneously, and describes their inhabitants as wearing long black garments, and walking about with long wands in their hands, looking like the Furies of tragedy. It is remarkable that he has no notion of the proximity of the Tin Islands to Britain, but treats them in connection with Spain. The fourth book deals with Gaul in its fourfold division under Augustus, gives a meagre account of Britain, its trade and relations with Rome, and mentions Ireland, the natives of which were said to be cannibals and to hold their women in common, and finally treats of the Alps. His authorities were Posidonius, who had travelled in Gaul and Britain, Artemidorus, Ephorus, Timagenes, Aristotle, Polybius, Asinius Pollio, and Cæsar. For Britain Pytheas, as quoted by others, furnished some important details. His description of Gallia Narbonensis is fuller than that of the rest of Gaul. He mentions the four great Roman roads converging at Lyons, probably following the chorography of Agrippa. He conceives the Pyrenees as running north and south, and parallel to the Rhine, and Britain as lying north of Gaul, extending from the Pyrenees to the Rhine's mouths. Of the Alpine region he gives an excellent description. He undoubtedly must have gathered much information for this book at Rome. The fifth and sixth books contain an accurate description of Italy and the adjacent islands. Besides his own observation he used Eratosthenes, Polybius, Artemidorus, Ephorus, Fabius Pictor, Cœlius, Antiochus of Syracuse for southern Italy, and the "chorographer," who was certainly a Roman, as he gave his distances in miles, and who probably was Agrippa, the chief objection to such an authorship being the wrong assumption that Strabo was not in Italy after 24 B.C., whilst Agrippa's work was not published until after his death 12 B.C. The sixth book ends with a short but valuable sketch of the extent and condition of the Roman empire. The seventh comprises northern and eastern Europe, both north and south of the Danube, Illyricum, Pannonia, Dalmatia, the coast of Thrace and the Euxine, and Epirus. The part which dealt with Macedonia and Thrace is only known to us from the epitomes. We do not know his authorities for the German tribes, but he probably used Roman materials. For the other northern tribes he had Posidonius, whilst for the region south of the Danube he had Aristotle's lost work on *Polities*, Polybius, Posidonius, Theopompus, and Ephorus. The eighth, ninth, and tenth books contain his description of the mainland of Greece and the islands, which he treats rather as an antiquarian than a geographer, using chiefly, besides Homer, Apollodorus, Demetrius of Scepsis, Ephorus, and Eudoxus. Personally he had but little knowledge. With the eleventh begins Asia. Divided from Europe by the Don, it is split up into two large masses by the Taurus. Beginning with the region bounded by the Taurus, Caspian, and Euxine, he next describes the parts east of the Caspian, then those south of the Caucasus, Media, and Armenia. His authorities are Artemidorus, Eratosthenes, Theophanes, Herodotus, Apollodorus of Artemita, Patrocles, Metrodorus of Scepsis, Hypsicrates of Amisus, Posidonius, and Aristobulus. In the twelfth he describes Asia Minor, basing his description on oral information, personal observation, and the Greek writers. In the thirteenth he continues with Asia Minor, devoting much space to the Troad, his sources being Demetrius, Menecrates, and the Greek mythographers. With the fourteenth he ends Asia Minor and the islands lying off it, using, in addition to the authorities for the last, Pherecydes, Thucydides, Anaximenes of Lampsacus, Herodotus, Ephorus, Artemidorus, Eratosthenes, and Posidonius. The fifteenth deals with India and Persia, giving much valuable information from Patrocles, Aristobulus, Nearchus, the historians of the campaigns of Alexander and Seleucus, and with reserve from Megasthenes, Onesicritus, Deimachus, and Clitarchus. In the sixteenth he treats of Assyria, under which he includes Babylonia and Mesopotamia, Syria, Phœnicia, Palestine, the Persian Gulf, the Red Sea and the coast of Ethiopia, and Arabia. For Asia he used the historians of Alexander, Eratosthenes and Herodotus; for Judæa and Syria probably Posidonius, himself a native of Apamea; for Arabia and the coast of Libya Eratosthenes and Artemidorus, the latter of whom followed Agatharchides of Cnidus. Strabo must have got many details about Arabia from Ælius Gallus and the Stoic Athenodorus. The last book comprises Egypt, Ethiopia, and the north coast of Libya. He describes Egypt from his own observation, having gained much information at Alexandria in addition to that of Eudoxus, Aristo, Eratosthenes, Polybius, and Posidonius, using the last three with the addition of Iphicrates for Libya, and for Ethiopia Petronius, Herodotus, and Agatharchides. Though probably acquainted with the work of Juba, he did not make much use of it. The book concludes with a summary of the provinces of the Roman empire, as organized by Augustus into senatorial and imperial.

EDITIONS.—Aldus, Venice, 1516; Hopper and Heresbach, Basel, 1549; Xylander, Basel, 1571; Casaubon, Geneva, 1587, Paris, 1620 (Casaubon revised the text); Almeloveen, Amsterdam, 1707, reprinted Casaubon's text; Falconer, Oxford, 1807, reprinted Almeloveen's text; Siebenkees and Tzschucke, Leipsic, 1811; Koray, Paris, 1815-18, the first really critical edition; Kramer, Berlin, 1844-52; C. Müller, Paris, 1853; Meineke, Leipsic, 1877. TRANSLATIONS.—*Latin:* Guarini and Gregorio, 1471; Xylander, 1571. *French:* Koray and Letronne, 1805-19. *German:* Groskurd, 1833 (with dissertations). *Italian:* Ambrosoli, 1828. DISSERTATIONS, ETC.—Bunbury, *Ancient Geography;* Heeren; Hasenmüller; Niese, *Hermes*, 1878. (W. BI.)

STRADELLA, ALESSANDRO, composer, singer, and performer on various instruments, was one of the most accomplished Italian musicians of the 17th century. The generally accepted statement that he was born at Naples about 1645 rests upon no trustworthy foundation; and the few biographical notices that we possess savor so strongly of romance that we can only be said to know him truly through his works, which show extraordinary genius, and have exercised a highly beneficial influence upon Italian art. The story of his life was first circumstantially narrated in Bonnet-Bourdelot's *Histoire de la Musique et de ses Effets* (Paris, 1715). According to this account, Stradella not only produced some successful operas at Venice, but also attained so great a reputation by the beauty of his voice that a Venetian nobleman engaged him to instruct his mistress, Ortensia, in singing. Stradella, the narrative goes on to say, shamefully betrayed his trust, and eloped with Ortensia to Rome, whither the outraged Venetian sent two paid *bravi* to put him to death. On their arrival in Rome the assassins learned that Stradella had just completed a new oratorio, over the performance of which he was to preside on the following day at S. Giovanni in Laterano. Taking advantage of this circumstance, they determined to kill him as he left the church; but the beauty of the music affected them so deeply that their hearts failed them at the critical moment, and, confessing their treachery, they entreated the composer to insure his safety by quitting Rome immediately. Thereupon Stradella fled with Ortensia to Turin, where, notwithstanding the favor shown to him by the regent of Savoy, he was attacked one night by another band of assassins, who, headed by Ortensia's father, left him on the ramparts for dead. Through the connivance of the French ambassador the ruffians succeeded in making their escape; and in the meantime Stradella, recovering from his wounds, married Ortensia, by consent of the regent, and removed with her to Genoa. Here he believed himself safe; but a year later he and Ortensia were murdered in their house by a third party of assassins in the pay of the implacable Venetian.

Bonnet-Bourdelot gives 1670 as the date at which the assassination actually took place; but the oratorio *San Giovanni Battista*, assumed to be that which saved its author's life, is dated "Roma, 1676"; and a cantata, called *Il Barcheggio*, is known to have been composed by Stradella for the marriage of Carlo Spinola and Paola Brignolo in 1681. These discrepancies are not, however, of sufficient moment to justify the rejection of Bonnet-Bourdelot's account, which has been accepted as genuine by Burney, Hawkins, Fétis, and many other careful writers, including the remarkably accurate and conscientious Wanley.[1] And it must be remembered, in its defence, that Pierre Bourdelot, by whom the materials for the *Histoire de la Musique et de ses Effets* were originally compiled, was an actual contemporary of Stradella, and died as early as 1685, when a host of the composer's friends must still have been living, and able to give evidence on the subject of his fate. It seems therefore only reasonable to assume that the main facts of the narrative are correctly given, though the dates may need confirmation; while for the embroidered versions of later writers the authors of the *Histoire* are certainly not responsible.

The finest collection of Stradella's works extant is that at the Biblioteca Palatina at Modena, which contains 148 MSS., including eleven operas and six oratorios. A collection of *canti a voce sola* was bequeathed by the Contarini family to the library of St. Mark at Venice; and some MSS. are also preserved at Naples and in Paris. Eight madrigals, three duets, and a sonata for two violins and bass will be found among the Additional MSS. at the British Museum, five pieces among the Harleian MSS., and eight cantatas and a motet among those in the library at Christ Church, Oxford. Very few of these compositions have been published; but an extremely beautiful *aria di chiesa*, entitled *Pietà Signore*,[1] has been frequently printed under the name of Stradella, and popularly accepted as the air which produced so marvellous an effect upon the assassins. The piece, however, is not to be found in *San Giovanni Battista;* and its style so little resembles that of Stradella's other works that no less decisive evidence than the discovery of an undoubted autograph could justify its ascription to him. On the other hand, no more extravagant mistake could be made than that of describing it, as some have done, as a forgery, perpetrated either by Fétis, Rossini, or Niedermeyer. Not one of these great musicians could have written it; and it is certainly no forgery, but a genuine work of the 17th century or the opening decade of the 18th. In the absence of trustworthy documentary evidence, all attempts to ascertain the real authorship of the piece must necessarily end in mere conjecture; but the extraordinary similarity of its style to that cultivated by Francesco de' Rossi, who is known to have been flourishing at Bari at the time of Stradella's death, is very significant.

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[1] See No. 1272 in *Cat. Harl. MSS.*, *Brit. Mus.* Wanley, however, believed Stradella alone to have been murdered and the lady to have escaped.

Much controversy has also been excited by another work, lately attributed to Stradella, viz., a *serenata* for voices and instruments, of which two copies only are known to exist, —one at the Conservatoire at Paris, and the other, a late transcript, now at the Royal College of Music in London. The date of this *serenata* is absolutely unknown. Of evidence proving it to be a genuine work by Stradella there is none in existence. Yet the question of its authenticity is a most important one, for upon the strength of it Handel may perhaps be some day gravely accused of having stolen from the Italian composer some of the finest passages in *Israel in Egypt*.

The compositions of Stradella are remarkable for their graceful form and the tenderness of their expression. Detached movements will be found in Burney's *History of Music* and the modern collection called *Gemme d' Antichità*.

STRADIVARIUS. See VIOLIN.

STRAFFORD, THOMAS WENTWORTH, EARL OF (1593–1641), son of Sir William Wentworth, of Wentworth Woodhouse, near Rotherham, was born in 1593 in Chancery Lane, London. He was educated at St. John's College, Cambridge, and in 1611 was knighted, and married Margaret, daughter of Francis, earl of Cumberland. In 1614 he represented Yorkshire in the Addled Parliament, but, as far as is now known, it was not till the parliament of 1621 that he took part in the debates. His position towards the popular party was peculiar. He did not sympathize with their eagerness for war with Spain, and he was eager, as no man of that time except Bacon was eager, for increased activity in domestic legislation. He was what, in modern times, would be called a reformer, and in those days a reformer was necessarily an upholder of the authority of the crown, in whose service the most experienced statesmen might be expected to be found, whilst the members of a House of Commons only summoned at considerable intervals would be deficient in the qualities necessary for undertaking successful legislation. On the other hand, James's conduct of the diplomatic struggle with Spain was not such as to inspire confidence, and Wentworth's bearing was therefore marked by a certain amount of hesitation. He was, however, more than most men prone to magnify his office, and James's contemptuous refusal to allow the House of Commons to give an opinion on foreign politics seems to have stung him to join in the vindication of the claims of the House of which he was a member. He was at all events a warm supporter of the protestation which drew down a sentence of dissolution upon the third parliament of James.

In 1622 Wentworth's wife died, and in February, 1625, he married Arabella Holles, the daughter of the earl of Clare. Of the parliament of 1624 he had not been a member, but in the first parliament of Charles I. he again represented Yorkshire, and at once marked his hostility to the proposed war with Spain by supporting a motion for an adjournment before the House proceeded to business. His election was declared void, but he was re-elected. When he returned to parliament he took part in the opposition to the demand made under the influence of Buckingham for war subsidies, and was consequently, after the dissolution, made sheriff of Yorkshire, in order to exclude him, as hostile to the court, from the parliament which met in 1626. After the dissolution of that parliament he was dismissed from the justiceship of the peace and the office of *custos rotulorum* of Yorkshire.

Wentworth's position was very different from that of the regular opposition. He was anxious to serve the crown, but he disapproved of the king's policy. "My rule," he wrote December, 1625, "which I will never transgress, is never to contend with the prerogative out of parliament, nor yet to contest with a king but when I am constrained thereunto or else make shipwreck of my peace of conscience." In January, 1626, he had asked for the presidency of the Council of the North, and had visited and made overtures to Buckingham. His subsequent dismissal was probably the result of his resolution not to support the court in its design to force the country to contribute money without a parliamentary grant. At all events, he refused in 1627 to contribute to the forced loan, and was placed in confinement in Kent for his refusal.

Wentworth's position in the parliament of 1628 was a striking one. He joined the popular leaders in resistance to arbitrary taxation and imprisonment, but he tried to obtain his end with the least possible infringement of the prerogative of the crown, to which he looked as a reserve force in times of crisis. With the approbation of the House he led the movement for a bill which would have secured the liberties of the subject as completely as the Petition of Right afterwards did, but in a manner less offensive to the king. The proposal was wrecked upon Charles's refusal to make the necessary concessions, and the leadership was thus snatched from Wentworth's hands by Eliot and Coke. Later in the session he fell into conflict with Eliot, as, though he supported the Petition of Right in substance, he was anxious to come to a compromise with the Lords, so as to leave room to the king to act unchecked in special emergencies.

On July 22, 1628, not long after the prorogation, Wentworth was created Lord Wentworth, and received a promise of the presidentship of the Council of the North at the next vacancy. Even on political matters he had never been quite at unison with the parliamentary opposition, and in church matters he was diametrically opposed to them. Since the close of the discussion on the Petition of Right, church matters had come into greater prominence than ever, and Wentworth was therefore thrown strongly on the side of Charles, from whom alone opposition to Puritanism could possibly come. This attachment to Charles was doubtless cemented by Buckingham's murder, but if he took the king's part with decision and vigor, it must be remembered that, as has been already said, he was above all a man prone to magnify his office, and that things would look differently to him than they had done before he was in his new position. For the charge of apostasy in its ordinary meaning there is no foundation.

As yet Wentworth took no part in the general government of the country. In December he became Viscount Wentworth and president of the Council of the North. In the speech delivered at York on his taking office he announced his intention of doing his utmost to bind up the prerogative of the crown and the liberties of the subject in indistinguishable union. "Whoever," he said, "ravels forth into questions the right of a king and of a people shall never be able to wrap them up again into the comeliness and order he found them."

The session of 1629 ended in a breach between the king and the parliament which made the task of a moderator hopeless. Wentworth had to choose between helping a Puritan House of Commons to dominate the king and helping the king to dominate a Puritan House of Commons. He instinctively chose the latter course, and he threw himself into the work of repression with characteristic energy, as if the establishment of the royal power was the one thing needful. Yet even when he was most resolute in crushing resistance he held that he and not his antagonists were maintaining the old constitution which they had attempted to alter by claiming supremacy for parliament.

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[1] Called in some editions *Se i miei sospiri*.

In November, 1629, Wentworth became a privy councillor. In October, 1631, he lost his second wife, and in October, 1632, he married Elizabeth Rhodes. In January, 1632, he had been named lord-deputy of Ireland, having performed his duties at York to the king's satisfaction, though he had given grave offence to the northern gentry by the enforcement of his authority. It was a cardinal point of his system that no wealth or station should exempt its possessor from obedience to the king. Not only was the announcement of this principle likely to give offence to those who were touched by it, but in its application Wentworth was frequently harsh and overbearing. In general he may have been said to have worked rather for equality under a strong Government than for liberty.

In Ireland Wentworth would have to deal with a people which had not arrived at national cohesion, and amongst which had been from time to time introduced English colonists, some of them, like the early Norman settlers, sharing in the Catholicism of the natives, whilst the later importations stood aloof and preserved their Protestantism. There was also a class of officials of English derivation, many of whom failed to reach a high standard of efficiency. Against these Wentworth, who arrived in Dublin in July, 1633, waged war sometimes with scanty regard to the forms of justice, as in the case of Lord Mountnorris, whom he sent before a court-martial on a merely formal charge, which necessarily entailed a death sentence, not because he wanted to execute him, but because he knew of no other way of excluding him from official life.

The purifying of official life, however, was but a small part of Wentworth's task. In one way, indeed, he conceived his duty in the best spirit. He tried at the same time to strengthen the crown and to benefit the poor by making the mass of the nation less dependent on their chiefs and lords than they had been before, and, though Wentworth could not do away with the effects of previous mistakes, he might do much to soften down the existing antagonism between the native population and the English Government. Unhappily his intentions were frustrated by causes resulting partly from his own character and partly from the circumstances in which he was placed.

In the first place, Wentworth's want of money to carry on the Government was deplorable. In 1634 he called a parliament at Dublin, and obtained from it a considerable grant, as well as its co-operation in a remarkable series of legislative enactments. The king, however, had previously engaged his word to make certain concessions known as the "graces," and Wentworth resolved that some of these should not be granted, and took upon himself to refuse what his master had promised. The money granted by parliament, however, would not last forever, and Wentworth resolved to create a balance between revenue and expenditure before the supply was exhausted. This he succeeded in doing, partly by making a vast improvement in the material condition of the country, and partly by the introduction of monopolies and other irregular payments, which created wide dissatisfaction, especially amongst the wealthier class.

Towards the native Irish Wentworth's bearing was benevolent but thoroughly unsympathetic. Having no notion of developing their qualities by a process of natural growth, his only hope for them lay in converting them into Englishmen as soon as possible. They must be made English in their habits, in their laws, and in their religion. "I see plainly," he once wrote, "that, so long as this kingdom continues Popish, they are not a people for the crown of England to be confident of." It is true that he had too much ability to adopt a system of irritating persecution, but from time to time some word or act escaped from him which allowed all who were concerned to know what his real opinion was. For the present, however, he had to content himself with forging the instrument by which the hoped-for conversion was to be effected. The Established Church of Ireland was in a miserable plight, and Wentworth busied himself with rescuing from the hands of such men as the earl of Cork the property of the church, which had in troublous times been diverted from its true purpose, and with enforcing the strict observance of the practices of the English Church, on the one hand upon recalcitrant Puritans, and on the other hand upon lawless disregarders of all decency. In this way he hoped to obtain a church to which the Irish might be expected to rally.

Till that time came, he must rely on force to keep order and to prevent any understanding growing up between the Irish and foreign powers. With this object in view he resolved on pouring English colonists into Connaught as James had poured them into Ulster. To do this he had taken upon himself to set at naught Charles's promise that no colonists should be forced into Connaught, and in 1635 he proceeded to that province, where, raking up an obsolete title, he insisted upon the grand juries in all the counties finding verdicts for the king. One only, that of Galway, resisted, and the confiscation of Galway was effected by the Court of Exchequer, whilst he fined the sheriff £1000 [$4860] for summoning such a jury, and cited the jurymen to the castle chamber to answer for their offence. He had succeeded in setting all Ireland against him.

High-handed as Wentworth was by nature, his rule in Ireland made him more high-handed than ever. As yet he had never been consulted on English affairs, and it was only in February, 1637, that Charles asked his opinion on a proposed interference in the affairs of the Continent. In reply, he assured Charles that it would be unwise to undertake even naval operations till he had secured absolute power at home. The opinion of the judges had given the king the right to levy ship-money, but, unless his Majesty had "the like power declared to raise a land army, the crown" seemed "to stand upon one leg at home, to be considerable but by halves to foreign princes abroad." The power so gained indeed must be shown to be beneficent by the maintenance of good government, but it ought to exist. A beneficent despotism supported by popular gratitude was now Wentworth's ideal.

In his own case Wentworth had cause to discover that Charles's absolutism was marred by human imperfections. Charles gave ear to courtiers far too often, and frequently wanted to do them a good turn by promoting incompetent persons to Irish offices. To a request from Wentworth to strengthen the position of the deputy by raising him to an earldom he turned a deaf ear. Yet to make Charles more absolute continued to be the dominant note of his policy, and, when the Scottish Puritans rebelled, he advocated the most decided measures of repression, and in February, 1639, he offered the king £2000 [$9720] as his contribution to the expenses of the coming war. He was, however, too clear-sighted to do otherwise than deprecate an invasion of Scotland before the English army was trained.

In September, 1639, after Charles's failure in the first Bishops' War, Wentworth arrived in England to conduct in the star-chamber a case in which the Irish chancellor was being prosecuted for resisting the deputy. From that moment he stepped into the place of Charles's principal adviser. Ignorant of the extent to which opposition had developed in England during his absence, he recommended the calling of a parliament to support a renewal of the war, hoping that by the offer of a loan from the privy councillors, to which he himself contributed £20,000 [$97,200], he would place Charles above the necessity of submitting to the new parliament if it should prove restive. In January, 1640, he was created earl of Strafford, and in March he went to Ireland to hold a parliament, where the Catholic vote secured a grant of subsidies to be used against the Presbyterian Scots. An Irish army was to be levied to assist in the coming war. When in April Strafford returned to England he found the Commons holding back from a grant of supply, and tried to enlist the peers on the side of resistance. On the other hand, he attempted to induce Charles to be content with a smaller grant than he had originally asked for. The Commons, however, insisted on peace with the Scots, and on May 9, at the privy council, Strafford, though reluctantly, voted for a dissolution.

After this Strafford supported the harshest measures. He urged the king to invade Scotland, and, in meeting the objection that England might resist, he uttered the words which cost him dear, "You have an army in Ireland,"—the army which in the regular course of affairs, was to have been employed to operate in the west of Scotland,—"you may employ here to reduce this kingdom." He tried to force the citizens of London to lend money. He supported a project for debasing the coinage and for seizing bullion in the Tower, the property of foreign merchants. He also advocated the purchasing a loan from Spain by the offer of a future alliance. He was ultimately appointed to command the English army, but he was seized with illness, and the rout of Newburn made the position hopeless. In the great council at York he showed his hope that if Charles maintained the defensive the country would still rally round him, whilst he proposed, in order to secure Ireland, that the Scots of Ulster should be ruthlessly driven from their homes.

When the Long Parliament met it was preparing to impeach Strafford, when tidings reached its leaders that Strafford, now lord-lieutenant of Ireland, had come to London and had advised the king to take the initiative by accusing his chief opponents of treason. On this the impeachment was hurried on, and the Lords committed Strafford to the Tower. At his trial in Westminster Hall he stood on the ground that each charge against him, even if true, did not amount to treason, whilst Pym urged that, taken as a whole, they showed an intention to change the Government, which in itself was treason. Undoubtedly the project of bringing over the Irish army, probably never seriously entertained, did the prisoner most damage, and when the Lords showed reluctance to condemn him the Commons dropped the impeachment and brought in a bill of attainder. The Lords would probably have refused to pass it if they could have relied on Charles's assurance to relegate Strafford to private life if the bill were rejected. Charles unwisely took part in projects for effecting Strafford's escape and even for raising a military force to accomplish that end. The Lords took alarm and passed the bill. On May 9, 1641, the king, frightened by popular tumults, reluctantly signed a commission for the purpose of giving to it the royal assent, and on the 12th Strafford was executed on Tower Hill. (S. R. G.)

STRAITS SETTLEMENTS, the collective name given to the British possessions in the Malay Peninsula (see vol. xv. p. 325, and Plate VI.), derived from the straits which separate the peninsula from Sumatra and which form so important a sea-gate between India and China. The Straits Settlements are defined, by letters patent 17th June, 1885, as consisting of the island of Singapore (which contains the seat of government), the town and province of Malacca, the territory and islands of the Dindings (off Perak), the island of Penang, and Province Wellesley, with their dependencies actual or prospective. The Cocos or Keeling Islands (*q.v.*), formerly attached to Ceylon, were transferred to the Straits Settlements in 1886. These possessions have formed a crown colony since 1867, previous to which they were administered as a presidency of the Indian empire. The governor, appointed for six years is assisted by an executive and a legislative council. Resident councillors are stationed at Penang and Malacca, and since 1874 British residents have exercised supervision at the native courts of Perak, Selangor, and Sungei Ujong, and are assisted by a staff of European officials.

The following are the area and population (with details of race divisions) of the settlements:

	Area in sq. miles	Population in 1871.	Population in 1881.				
			Total.	Europeans	Malays.	Chinese.	Natives of India
Singapore	206	97,131	139,208	2,769	22,155	86,766	12,058
Penang....	107	131,889	90,951	612	21,772	45,135	15,780
Province Wellesley	270		97,324	76	58,728	21,687	10,616
Malacca...	659	77,755	93,579	40	67,513	19,741	1,891
Dindings..	...	...	2,322	...	...	...	...

The population, which thus was 306,775 in 1871 and 423,384 in 1881, was estimated at 473,000 in 1884. The increase is solely produced by immigration of Chinese and natives of India; for, while the total number of births registered in Singapore, Penang, Province Wellesley, and Malacca was in the three years 1881–83 only 21,134, the deaths were 37,151.[1] In 1883 61,206 Chinese landed at Singapore and 48,419 in Penang; and, though the influx of Indian Coolies has been retarded by the stringent protective laws of the Indian Government, the stream of immigration has been steadily increasing in volume. The number of Chinese is probably below the truth, as they were very reluctant to fill up the returns. In 1867, the date of the transfer to the crown, the colony had, it was estimated, not more than 283,384 inhabitants.

The revenue, which was in 1868 only about 1,301,843 dollars, had risen by 1886 to 3,710,639, a large proportion being derived from opium and spirit taxation (712,600 dollars in 1868 and 2,152,700 in 1884). The expenditure in the same period increased from 1,197,177 to 3,652,771 dollars. In 1868 12,400 dollars were devoted to education (95,600 in 1884). Public works were credited with 146,800 dollars in 1868 but with 1,170,000 in 1884. The ports of the Straits Settlements are all free. In 1867 the total burden was 1,237,700 tons, in 1873 2,507,000 tons and in 1883 4,290,600. The value of the united imports and exports was in 1867 about £14,040,000 [$68,234,400], and in 1883 it was estimated by Sir Frederick Weld at £38,624,200 [$187,713,612]. The imports usually somewhat exceed the exports.

Malacca.—The territory of Malacca lies between the river Linggi and the Kesang, which separate it respectively from Sungei Ujong to the northwest and the Moar district of Johor to the east. To the north it marches with Negri Sembilan. Forest conservancy is beginning to be carefully attended to, and pepper growing has recently been started with success at Arrah Kudah by Achinese settlers. Tapioca and tin are among the exports, the latter, brought from the Selangor mines, being smelted in Malacca. The average birth-rate in 1881–83 was 2046 and the death-rate 2642. The city of Malacca has already been described, vol. xv., p. 315.

Prince of Wales Island (or Penang) and Singapore are treated in separate articles.

Province Wellesley, which lies opposite Penang, was at one time part of the Kedah territory, from which it is now separated by the Kwala Muda river. Southwards it extends (since 1874) a little to the south of the Krian river and marches with Perak. The boundary was rectified by treaty with Siam in 1867. Butterworth is the seat of the Government headquarters. The country consists for the most part of fertile plain, and the remainder, about one-eleventh of the whole, is low wooded hills (highest 1843 feet). Some of the low land is rich dark alluvial soil, and much of it is sandy; in the hills a ferruginous sandy loam of rather poor quality prevails. Sugar-growing has long been a staple industry, and tea plantations began to be formed in 1869–70.

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[1] The number of hospital cases, and consequently the death-rate, is affected, however, by the fact that natives from the rest of the peninsula whose diseases prove beyond native skill, are often brought to the colonial hospitals.

The Dindings belonged originally to the state of Perak. The British territory extends some 26 miles from north to south. Though it has a magnificent natural harbor, "it has not hitherto," says Sir Frederick Weld, "been a progressive district. But I think its time is at hand. It produces tin, timber, and ebony, and turtles frequent the neighboring islands." Dinding Island lies off the mouth of the river of the same name.

Perak is an extensive tract of country, comprising the great part of the basin of the Perak river (which runs north and south, almost parallel with the coast of the peninsula, for upwards of 130 miles, excluding the windings, before it turns abruptly west to the Strait) and all the basin of the Bernam river. The boundary towards Patani cuts the Perak river at the rapids of Jeram Panjang. The population of the states is about 110,000, among the more noteworthy tribes being the Sakeis. Perak was brought into closer relation to Britain by the treaty signed at Pankor (Pangkore) in the Dindings, 20th January, 1874, which authorized the appointment of a British resident and assistant resident. The first resident, J. W. Birch, was murdered in November, 1875; but British troops from India and China under General (Sir Francis) Colborne, soon suppressed the insurrectionary movement. One column crossed from Larut to Kwala Kungsa and defeated the rebels at Kotah Lamah, Enggar, and Prek, and another advanced from Banda Baru (where Mr. Birch was buried) to Blanja, the residence of the ex-sultan Ismail, and thence to Kinta on the Kinta river, the capital of Perak. As it was discovered that Abdullah, the ruling sultan, had been accessory to the murder of Mr. Birch, he was deposed in 1877 and banished to Mahé (Seychelles). The residency of Lower Perak was removed from Banda Baru to Durian Sabatang, the place where the Bidor and Batang Padang join the main stream of the Kungsa or Perak, and it has again been removed to Teluk Anson (Teluk Mah Intan), lower down, the centre of the inland trade. The residency of Upper Perak is at Kwala Kungsa. Perak has made wonderful advance since the war. Its revenue was 312,875 dollars in 1877, and in 1884, at a moderate estimate, 1,435,697. In 1877 there was only one line of good road in the country,—from Larut through the pass of Bukit Berapit to Kwala Kungsa; now large tracts have been opened up with roads and bridle-paths. "Rivers have been cleared of obstructions, telegraph lines laid down, court-houses, hospitals, police-stations, etc., built, and a line of railway (8 miles) constructed from Port Weld, the port of Larut, at Teluk Kartang, where vessels drawing 13 to 15 feet can enter to Taipeng (Thaipeng)." The revenue is mainly derived from a duty on tin, which is largely mined in Larut, etc. The mines of the Capitan China in 1883 produced to the value of £105,000 [$510,300]. Coffee and tea planting seem to promise well.

Selangor lies to the south of Perak, and consists mainly of the basins of the Selangor, the Klang, and the Langat, of which the last two meet in a common delta to the south of 3° N. lat. Previous to 1880 the seat of the British resident and staff was at Klang, at the head of 13-feet navigation on the Klang river; at that date it was transferred to Kwala Lumpur, at the junction of the Gombah with the Klang, the highest point reached by the cargo boats which bring up provisions for the tin-miners, and return with tin, gutta-percha, and other produce. There are tin mining settlements at Kanching, Ulu Selangor, Ulu Bernam, Ulu Gombah, Ulu Klang, Ulu Langat, Sungie Pateh Becko, Kajang, Ampagnan, etc. The mine at Ampagnan was bought for 170,000 dollars by Singapore merchants. The population of Selangor (50,000,—29,000 of them Chinese) is rapidly increasing by immigration from China, India, and Sumatra. Since the close of the civil war (1867–74) and the acceptance of the British resident the country has rapidly developed. At the mouth of the Selangor lies the town of that name, with ruins of an old Dutch fort and the stone on which the sultans of Selangor received investiture. At Klang, up the Klang river, lies the principal port of the country, now connected by railway with Kwala Lumpor (22 miles distant), the capital, which has grown into a considerable town, with a hospital, Government house, residency, etc. The sultan resides at Jugra, on a deltaic branch of the Langat. The revenue of Selangor was estimated at 596,877 dollars in 1884; but the war debt was still 259,000 dollars in 1883.

Sungei Ujong (500 square miles, including Lukut and Sungei Riah; population 14,000, the greater part being Chinese) also shows steady progress. Its revenue rose from 67,000 dollars in 1874–75 to 121,176 in 1884. European coffee and cocoa plantations and Chinese tapioca, pepper and gambier plantations are at work.

The interference of the British Government is frequently sought in the territory of the Negri Sembilan (the so-called "Nine States," which are now really seven in number), Sri Menanti, Numbaw, Johole, Jellye, Muar, Jempolt, Segamet.

See *Journal of the Straits Asiatic Society*, Singapore; Dowden, *The Malay Peninsula*, 1882; Vacher, *Twelve Years in Malaya;* M'Nair, *Perak and the Malays*, 1878; W. B. D'Almeida, "Geography of Perak and Salangore," in *J. Roy. Geog. Soc.*, 1876; Sir Frederick Weld, "Straits Settlements," in *Proceedings of Royal Colonial Institute*, 1883–84; *The Straits Directory*, 1886; and the works mentioned in the article MALAY PENINSULA, vol. xv. p. 323.

STRALSUND, a seaport and small manufacturing town in Western Pomerania, Prussia, is situated on the Strelasund, an arm of the Baltic Sea, 2 miles wide, which separates the island of Rügen from the mainland, 115 miles to the north of Berlin and 85 miles to the northwest of Stettin. The position of the town on a small triangular islet, only connected with the mainland by moles and bridges at the angles, has always rendered its fortification comparatively easy, and down to 1873 it was a fortress of the first rank. The quaint architecture of the houses, many of which present their curious and handsome gables to the street, gives Stralsund an interesting and old-fashioned appearance. The three vast Gothic churches of St. Nicholas, St. Mary, and St. James, erected in the 14th and 15th centuries, and the town-house, dating in its oldest part from 1316, are among the more striking buildings. The public library, founded in 1709, contains 60,000 volumes. The manufactures of Stralsund are more miscellaneous than extensive; they include machinery, beer, oil, paper, playing-cards, and sugar. The trade is chiefly confined to the shipping of grain, malt, and timber, with some cattle and wool. In 1884 542 sea-going ships and 1964 river-craft entered the harbor, which is protected by the fortified island of Dänholm, and 513 ships and 1964 river-craft cleared. In 1882 the port owned a fleet of 247 sea-going ships, with a burden of 41,176 tons, besides numerous smaller craft below 60 tons. The population in 1880 was 29,481, in 1885 28,981. More than a fourth of the inhabitants reside in the Knieper, Tribseer, Franken and Harbor suburbs on the mainland. About 1000 are Roman Catholics and 140 Jews.

Stralsund was founded in 1209 by Jaromar I., prince of Rügen, and, though several times destroyed, steadily prospered. It was one of the five Wendish towns whose alliance extorted from King Eric of Norway a favorable commercial treaty in 1284–85; and in the 14th century it was second only to Lubeck in the Hanseatic League. Although under the sway of the dukes of Pomerania, the city was able to maintain a marked degree of independence, which is still apparent in its municipal privileges; it is also the only town in Prussia, with the exception of Breslau, which has an independent municipal ecclesiastical consistory. Its early Protestant sympathies placed it on the side of Sweden during the Thirty Years' War; and in 1628 it successfully resisted a siege of eleven weeks by Wallenstein, who had sworn to take it "though it were chained to heaven." He was forced to retire with the loss of 12,000 men; and a yearly festival in the town still celebrates the occasion. After the peace of Westphalia Stralsund was ceded with the rest of Western Pomerania to Sweden; and for more than a century and a half it was exposed to attack and capture as the *tête-de-pont* of the Swedes in Continental Europe. In 1815 it passed to Prussia. In 1809 it was the scene of the death of Major Schill, in his gallant though ineffectual attempt to rouse his countrymen against the French invaders.

STRANGE, Sir Robert (1721–1792), an eminent line engraver, was descended from the Scottish family of Strange, or Strang, of Balcasky, Fife, and was born in the Mainland of Orkney, on July 14, 1721. In his youth he spent some time in an attorney's office; but, having manifested a taste for drawing, he was apprenticed, in 1735, to Richard Cooper, an engraver in Edinburgh. After leaving Cooper in 1741, he started on his own account as an engraver, and had attained a fair position when, in 1745, he joined the Jacobite army as a member of the corps of life guards. He engraved a half-length of the Young Pretender, and also etched plates for a bank-note designed for the payment of the troops. He was present at the battle of Culloden, and after the defeat remained in hiding in the Highlands, but ultimately returned to Edinburgh, where, in 1747, he married Isabella, only daughter of William Lumisden, son of a bishop of Edinburgh.

In the following year he proceeded to Rouen, and there studied drawing under J. B. Descamps, carrying off the first prize in the Academy of Design. In 1749 he removed to Paris, and placed himself under the celebrated Le Bas. It was from this master that he learned the use of the dry point, an instrument which he greatly improved, and employed with excellent effect in his own engravings. In 1750 Strange returned to England. Presently he settled in London along with his wife and daughter, and superintended the illustrations of Dr. William Hunter's great work on the *Gravid Uterus*, published in 1774. The plates were engraved from red chalk drawings by Van Rymsdyk, now preserved in the Hunterian Museum, Glasgow, and two of them were executed with great skill by Strange's own hand. By his plates of the Magdalen and Cleopatra, engraved after Guido in 1753, he at once established his professional reputation.

He was invited in 1759 to engrave the portraits of the prince of Wales and Lord Bute, by Allan Ramsay, but declined, on the ground of the insufficient remuneration offered and of the pressure of more congenial work after the productions of the Italian masters. His refusal was attributed to his Jacobite proclivities, and it led to an acrimonious correspondence with Ramsay, and to the loss, for the time, of royal patronage. In 1760 Strange started on a long-meditated tour in Italy. He studied in Florence, Naples, Parma, Bologna, and Rome, executing innumerable drawings, of which many—the Day[1] of Correggio, the Danae and the Venus and Adonis of Titian, the St. Cecilia of Raphael, and the Barberini Magdalen of Guido, etc.—were afterwards reproduced by his burin. On the Continent he was received with great distinction, and he was elected a member of the academies of Rome, Florence, Parma, and Paris. He left Italy in 1764, and, having engraved in the French capital the Justice and the Meekness of Raphael, from the Vatican, he carried them with him to London in the following year.

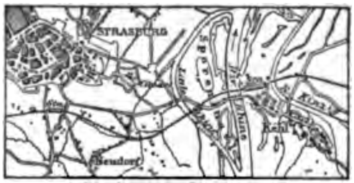
The rest of his life was spent mainly in these two cities, in the diligent prosecution of his art. In 1766 he was elected a member of the Incorporated Society of Artists, and in 1775, piqued by the exclusion of engravers from the Royal Academy, he published an attack on that body, entitled *An Enquiry into the Rise and Progress of the Royal Academy of Arts at London*, and prefaced by a long letter to Lord Bute. In 1787 he engraved West's Apotheosis of the Princes Octavius and Alfred, and was rewarded with the honor of knighthood. He died in London on the 5th of July, 1792.

In the technique of engraving Strange was a master. His line is tender and flowing, without monotony or confusion, and his expression of flesh is characterised by uncommon delicacy and transparency. In draftsmanship his works are often defective.

After his death a splendid edition of reserved proofs of his engravings was issued; and a catalogue of his works, by Charles Blanc, was published in 1848 by Rudolph Weigel of Leipsic, forming part of *Le Graveur en Taille Douce*. See *Memoirs of Sir Robert Strange, Knt., and his brother-in-law Andrew Lumisden*, by James Dennistoun of Dennistoun, 1855.

STRANRAER, a royal burgh of Wigtownshire, Scotland, is situated on the North Channel, at the head of Loch Ryan, 7½ miles northeast of Portpatrick, and 59 miles south-southwest of Ayr. In the centre of the town is the old baronial castle of the 15th century occupied by Claverhouse when he held the office of sheriff of Galloway. The principal public buildings are the old town-hall, the new town-hall and court-house (1873), and the academy (1845). A reformatory provides accommodation for 100 boys, and there is a combination poorhouse for the county and a few parishes beyond it. The town possesses a library and public reading-room. The harbor, which is tidal, only admits the entrance of vessels of 150 tons, but there is good anchorage in the loch, and the east pier permits of the approach of large steamers, which ply in connection with the railway daily to Larne in Ireland. There is also steam communication with Glasgow, Liverpool, and other towns; but since the construction of the Girvan and Portpatrick Railway the trade of the port has been on the decline. The principal import is coal, and the principal exports are agricultural produce. The town is chiefly dependent on agriculture. The fishing industry is of minor importance. The population in 1881 of the royal burgh (area 55 acres) was 3455, and of the police burgh 6342. The town was created a burgh of barony in 1596, and a royal burgh in 1617. In 1885 its parliamentary representation (it had been one of the Wigtown burghs) was merged in that of the county.

STRASBURG (Germ. *Strassburg*, Fr. *Strasbourg*), the principal town of Alsace, and a fortress of the first rank, is situated at the junction of the Ill and the Breusch, about two miles to the west of the Rhine, in one of the most fertile districts in the upper Rhenish plain. It lies about 90 miles to the north of Basel, 250 miles to the east of Paris, and 370 miles to the southwest of Berlin. Since 1871 it has been the seat of government for the German crownland of Alsace-Lorraine (Elsass-Lothringen); and it is also the see of a Roman Catholic bishop and the headquarters of the 15th corps of the German army.



Environs of Strasburg.

The town proper is divided by the arms of the Ill into three parts, of which the central is the largest and most important. Most of the streets are narrow and irregular, and the quaint aspect of a free mediæval town has to a considerable extent been maintained. The quarters which suffered most in the bombardment of 1870 have, however, been rebuilt in a more modern fashion, and the recent widening of the circle of fortifications, with the destruction of the old walls, has given the city opportunity to expand in all directions.

By far the most prominent building is the minster, or cathedral, which in its present form represents the activity of four centuries. Part of the crypt dates from about 1015; the apse shows the transition from the Romanesque to the Gothic style; and the nave, finished in 1275, is a fine specimen of pure Gothic. Of the elaborate west façade, with its singular screen of double tracery, the original design was furnished by Erwin of Steinbach (*c.* 1318). The upper part of the façade and the towers were afterwards completed in accordance with a different plan, and the intricate open-work spire on the north tower, 465 feet high, was added in 1435. The sculptural ornamentation both without and within is very rich. The astronomical clock in the south transept, constructed in 1838–42, contains some fragments of the famous clock built by Dasypodius in 1571. The church of St. Thomas, a Gothic building of the 13th and 14th centuries, contains a fine monument to Marshal Saxe, considered the *chef d'œuvre* of the sculptor Pigalle. Other notable buildings are the Temple-Neuf, or Neukirche, rebuilt since 1870; the old episcopal palace

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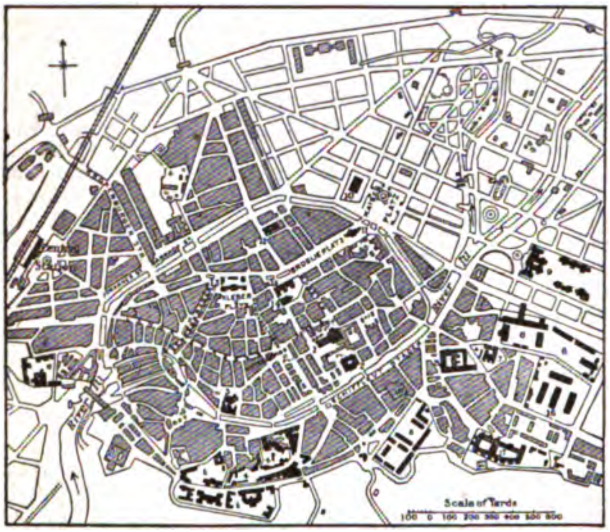
[1] [Also known as *St. Jerome*.—AM. ED.]

(1731–41), now the library; the old prefecture; the theatre; the town-house; and the so-called "aubette," containing the conservatorium of music. The university of Strasburg, which was suppressed in the French Revolution as a stronghold of German sentiment, was reopened in 1872, and now occupies a handsome new building erected for it in 1884. The university and town library, containing about 600,000 volumes, consists largely of the books sent from all parts of Germany to compensate for the town library destroyed in the bombardment of 1870. The precious incunabula and manuscripts which then perished are, however, irreplaceable. General Kleber, who was a native of Strasburg, and Gutenberg, who spent part of his life here, are both commemorated by statues. Many private houses are most quaint and interesting illustrations of timber architecture. Pleasant public parks and gardens fringe the town.

The population in 1880 was 104,471, including 51,859 Roman Catholics, 48,691 Protestants, and 3521 Jews. In 1885 the total population had risen to 112,091, showing an increase of 7.29 per cent. The town, strictly so called, does not contain more than 90,000 inhabitants, the rest belonging to the suburban villages. Even before the war of 1870–71 more than half of the inhabitants spoke German as their mother-tongue, and this proportion has probably been somewhat increased since. The sympathies of the people, however, like those of most of the Alsatians, lay with France, and it will require the growth of a new generation to bring about a complete reconciliation to German rule.



Plan of Strasburg.

1. Cathedral.
2. Library.
3. St.Thomas's Ch.
4. Hospital.
5,5. Univ.Med.Fac.
6,6. Barracks.
7. Akademie.
8. Govt.Tobacco Factory.
9. University.
10. Imp. Palace.
11. Theatre.
12. Law Courts.
13. Aubette.
14. Neukirche.
15. Prot. Gymnasium.
16. Arsenal.
17. Military Hospital.

The chief industries of Strasburg are tanning, brewing, and the making of steel goods, machinery, and tobacco. To these must be added the stall-fattening of geese for its celebrated *pâtés de foie gras*, an occupation which forms a most useful source of income to the poorer classes. The annual value of these "fat liver pies" sent out from Strasburg is over £100,000 [$486,000]. The position of the town at the intersection of natural highways between France and Germany, Switzerland and Belgium, early made it a place of considerable commercial importance, and it now carries on a brisk trade in agricultural produce, hams, sausages, sauerkraut, and hops. Its full development in this direction, though favored by the canals connecting the Rhine with the Rhone and the Marne, has been somewhat hampered by the iron girdle of fortifications.

Strasburg has always been a place of great strategic importance, and as such strongly fortified. The pentagonal citadel constructed by Vauban in 1682–84 was destroyed during the siege of 1870. The new German system of fortifications consists of a girdle of fourteen detached forts, at a distance of three to five miles from the centre of the town. Kehl, the *tête-de-pont* of Strasburg, and several villages are included within this enceinte, and three of the outworks lie on the right bank of the Rhine, in the territory of Baden. In case of need a great part of the environs can be laid under water by the garrison.

The site of Strasburg seems to have been originally occupied by a Celtic settlement, which the Romans conquered and replaced by the fortified station of *Argentoratum*, afterwards the headquarters of the eighth legion. In the year 357 the emperor Julian saved the frontier of the Rhine by a decisive victory gained here over the Alemanni, but about half a century later the whole of the district now called Alsace fell into the hands of that Teutonic people. Towards the end of the 5th century the town passed to the Franks, who named it *Strataburgum*. The famous "Strasburg oaths" (see Germany, vol. x. p. 431) were taken here in 842; and in 923, through the homage paid by the duke of Lorraine to Henry I., began the connection of the town with the kingdom of Germany which was to last for more than seven centuries. The bishopric of Strasburg was founded in the Merovingian period, and soon attained great wealth and importance. The early history of Strasburg, as in the case of most episcopal cities, consists mainly of a record of the struggle between the bishops and the citizens,—the latter, as they grew in wealth and power, feeling the fetters of ecclesiastical rule inconsistent with their full development. The conflict was finally decided in favor of the citizens by the battle of Oberhausbergen in 1262; and the position of free imperial city, which had been conferred upon Strasburg by Philip of Swabia, was not again disputed. The throwing off of the episcopal yoke was followed by an internal revolution (1332), which admitted the guilds to a share in the government of the city and impressed upon it the democratic character that it bore down to the French Revolution. Strasburg now became one of the most flourishing of all the imperial towns, and the names of natives or residents like Sebastian Brant, Tauler, Fischart, and Geiler von Kaysersberg show that its pre-eminence was not confined to the material sphere. On the other hand, its fair fame is sullied by such acts as the burning in 1349 of 2000 Jews, accused of causing a pestilence by poisoning the wells. In 1381 Strasburg joined the Städtebund, or Swabian League, and about a century later it rendered efficient aid to the Swiss confederates at Granson and Nancy. The Reformation found ready acceptance at Strasburg, its foremost champion here being Martin Bucer, and the city was skilfully piloted through the ensuing period of religious dissension by its "stadtmeister" Jacob Sturm, who secured for it very favorable terms at the end of the Schmalkald War. In the Thirty Years' War Strasburg escaped without molestation by observing a prudent neutrality. In 1681, during a time of peace, it was suddenly seized by Louis XIV., and this unjustifiable action received formal recognition at the peace of Ryswick in 1697. The immediate effect of the change of superiors was a partial reaction in favor of Roman Catholicism, but the city remained essentially German until the French Revolution, when it was deprived of its privileges as a free town and sank to the level of a French provincial capital. It was at Strasburg that Louis Napoleon made his first ineffectual attempt to grasp power. In the war of 1870 Strasburg, with its garrison of 17,000 men, surrendered to the Germans after a siege of seven weeks. The town and cathedral suffered considerably from the bombardment, but all traces of the havoc have now disappeared.

STRASS, or Paste. See Glass, vol. x. p. 593.

STRATEGY. See War.

STRATFORD, usually designated Stratford-on-Avon, a market-town and municipal borough of England, in Warwickshire, near the Gloucestershire border, is pleasantly situated on the Avon, and on the Great Western and Midland Railway lines, 26 miles south of Birmingham and 8 southwest of Warwick. The Avon is crossed by a stone bridge of fourteen arches, built by Sir Hugh Clopton in the reign of Henry VII., and widened in 1814; by a bridge of nine arches, built of brick in 1826; and by a foot-bridge erected in 1867, at a cost of £500 [$2430], on the site of a foot-bridge originally erected in 1599, and rebuilt in 1812. The streets are wide and regular, crossing each other generally at right angles, and, says J. O. Halliwell-Phillipps, "with the exception of a few diffused buildings, scarcely one of which is in its original condition, there is no resemblance between the present town and the Shakespearean borough" (compare article SHAKESPEARE, vol. xxi. p. 777 *sq.*). The church of the Holy Trinity occupies the site of a Saxon monastery, which existed before 691, when the bishop of Worcester received it in exchange from Ethelred, king of Mercia. It is a fine cruciform structure, party Early English and partly Perpendicular, with a central tower and lofty octagonal spire. It was greatly improved in the reign of Edward III. by John de Stratford, who rebuilt the south aisle. He also in 1332 founded a chantry for priests, and in 1351 Ralph de Stratford built for John's chantry priests "a house of square stone," which came to be known as the college, and in connection with which the church became collegiate. The present beautiful choir was built by Dean Balshall (1465–91), and in the reign of Henry VII. the north and south transepts were erected. The mural monument of Shakespeare, who is buried in the chancel, is of special interest from its effigy of the poet, undoubtedly an authentic representation, though somewhat altered and damaged by time. The foundation of the chapel of the Guild of the Holy Cross was laid by Robert de Stratford. The guild, to which both sexes were admitted, was in existence early in the 13th century, and it was incorporated by a charter from Edward III. in 1322. It was dissolved in 1547. The house in which Shakespeare was born still stands,—although its external appearance is much altered,—and an apartment is by immemorial tradition pointed out as his birth-room. In 1597 Shakespeare purchased New Place for his residence (see vol. xxi. p. 801). Shakespeare's house was pulled down by Sir John Clopton in 1702, and the large new mansion erected on its site was pulled down by Sir Francis Gastrell in 1759. Chiefly through the exertions of J. O. Halliwell-Phillipps, the site of New Place was purchased by public subscription, and in 1876 handed over to the trustees of the birthplace. The old theatre, which had occupied part of the ground, was taken down in 1872, and in 1877 a new memorial theatre was erected at a cost of £30,000 [$145,800]. The other principal buildings of the town are the town-hall, originally erected in 1633, almost entirely rebuilt in 1767–68, after having been severely injured by an explosion, and greatly altered in 1863 at a cost of £2000; the market-house (1820); the corn exchange (1850); the children's hospital (1871); and the new hospital (1884). The Edward VI. grammar school, where Shakespeare received his education, was founded in 1553. The town is chiefly dependent on the agriculture of the neighborhood. The population of the borough in 1871 was 7183, and in 1881 (area extended in 1879 to 3865 acres) it was 8054.

There is no authentic mention of Stratford earlier than the 7th century. It received a charter for a market in the reign of Richard I., but was not incorporated till the reign of Edward VI. The charter of Charles II., granted in his 26th year, remained the governing charter of the town till the passing of the Municipal Act in 1835. The town suffered from a severe epidemic in 1564, from inundations in 1588, and from fire in 1598.

See S. L. Lee, *Stratford-on-Avon*, 1884; J. O. Halliwell-Phillipps, *Outlines of the Life of Shakespeare*, sixth edition (with a history of New Place), 1886; and the article SHAKESPEARE.

STRATFORD, a town of Canada, capital of Perth county, Ontario, lies on the river Avon (a tributary of the Thames which discharges into Lake St. Clair), about 45 miles by rail southeast of Goderich, at the junction of the Goderich and Buffalo division with the main line of the Grand Trunk Railway. In 1849 it was a village of only 200 inhabitants; but between 1871 and 1881 its population rose from 4313 to 8239. It has a town-hall, extensive repairing shops, and several manufactures.

STRATFORD DE REDCLIFFE, STRATFORD CANNING, VISCOUNT (1786–1880), diplomatist, was the first cousin of George Canning the statesman, and the youngest son of Stratford Canning, who, having been disinherited for marrying beneath his rank, settled in London as a merchant in Clement's Lane, where young Canning was born 4th November, 1786. Shortly afterwards the father died, and the family removed to Wanstead, the boy attending the village school and afterwards a school at Hackney until 1794, when he went to Eton. Ultimately he became captain of the school, and he also manifested his literary predilections by publishing, in conjunction with Wellesley and others, a collection of essays entitled *The Miniature*. In 1805 he was elected scholar of King's College, Cambridge, and, while still attending the university, became in 1807 précis writer to his cousin, who had been appointed foreign minister. At the close of the year he went to Copenhagen as one of the secretaries of a special diplomatic mission, and after his return he was appointed in June, 1808, first secretary at Constantinople. On the removal of his chief Mr. Adair to Vienna in July, 1810, Canning remained minister plenipotentiary, making use of the opportunity to give indications of that overmastering purpose and bold yet subtle diplomacy which were to have such an important influence on the history of the Eastern question. In 1812 he succeeded in effecting the treaty of Bucharest between Russia and Turkey, which was signed on the 12th May, shortly before the arrival of his successor. This was properly the inauguration of that English influence in Turkey which did not cease until within recent years. The treaty was also of immense immediate advantage by freeing the Russian army to act against Napoleon, and on his return to England Canning was rewarded by a pension of £1200 a year. He remained in London, occupying himself with literature, and contributing some articles to the *Quarterly Review*, then newly founded, until in May, 1814, he was appointed by Lord Castlereagh minister plenipotentiary to Switzerland, where he succeeded in effecting the federation of the cantons as a neutral state. He returned to England in 1817, and in August, 1820, was sent as plenipotentiary to the United States, to arrange certain outstanding differences between the States and England; but, although a convention was signed 13th March, 1824, this was rejected by the American senate, and matters for several years remained, so far as any actual arrangement was concerned, *in statu quo*. In October, 1825, Canning was sent on a second commission to Constantinople, chiefly to promote the independence of Greece, but after long and complicated negotiations the attack, without the knowledge of the ambassadors, on the Turkish fleet by the allies under Sir E. Codrington at Navarino, 20th October, 1827, caused a conference then being held to be suddenly broken up, and rendered necessary the withdrawal of the ambassadors from Constantinople. They, however, again met at Poros towards the close of the following year, and ultimately Turkey was compelled, by the treaty of Adrianople, 14th August, 1829, following a short war with Russia, to loose her grasp on Greece, and consent to the arrangement of a frontier limit. On his return to England Canning was made G.C.B. In 1828 he had been elected to the House of Commons for Old Sarum, and he sat for different boroughs until 1841, when he again accepted the office of ambassador to Turkey. During the next twelve years he gradually succeeded in winning the confidence of the sultan, as well as awakening his wholesome awe, by convincing him, not merely of his sincere interest in the welfare of Turkey, but of his sole ability to thwart the wiles of the Russian emperor. There is no doubt a certain degree of exaggeration in Kinglake's description of Canning as the "Great Elchi," at whose slightest frown the Turks were ready to quail, and by whose matchless skill and coolness the emperor Nicholas was placed at his wits' end; but the consummate ability with which he managed the negotiations connected with the question of the Holy Places, so as to place the emperor as much as possible in the wrong, and to render his act of hostility on 3d July, 1853—which led to the Crimean war—unjustifiable, cannot be denied. During the war he retained his position at Constantinople, but at its conclusion he returned in 1858 to London. In 1852 he had been raised to the peerage with the title Viscount Stratford de Redcliffe. His later years were spent chiefly in retirement, and, except when the Eastern question came prominently into notice, he took little part in political discussion. On Eastern politics he contributed several papers to the *Times* and the *Nineteenth Century*. He died without surviving male issue 14th August, 1880.

His essays were collected and published in 1881 under the title of the *Eastern Question*, with a memorial preface by Dean Stanley. A memoir by Stanley Lane Poole is in preparation.

STRATO. See PERIPATETICS, vol. xviii. p. 557.

STRAUBING, an ancient town in the most fertile part of Lower Bavaria, is situated on the right bank of the Danube, 25 miles to the southeast of Ratisbon. Its oldest and most characteristic building is the tall square tower of the town-hall, with its five pointed turrets, dating from 1208. The Church of St. James is a good Late Gothic edifice (1292–1512), with some paintings ascribed to Wohlgemuth, and the old Carmelite church contains a handsome monument to Duke Albert II. of Bavaria. The industries of Straubing are tanning, brewing, and trade in grain and cattle. The population in 1880 was 12,625, nearly all Roman Catholics.

Straubing is a town of remote origin, believed to be identical with the Roman station of *Serviodurum*. In definite history, however, it is known only as a Bavarian town, and from 1333 to 1425 it was the seat of the collateral ducal line of Baiern-Straubing. Its chief historical interest attaches to its connection with the unfortunate Agnes Bernauer, who lived at the chateau here with her husband Duke Albert III. During the latter's absence his father, Duke Ernest, exasperated at the mesalliance, cruelly and unjustly condemned his son's low-born wife to death, and caused her to be hurled into the Danube from the bridge (1435). A chapel in the churchyard of St. Peter's is said to cover her remains. Fraunhofer the optician was born at Straubing in 1787.

STRAUSS, DAVID FRIEDRICH (1808–1874), author of the *Leben Jesu*, was born at Ludwigsburg, near Stuttgart, January 27, 1808. He was the son of a small tradesman who loved literature and thought more than business, and his mother was a bright intelligent woman whose piety was practical rather than meditative, while she had an open eye for the beauties of art and nature. In his thirteenth year the boy was sent to the evangelical seminary at Blaubeuren, near Ulm, to be prepared for the study of theology. Amongst his school-fellows were youths destined to become equally distinguished with himself, of whom he has given sketches in his *Christian Märklin*. Amongst the principal masters in the school were Professors Kern and F. C. Baur, who infused into their pupils above all a deep love of the ancient classics. In 1825 Strauss passed from school to the university of Tübingen. The course of study was two years of philosophy and history and three of theology. The professors of philosophy failed to interest him, and he accordingly followed pretty much his own devices in this field, devoting himself especially to Schelling, the writers of the romantic school, Jacob Böhme, and even to somnambulistic and other modern superstitions. In 1826 his previous teachers, Kern and Baur, removed to Tübingen, and the latter introduced him to the writings of Schleiermacher, which awoke his keen dialectical faculty and delivered him from the vagueness and exaggerations of romantic and somnambulistic mysticism, while for a time he found satisfaction for his religious nature in Schleiermacher's idea of religion. In the last year of his stay at Tübingen he read with Märklin Hegel's *Phänomenologie*, which was the beginning of his abandonment of Schleiermacher for Hegel. In 1830 he passed his examination brilliantly, and became assistant to a country clergyman, and was greatly beloved as preacher and pastor by the parishioners. After nine months in this position he accepted the post of professor in the high school at Maulbronn, having to teach Latin, history, and Hebrew. Here also he was most successful and highly valued. But in October, 1831, he resigned his office in order to study under Schleiermacher and Hegel in Berlin. Hegel died just as he arrived, and though he regularly attended Schleiermacher's lectures, it was only those on the life of Jesus which exercised a very powerful influence upon him. It was amongst the followers of Hegel that he found kindred spirits. Under the leading of Hegel's distinction between "Vorstellung" and "Begriff," he had already conceived the idea of his two principal theological works—the *Life of Jesus* and the *Christian Dogmatics*. In 1832 he returned to Tübingen and became repetent in the university, lecturing on logic, history of philosophy, Plato, and history of ethics, with great success. But in the autumn of 1833 he resigned this position in order to devote all his time to the completion of his projected *Life of Jesus*. In a year the manuscript was finished, and in 1834 the first volume and in 1835 the second were given to the world. The work produced an immense sensation and created a new epoch in the treatment of the rise of Christianity. The chief replies to it were by Tholuck, Neander, A. Schweizer, Ullmann, and Bruno Bauer. In 1837 Strauss replied to his critics (*Streitschriften zur Vertheidigung meiner Schrift über das Leben Jesu*). In the third edition of the work (1839), and in *Zwei friedliche Blätter*, he made important concessions to his critics, which he withdrew, however, in the fourth edition (1840, translated into English by George Eliot, with Latin preface by Strauss, 1846). In 1840 and the following year he published his *Christliche Glaubenslehre* (2 vols.), the principle of which is that the history of Christian doctrines is their disintegration. Between the publication of this work and that of the *Friedliche Blätter* he had been elected to a chair of theology in the university of Zurich. But the appointment provoked such a storm of popular ill-will in the canton that the authorities considered it wise to pension him before he entered upon his duties, although this concession came too late to save the Government. With his *Glaubenslehre* he took leave of theology for upwards of twenty years. In August, 1842, he married Agnes Schebest, a cultivated and beautiful opera singer of high repute, but not adapted to be the wife of a scholar and literary man like Strauss. Five years afterwards, when two children had been born, a separation by arrangement was made. Strauss resumed his literary activity by the publication of *Der Romantiker auf dem Throne der Cæsaren*, in which he drew a satirical parallel between Julian the Apostate and Frederick William IV. of Prussia (1847). In 1848 he was nominated as member of the Frankfort parliament, but was defeated. He was elected for the Würtemberg chamber, but his action was so conservative that his constituents requested him to resign his seat. He forgot his political disappointments in the production of a series of biographical works, which secured for him a permanent place in German literature (*Schubart's Leben*, 2 vol., 1849; *Christian Märklin*, 1851; *Frischlin*, 1855; *Ulrich von Hutten*, 3 vols., 1858–60, 4th ed., 1878; *H. S. Reimarus*, 1862). With this last-named work (see REIMARUS) he returned to theology, and two years afterwards (1864) published his *Leben Jesu für das Deutsche Volk* (4th ed., 1877). It failed to produce an effect comparable with that of the first *Life*, but the replies to it were many, and Strauss answered them in his pamphlet *Die Halben und die Ganzen* (1865), directed specially against Schenkel and Hengstenberg. His *Christus des Glaubens und der Jesus* *der Geschichte* (1865) is a severe criticism of Schleiermacher's lectures on the Life of Jesus, which were then first published. From 1865 to 1872 Strauss resided in Darmstadt, where he made the personal acquaintance of the princess Alice and the crown-princess of Germany, receiving from both ladies many marks of esteem. In 1870 he published his lectures on *Voltaire* (3d ed., 1872), which were written for the princess Alice and delivered before her. In the works of these years it seemed that the truth of Christianity had become still more problematic to Strauss, and this was more obvious than ever in his next and last important work, his confession, and final summary answer to the four great questions—Are we Christians? Have we still religion? What is our conception of the world? How are we to regulate our lives? (*Der Alte und der Neue Glaube*, 1872, 11th ed., 1881, English translation by M. Blind, 1873). The work produced a greater sensation than his first *Life of Jesus*, and not least amongst Strauss's own friends, who wondered at his one-sided view of Christianity, his professed abandonment of all spiritual philosophy, the strange inconsistencies of his thought, his scientific credulity, and the offensive form of his negations. To the fourth edition of the book he added a *Nachwort als Vorwort* (1873). The same year symptoms of a fatal malady appeared, and death followed February 7, 1874. Though his last book renounced in almost frivolous language the hope of immortality, he read Plato's *Phædo* in the Greek during his last days, and Zeller says "his friends bade him adieu with feelings such as Plato has described at the end of that dialogue."

Strauss's mind was almost exclusively analytical and critical, without depth of religious feeling, or philosophical penetration, or historical sympathy. His work was accordingly rarely constructive, and, save when he was dealing with a kindred spirit, he failed as an historian, biographer, and critic, strikingly illustrating Goethe's profoundly true principle that loving sympathy is essential for productive criticism. His first *Life of Jesus* was directed against not only the traditional orthodox view of the Gospel narratives, but likewise the rationalistic treatment of them, whether after the manner of Reimarus or that of Paulus. The mythical theory that the Christ of the Gospels, excepting the most meagre outline of personal history, was the unintentional creation of the early Christian Messianic expectation he applied with merciless rigor and mechanical inconsideration to the narratives. But his operations were based upon fatal defects, positive and negative. He held a narrow theory as to the miraculous, a still narrower as to the relation of the divine to the human, and he had no true idea of the nature of historical tradition, while, as C. F. Baur complained, his critique of the Gospel history had not been preceded by the essential preliminary critique of the Gospels themselves. With a broader and deeper philosophy of religion, juster canons of historical criticism, with a more exact knowledge of the date and origin of the Gospels, his rigorous application of the mythical theory with its destructive results would have been impossible. In his second *Life of Jesus*, though conceding something to C. F. Baur, he adheres substantially to his mythical theory, while he seeks to make good one defect of the first *Life* by supplying a previous examination of the Gospels. But this examination shows little independent research, being scarcely more than the adoption of the conclusions of C. F. Baur and his earlier disciples. Another advance on the first work is the addition of a sketch of the historical facts of the life of Jesus and of his religious character, but he adheres to his early limited and shallow view of the relation of the divine and the human, and still fails to apprehend the true mission of the founder of the Christian religion. But the estimate of the religious mission of Jesus, and of the historical trustworthiness of the Gospels, is far higher in this *Life* than the final one in *Der Alte und der Neue Glaube*. As in his philosophical development he exhibited wavering uncertainty, so it is impossible to reconcile his views of Christ and Christianity at different periods of his life. Some of the expressions of his last book in this respect are in glaring contrast with the positions he maintained in earlier years.

Strauss's works are published in a collected edition in 12 vols., by Zeller, Bonn, 1876–78, without his *Christliche Dogmatik*. On his life and works see Zeller's *David Friedrich Strauss in seinem Leben und seinem Schriften*, Bonn, 1874; A. Hausrath's *D. F. Strauss und die Theologie seiner Zeit*, 2 vols., Heidelberg, 1876–78; his own essay on *Julius Kerner;* F. J. Vischer's *Kritische Gänge*, i. 3. Karl Schwarz, *Zur Geschichte der neusten Theologie*, 4th ed., 1869; Heinrich Lang, *Religiöse Reden*, vol. ii.; Dorner, *Geschichte der protestantischen Theologie*, 1876; Nippold, *Handbuch der neuesten Kirchengeschichte*, 1868; J. H. Scholten, "Strauss and Christianity," in *Theological Review*, 1874, Jan. and April; Hase, *Geschichte Jesu*, 1876, give critiques from different points of view of Strauss's theological works, particularly his Lives of Jesus. (J. F. S.)

STRAUSS, Johann (1804–1849), orchestral conductor and composer of dance-music, was born at Vienna, March 14, 1804. In 1819 he obtained his first engagement as a violinist in a small band then playing at the Sperl, in the Leopoldstadt. Shortly afterwards he joined Lanner, with whom he remained associated as deputy-conductor until 1825, when he organized a little band of fourteen performers on his own account. It was during the carnival of 1826 that Strauss inaugurated his long line of triumphs by introducing his band to the public of Vienna at the Schwan, in the Rossau suburb, where his famous *Taüberl-Walzer* (op. 1) at once established his reputation as the best composer of dance-music then living. Upon the strength of this success he was invited back to the Sperl, where he accepted an engagement, with an increased orchestra, for six years. Soon after this he was appointed kapellmeister to the 1st Bürger regiment, and intrusted with the duty of providing the music for the court balls; while the number of his private engagements was so great that he found it necessary to enlarge his band from time to time until it consisted of more than two hundred performers. In 1833 he began a long and extended series of tours throughout northern Europe, eventually visiting England in 1838. In Paris he associated himself with Musard, whose quadrilles became not much less popular than his own waltzes; but his greatest successes were achieved in London, where he arrived in time for the coronation of Queen Victoria, and played at seventy-two public concerts, besides innumerable balls and other private entertainments. The fatigue of these long journeys seriously injured Strauss's health; but he soon resumed his duties at the Sperl; and on May 5, 1840, he removed with his band to the Imperial "Volksgarten," which thenceforth became the scene of his most memorable successes. Those who enjoyed the privilege of hearing him conduct there could never forget the wonderful delicacy of the performance, over which the master presided with a quiet power which insured the perfection of every minutest *nuance*. In 1844 Strauss began another extensive series of tours. In 1849 he revisited London, and, after his farewell concert was escorted down the Thames by a squadron of boats, in one of which a band played tunes in his honor. This was his last public triumph. On his return to Vienna he was attacked with scarlet fever, of which he died, September 25, 1849.

Strauss was survived by three sons,—Johann (born 1825), Joseph (1827–1870), and Edward (born 1835), all of whom have distinguished themselves as composers of dance-music and assisted in recruiting the ranks and perpetuating the traditions of the still famous band.

STRAUSS-DURCKHEIM, Hercule (b. 1790, d. 1865), an eminent French entomologist, was the author of anatomical works of exquisite precision and fulness of detail. Two of these (his monographs of the anatomy of the cockchafer and of the cat) are permanent classics, of which the influence has aided greatly in raising the standard of zoological works.

STRAWBERRY (*Fragaria*). Apart from its interest as a dessert fruit (see Horticulture, vol. xii. p. 287), the strawberry has claims to attention by reason of the peculiarities of its structure and the excellent illustrations it offers of the inherent power of variation possessed by the plant and of the success of the gardener in availing himself of this tendency. The genus *Fragaria* consists of a small number (three to four, according to Hooker) of species, native of the temperate regions of both hemispheres, as well as of mountain districts in warmer climes. The tufted character of the plant, and its habit of sending out long slender branches (runners) which produce a new bud at the extremity, are well known. The leaves are usually palmately three-parted, but the number of leaflets may be increased to five or reduced to one. While the flower has the typical Rosaceous structure, the so-called fruit is very peculiar, but it may be understood by the contrast it presents with the "hip" of the rose. In the last-named plant the top of the flower-stalk expands as it grows into a vase-shaped cavity, the "hip," within which are concealed the true fruits or seed-vessels. In the rose the extremity of the floral axis is concave and bears the carpels in its interior. In the strawberry the floral axis, instead of becoming concave, swells out into a fleshy, dome-shaped or flattened mass in which the carpels or true fruits, commonly called pips or seeds, are more or less imbedded but never wholly concealed. A ripe strawberry in fact may be aptly compared to the "fruit" of a rose turned inside out.

The common wild strawberry of Great Britain, which indeed, is found throughout Europe and great part of North America, is *F. vesca*, and this was the first species brought under cultivation in the early part of the 17th century. Later on other species were introduced, such as *F. elatior*, a European species, the parent stock of the hautbois strawberries, and especially *F. virginiana* from the United States and *F. chiloensis* from Chiloe. From these species, crossed and recrossed in various manners have sprung the vast number of different varieties now enumerated in catalogues, whose characteristics are so inextricably blended that the attempt to trace their exact parentage or to follow out their lineage has become impossible. It must suffice to say that the varieties at present cultivated vary in the most remarkable degree in size, color, flavor, shape, degree of fertility, season of ripening, liability to disease, and constitution of plant. Some, as previously stated, vary in foliage, others produce no runners, and some vary materially in the relative development of their sexual organs, for, while in most cases the flowers are in appearance hermaphrodite, at least in structure, there is a very general tendency towards a separation of the sexes, so that the flowers are males or females only as to function, even although they may be perfect in construction. This tendency to diœcism is a common characteristic among *Rosaceæ*, and sometimes proves a source of disappointment to the cultivator, who finds his plants barren where he had hoped to gather a crop. This happens in the United States more frequently than in Britain, but when recognized can be readily obviated by planting male varieties in the vicinity of the barren kinds. Darwin, in alluding to the vast amount of variability in the so-called "fruit,"—a change effected by the art of the horticulturist in less than three centuries,—contrasts with this variability the fixity and permanence of character presented by the true fruits, or pips, which are distributed over the surface of the swollen axis. The will and art of the gardener have been directed to the improvement of the one organ, while he has devoted no attention to the other, which consequently remains in the same condition as in the wild plant. Too much stress is not, however, to be laid on this point, for it must be remembered that the foliage, which is not specially an object of the gardener's "selection," nevertheless varies considerably.

STRAW MANUFACTURES. Straw forms the raw material of some not unimportant industries. It serves for the thatching of roofs, for a paper-making material, for ornamenting small surfaces as a "straw mosaic," for plaiting into door and table mats, mattresses, etc., and for weaving and plaiting into light baskets, artificial flowers, etc. These applications, however, are insignificant in comparison with the place occupied by straw as a raw material for the straw bonnets and hats worn by both sexes. Of the various materials which go to the fabrication of plaited head-gear the most important is wheaten straw. It is only in certain areas that straw suitable for making plaits is produced. The straw must have a certain length of "pipe" between the knots, must possess a clear delicate golden color, and must not be brittle. The most valuable straw for plaits is grown in Tuscany, and from it the well-known Tuscan plaits and Leghorn hats are made. The straw of Tuscany, specially grown for plaiting, is distinguished into three qualities,—*Pontederas Semone* being the finest, *Mazzuolo* the second quality, from which the bulk of the plaits are made, while from the third quality, *Santa Fioro*, only "Tuscan pedals" and braids are plaited. The wheat-seed for these straws is sown very thickly on comparatively elevated and arid land, and it sends up long attenuated stalks. When the grain in the ear is about half developed the straw is pulled up by the roots, dried in the sun, and subsequently spread out for several successive days to be bleached under the influence of alternate sunlight and night-dews. The pipe of the upper joint alone is selected for plaiting, the remainder of the straw being used for other purposes. These pipes are made up in small bundles, bleached in sulphur fumes in a closed chest, assorted into sizes, and so prepared for the plaiters. Straw plaiting is a domestic industry among the women and young children of Tuscany and some parts of Emilia. Tuscan plaits and hats vary enormously in quality and value; the plait of a hat of good quality may represent the work of four or five days, while hats of the highest quality may each occupy six to nine months in making. The finest work is excessively trying to the eyes of the plaiters, who can at most give to it two or three hours' labor daily. The exports of plaits and manufactured hats from Leghorn average in value £480,000 [$2,332,800] annually, about one half of the goods going to America.

The districts around Luton in Bedfordshire and the neighboring counties have since the beginning of the 17th century, been the British home of the straw-plait industry. The straw of certain varieties of wheat cultivated in that region is, in favorable seasons, possessed of a fine bright color and due tenacity and strength. The straw is cut as in ordinary harvesting, but is allowed to dry in the sun before binding. Subsequently straws are selected from the sheaves, and of these the pipes of the two upper joints are taken for plaiting. The pipes are assorted into sizes by passing them through graduated openings in a grilled wire frame, and those of good color are bleached by the fumes of sulphur. Spotted and discolored straws are dyed either in pipe or in plait. The plaiters work up the material in a damp state, either into whole straw or split straw plaits. Split straws are prepared with the aid of a small instrument having a projecting point which enters the straw pipe, and from which radiate the number of knife-edged cutters into which the straw is to be split. The plaiting of straw in the Luton district formerly gave employment to many thousands of women and young children; but now vast quantities of plaits are imported at a very cheap rate from Canton in China. The result is that, while the Luton trade is extending, the number of persons it there gives occupation is greatly diminished. In 1871 about 50,000 persons were employed in the straw industry, and in 1881 the number was only about 31,000. The plaits are sewed partly by hand and in a special sewing-machine, and the hats or bonnets are finished by stiffening with gelatin size, and blocking into shape with the aid of heat and powerful pressure, according to the dictates of fashion. The annual output of the straw-plait industry in England is estimated to amount in value to about £4,000,000 [$19,440,000].

In the United States straw-plait work is principally centred in the State of Massachusetts.[1]

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[1] [According to the U. S. census of 1880 the manufacture of straw-goods was carried on in 77 establishments, with a total capital of $3,333,560, the products being valued at $9,345,759. In Massachusetts there were 33 establishments (capital $2,361,960), whose prod-

Many substances besides straw are worked into plaits and braids for bonnets. Among these may be noticed thin strips of willow and cane, and the fronds of numerous palms. "Brazilian" hats made from the fronds of the palmetto palms, *Sabal Palmetto* and *S. mexicana*, are now largely made at St. Albans. The famous Panama hats, fine qualities of which at one time were worth £20 [$97.20] to £30 [$145.80] each, are made from the leaves of the screw pine, *Carludovica palmata*. They are now manufactured at Dresden, Strasburg, and Nancy, and can be purchased at 30s. or £2 [$7.29 or 9.72.]

STREET, **George Edmund** (1824–1881), one of the ablest architects of the present century, was born at Woodford in Essex in 1824. He obtained his architectural education in the office of Mr. Owen Carter at Winchester, and afterwards worked for five years as an "improver" with Sir G. G. Scott in London. At an early age Street became deeply interested in the principles of Gothic architecture, and devoted an unsparing amount of time and labor to studying and sketching the finest examples of mediæval buildings in England and on the Continent. He was a draughtsman of a very high order; his sketches are masterpieces of spirit and brilliant touch. In 1855 he published a very careful and well illustrated work on *The Brick and Marble Architecture of Northern Italy*, and in 1865 a book on *The Gothic Architecture of Spain*, with very beautiful drawings by his own hand. Street's personal taste led him in most cases to select for his design the 13th century Gothic of England or France, his knowledge of which was very great, especially in the skilful use of rich mouldings. By far the majority of the buildings erected by him were for ecclesiastical uses, the chief being the convent of East Grinstead, the theological college at Cuddesden, and a very large number of churches, such as St. Philip and St. James's at Oxford, St. John's at Torquay, All Saints at Clifton, St. Saviour's at Eastbourne, St. Margaret's at Liverpool, and St. Mary Magdalene, Paddington. His largest works were the nave of Bristol cathedral, the choir of the cathedral of Christ Church in Dublin, and, above all, the new Courts of Justice in London, second only in architectural importance (during this century) to the Houses of Parliament. After a prolonged competition Street was appointed architect to the Courts of Justice in 1868; but the building was not complete at the time of his death in December, 1881. A great deal of somewhat unfair criticism has been lavished on this building; but it should be remembered that Street was much hampered both by want of a sufficiently large site and by petty economies in money insisted on by the commissioner of works. Though perhaps deficient in unity of composition, this great building possesses much grace in its separate parts, and has great refinement of detail throughout. Street was elected an associate of the Royal Academy in 1866 and R.A. in 1871; at the time of his death he was professor of history to the Royal Academy, and had just finished a very interesting course of lectures on the development of mediæval architecture. He was also a member of the Royal Academy of Vienna, and a knight of the Legion of Honor. His somewhat sudden death, on December 18, 1881, was hastened by over-work and professional worries connected with the erection of the law courts. He was buried in the nave of Westminster Abbey, where his grave is marked by a handsome sepulchral brass designed by Mr. Bodley.

STREETS. See Roads, vol. xx. p. 597 *sq.*

STRENGTH OF MATERIALS.

1. THE name "strength of materials" is given to that part of the theory of engineering which deals with the nature and effects of stresses in the parts of engineering structures. Its principal object is to determine the proper size and form of pieces which have to bear given loads, or, conversely, to determine the loads which can be safely applied to pieces whose dimensions and arrangement are already given. It also treats of the relation between the applied loads and the changes of form which they cause. The subject comprises experimental investigation of the properties of materials as to strength and elasticity, and mathematical discussion of the stresses in ties, struts, beams, shafts, and other elements of structures and machines.

Stress.

2. **Stress** is the mutual action at the surface of contact between two bodies, or two imaginary parts of a body, whereby each of the two exerts a force upon the other. Thus, when a stone lies on the ground there is at the surface of contact a stress, one aspect of which is the force directed downwards with which the stone pushes the ground, and the other aspect is the equal force directed upwards with which the ground pushes the stone. A body is said to be in a state of stress when there is a stress between the two parts which lie on opposite sides of an imaginary surface of section. A pillar or block supporting a weight is in a state of stress because at any cross section the part above the section pushes down against the part below, and the part below pushes up against the part above. A stretched rope is in a state of stress, because at any cross section the part on each side is pulling the part on the other side with a force in the direction of the rope's length. A plate of metal that is being cut in a shearing machine is in a state of stress, because at the plane which is about to become the plane of actual section the portion of metal on each side is tending to drag the portion on the other side with a force in that plane.

State of stress.

Normal and tangential stress.

3. In a solid body which is in a state of stress the direction of stress at an imaginary surface of division may be normal, oblique, or tangential to the surface. When oblique it is often conveniently treated as consisting of a normal and a tangential component. Normal stress may be either push (compressive stress) or pull (tensile stress). Stress which is tangential to the surface is called shearing stress. Oblique stress may be regarded as so much push or pull along with so much shearing stress. The amount of stress per unit of surface is called the intensity of stress. Stress is said to be uniformly distributed over a surface when each fraction of the area of surface bears a corresponding fraction of the whole stress. If a stress P is uniformly distributed over a plane surface of area S, the intensity is P/S. If the stress is not uniformly distributed, the intensity at any point is $\delta P/\delta S$, where δP is the amount of stress on an indefinitely small area δS at the point considered. For practical purposes intensity of stress is usually expressed in tons weight per square inch, pounds weight per square inch, or kilogrammes weight per square millimetre or per square centimetre.[1]

Simple longitudinal stress.

4. The simplest possible state of stress is that of a short pillar or block compressed by opposite forces applied at its ends, or that of a stretched rope or other tie. In these cases the stress is wholly in one direction, that of the length. These states may be distinguished as simple longitudinal push and simple longitudinal pull. In them there is no stress on planes parallel to the direction of the applied forces.

Compound stress.

A more complex state of stress occurs if the block is compressed or extended by forces applied to a pair of opposite sides, as well as by forces applied to its ends,—that is to say, if two simple longitudinal stresses in different directions act together. A still more complex state occurs if a third stress be applied to the remaining pair of sides. It may be shown that any state of stress which can possibly exist at any point of a body

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ucts were valued at $6,898,628. No other State had a product amounting to half a million dollars. In value of product they ranked as follows: Illinois, Connecticut, Maryland, New York, New Jersey, Wisconsin.—Am. Ed.]

[1] One ton per sq. in. = 2240 ℔ per sq. in. = 1.511 kilos. per sq. mm.

may be produced by the joint action of three simple pull or push stresses in three suitably chosen directions at right angles to each other.[1] These three are called principal stresses, and their directions are called the axes of principal stress. These axes have the important property that the intensity of stress along one of them is greater, and along another it is less, than in any other direction. These are called respectively the axes of greatest and least principal stress.

Resolution of stress.

5. Returning now to the case of a single simple longitudinal stress, let AB (Fig. 1) be a portion of a tie or a strut which is being pulled or pushed in the direction of the axis AB with a total stress P. On any plane CD taken at right angles to the axis we have a normal pull or push of intensity $p = P/S$, S being the area of the normal cross-section. On a plane EF, whose normal is inclined to the axis at an angle θ, we have a stress still in the direction of the axis, and therefore oblique to the plane EF, of intensity P/S', where S' is the area of the surface EF, or $S/\cos\theta$. The whole stress P on EF may be resolved into two components, one normal to EF, and the other a shearing stress tangential to EF. The normal component (P_n, Fig. 2) is $P\cos\theta$; the tangential component (P_t) is $P\sin\theta$. Hence the intensity of normal pull or push on EF, or p_n, is $p\cos^2\theta$, and the intensity of shearing stress EF, or p_t, is $p\sin\theta\cos\theta$. This expression makes p_t a maximum when $\theta = 45°$: planes inclined at 45° to the axis are called planes of maximum shearing stress; the intensity of shearing stress on them is $\frac{1}{2}p$.

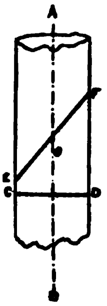

FIG. 1.

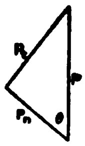

FIG. 2.

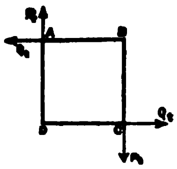

FIG. 3.

Shearing stress.

6. Shearing stress in one direction is necessarily accompanied by an equal intensity of shearing stress in another direction at right angles to the first. To prove this it is sufficient to consider the equilibrium of an indefinitely small cube (Fig. 3), with one pair of sides parallel to the direction of the shearing stress P_t. This stress, acting on two opposite sides, produces a couple which tends to rotate the cube. No arrangement of normal stresses on any of the three pairs of sides of the cube can balance this couple; that can be done only by a shearing stress Q_t, whose direction is at right angles to the first stress P_t and to the surface on which P_t acts, and whose intensity is the same as that of P_t. The shearing stresses P_t and Q_t may exist alone, or as components of oblique stress.

7. If they exist alone, the material is said to be in a state of simple shearing stress. This state of stress may be otherwise described by reference to the stresses on diagonal planes of the cube ABCD. Thus P_t and Q_t produce a normal stress R on a diagonal plane, and the equilibrium of the triangular prism (Fig. 4) requires that $R = P_t\sqrt{2}$. But R acts on a surface which is greater than each of the sides in the ratio of $\sqrt{2}:1$. The intensity of normal stress on the diagonal plane AC is therefore the same as the intensity of shearing stress on AB or BC. The same considerations apply to the other diagonal plane BD at right angles to AC, with this difference, that the stress on it is normal pull instead of push. Hence we may regard a state of simple shearing stress as compounded of two simple longitudinal stresses, one of push and one of pull, at right angles to each other, of equal intensity, and inclined at 45° to the direction of the shearing stress.

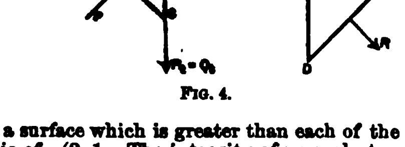

FIG. 4.

Strain.

8. STRAIN is the change of shape produced by stress. If the stress is a simple longitudinal pull, the strain consists of lengthening in the direction of the pull, accompanied by contraction in both directions at right angles to the pull. If the stress is a simple push, the strain consists of shortening in the direction of the push and expansion in both directions at right angles to that; the stress and the strain are then exactly the reverse of what they are in the case of simple pull. If the stress is one of simple shearing, the strain consists of a distortion such as would be produced by the sliding of layers in the direction of the shearing stresses.

A material is elastic with regard to any applied stress if the strain disappears when the stress is removed. Strain which persists after the stress that produced it is removed is called permanent set. For brevity, it is convenient to speak of strain which disappears when the stress is removed as elastic strain.

Limits of elasticity.

9. Actual materials are generally very perfectly elastic with regard to small stresses, and very imperfectly elastic with regard to great stresses. If the applied stress is less than a certain limit, the strain is in general small in amount, and disappears wholly or almost wholly when the stress is removed. If the applied stress exceeds this limit, the strain is, in general, much greater than before, and the principal part of it is found, when the stress is removed, to consist of permanent set. The limits of stress within which strain is wholly or almost wholly elastic are called limits of elasticity.

For any particular mode of stress the limit of elasticity is much more sharply defined in some materials than in others. When well defined it may readily be recognized in the testing of a sample from the fact that after the stress exceeds the limit of elasticity the strain begins to increase in a much more rapid ratio to the stress than before. This characteristic goes along with the one already mentioned, that up to the limit the strain is wholly or almost wholly elastic.

Hooke's law.

10. Within the limits of elasticity the strain produced by a stress of any one kind varies as the stress producing it. This is Hooke's law, enunciated by him in 1676.

In applying Hooke's law to the case of simple longitudinal stress,—such as the case of a bar stretched by simple longitudinal pull,—we may measure the state of strain by the change of length per unit of original length which the bar undergoes when stressed. Let the original length be l, and let the whole change of length be δl when a stress is applied whose intensity p is within the elastic limit. Then the strain is measured by $\delta l/l$, and this by Hooke's law varies as p. This may be written

$$\delta l : l :: p : E,$$

where E is a constant for the particular material considered. The same value of E applies to push and to pull, these modes of stress being essentially continuous, and differing only in sign.

Young's modulus.

11. This constant E is called the modulus of longitudinal extensibility, or Young's modulus. Its value, which is expressed in the same units as are used to express intensity of stress, may be measured directly by exposing a long sample of the material to longitudinal pull and noting the extension, or indirectly by measuring the flexure of a loaded beam of the material, or by experiments on the frequency of vibrations. It is frequently spoken of by engineers simply as the modulus of elasticity, but this name is too general, as there are other moduluses applicable to other modes of stress. Since $E = pl/\delta l$, the modulus may be defined as the ratio of the intensity of stress p to the longitudinal strain $\delta l/l$.

Modulus of rigidity.

12. In the case of simple shearing stress, the strain may be measured by the angle by which each of the four originally right angles in the square prism of Fig. 3 is altered by the distortion of the prism. Let this angle be ϕ in radians; then, by Hooke's law, $p/\phi = C$, where p is the intensity of shearing stress and C is a constant which measures the rigidity of the material. C is called the modulus of rigidity, and is usually determined by experiments in torsion.

Modulus of cubic compressibility.

13. When three simple stresses of equal intensity p and of the same sign (all pulls or all pushes) are applied in three directions, the material (provided it be isotropic, that is to say, provided its properties are the same in all directions) suffers change of volume only, without distortion of form. If the volume is V and the change of volume δV,

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[1] See ELASTICITY, vol. vii. p. 711.

the ratio of the stress p to the strain $\delta V/V$ is called the modulus of cubic compressibility, and will be denoted by K. The state of stress here considered is the only one possible in a fluid at rest. The intensity of stress is equal in all directions.

14. Of these three moduluses the one of most importance in engineering applications is Young's modulus E. When a simple longitudinal pull or push of intensity p is applied to a piece, the longitudinal strain of extension or compression is p/E. This is accompanied by a lateral contraction or expansion, in each transverse direction, whose amount may be written $p/\sigma E$, where σ is the ratio of longitudinal to lateral strain. It is shown in the article ELASTICITY, § 47, that $E=\frac{9CK}{3K+C}$ and $\sigma=\frac{2(3K+C)}{3K-2C}$.

Plastic strain.

15. Beyond the limits of elasticity the relation of strain to stress becomes very indefinite. Materials then exhibit, to a greater or less degree, the property of plasticity. The strain is much affected by the length of time during which the stress has been in operation, and reaches its maximum for any assigned stress only after a long (probably an indefinitely long) time. Finally, when the stress is sufficiently increased, the ratio of the increment of strain to the increment of stress becomes indefinitely great if time is given for the stress to take effect. In other words, the substance then assumes what may be called a completely plastic state; it *flows* under the applied stress like a viscous liquid.

Ultimate strength.

16. The *ultimate strength* of a material with regard to any stated mode of stress, is the stress required to produce rupture. In reckoning ultimate strength, however, engineers take, not the actual intensity of stress at which rupture occurs, but the value which this intensity would have reached had rupture ensued without previous alteration of shape. Thus, if a bar whose original cross-section is 2 square inches breaks under a uniformly distributed pull of 60 tons, the ultimate tensile strength of the material is reckoned to be 30 tons per square inch, although the actual intensity of stress which produced rupture may have been much greater than this, owing to the contraction of the section previous to fracture. The convenience of this usage will be obvious from an example. Suppose that a piece of material of the same quality be used in a structure under conditions which cause it to bear a simple pull of 6 tons per square inch; we conclude at once that the actual load is one-fifth of that which would cause rupture, irrespective of the extent to which the material might contract in section if overstrained. The stresses which occur in engineering practice are, or ought to be, in all cases within the limits of elasticity, and within these limits the change of cross-section caused by longitudinal pull or push is so small that it may be neglected in reckoning the intensity of stress.

Ultimate tensile strength and ultimate shearing strength are well defined, since these modes of stress (simple pull and simple shearing stress) lead to distinct fracture if the stress is sufficiently increased. Under compression some materials yield so continuously that their ultimate strength to resist compression can scarcely be specified; others show so distinct a fracture by crushing (§ 43 below) that their compressive strength may be determined with some precision. In what follows, the three kinds of ultimate strength will be designated by the symbols f_t, f_s, and f_c, for tension, shearing, and crushing respectively.

Some of the materials used in engineering, notably timber and wrought-iron, are so far from being isotropic that their strength is widely different for stresses in different directions. In the case of wrought-iron the process of rolling develops a fibrous structure on account of the presence of streaks of slag which become interspersed with the metal in puddling; and the tensile strength of a rolled plate is found to be considerably greater in the direction of rolling than across the plate. Steel plates, being rolled from a nearly homogeneous ingot, have nearly the same strength in both directions.

Factor of safety.

17. In applying a knowledge of the ultimate strength of materials to determine the proper sizes of parts in an engineering structure, these parts are proportioned so that the greatest intensity of stress (which for brevity is called the working stress) will be only a certain fraction of the ultimate strength. The ratio $\frac{\text{ultimate strength}}{\text{working stress}}$ is called the factor of safety.[1] The choice of a factor of safety depends on many considerations, such as the probable accuracy of the theory on which the calculation of working stress has been based; the uniformity of the material dealt with, and the extent to which its strength may be expected to conform to the assumed value or to the values determined by experiments on samples; the deviations from the specified dimensions which may be caused by bad workmanship; the probable accuracy in the estimation of loads; the extent to which the materials will deteriorate in time. The factor is rarely less than 3, is very commonly 4 or 5, and is sometimes as much as 12, or even more.

The ultimate strength for any one mode of stress, such as simple pull, has been found to depend on the time rate at which stress is applied; this will be noticed more fully later (§§ 28–34). It has also been found to depend very greatly on the extent and frequency of variation in the applied stress. A stress considerably less than the normal ultimate strength will suffice to break a piece when it is frequently applied and removed; a much smaller stress will cause rupture if its sign is frequently reversed; and hence in a structure which has to bear what is called live load the permissible intensity of stress is less than in a structure which has to bear only loads mainly on account of its frequency of variation (§§ 45, 46 below).

18. From an engineering point of view, the structural merit of a material, especially when live loads and possible shocks have to be sustained, depends not only on the ultimate strength but also on the extent to which the material will bear deformation without rupture. This characteristic is shown in tests made to determine tensile strength by the amount of ultimate elongation, and also by the contraction of the cross-section which occurs through the flow of the metal before rupture. It is often tested in other ways, such as by bending and unbending bars in a circle of specified radius, or by examining the effect of repeated blows. Tests by impact are generally made by causing a weight to fall through a regulated distance on a piece of the material supported as a beam.

Tests of strength.

19. Ordinary tests of strength are made by submitting the piece to direct pull, direct compression, bending, or torsion. Testing machines are frequently arranged so that they may apply any of these four modes of stress; tests by direct tension are the most common, and next in order are tests by bending. When the samples to be tested for tensile strength are mere wires, the stress may be applied directly by weights; for pieces of larger section some mechanical multiplication of force becomes necessary. Owing to the plasticity of the materials to be tested, the applied loads must be able to follow considerable change of form in the test-piece: thus in testing the tensile strength of wrought-iron or steel provision must be made for taking up the large extension of length which occurs before fracture. In most modern forms of large testing machines the loads are applied by means of hydraulic pressure acting on a piston or plunger to which one end of the specimen is secured, and the stress is measured by connecting the other end to a lever or system of levers provided with adjustable weights. In small machines, and also in some large ones, the stress is applied by screw gearing instead of by hydraulic pressure. Springs are sometimes used instead of weights to measure the stress, and sometimes one end of the specimen is made to act on a diaphragm forming part of a hydrostatic pressure-gauge (§ 23 below.)

Single-lever testing machine.

20. Figs. 5 and 6 show an excellent form of single-lever testing machine designed by Mr. J. H. Wicksteed,[2] in which the stress is applied by an hydraulic plunger and is measured by a lever or steelyard and a movable weight. The illustration shows a 30-ton machine, but machines of similar design have been built to exert a force of 100 tons or more. AA is the lever, on which there is a graduated scale. The stress on the test-piece T is measured by a weight W of 1 ton (with an attached vernier scale), which is moved along the lever by a screw-shaft S; this screw-shaft is driven by a belt from a parallel shaft R, which takes its motion, through bevel-wheels and a Hooke's joint in the axis of the fulcrum, from the hand-wheel H. (The Hooke's joint in the shaft R is shown in a separate sketch above the lever in Fig. 6.) The holder for the upper end of the sample hangs from a knife-edge three inches from the fulcrum of the lever. The lower holder is jointed to a crosshead C, which is connected by two vertical screws to a lower crosshead B, upon which the hydraulic plunger P, shown in section in Fig. 5, exerts its thrust. G is a counterpoise which pushes up the plunger, when the water is allowed to escape. Hydraulic pressure may be applied to P by pumps or by an accumulator. In the present instance

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[1] French engineers usually estimate the permissible working stress as a certain fraction of the elastic strength (that is, of the stress which reaches the limit of elasticity), instead of estimating it as a certain fraction of the ultimate strength.

[2] *Proc. Inst. Mech. Eng.*, August, 1882.

it is applied by means of an auxiliary plunger Q, which is pressed by screw gearing into an auxiliary cylinder. Q is driven by a belt on the pulley D. This puts stress on the specimen, and the weight W is then run out along the lever so that the lever is just kept floating between the stops E, E. Before the test-piece is put in, the distance between the holders is regulated by means of the screws connecting the upper and lower crossheads C and B, these screws being turned by a handle applied at F. Fig. 7 is a section of one of the holders, showing how the test-piece T is gripped by serrated wedges. The knife-edges are made long enough to prevent the load on them ever exceeding 5 tons to the linear inch.

Multiple-lever testing machines.

21. Another example of the single-lever type is the Werder testing machine, much used on the continent of Europe. In it the specimen is horizontal; one end is fixed; the other is attached to the short vertical arm of a bell-crank lever, whose fulcrum is pushed out horizontally by an hydraulic ram.[1] In many other testing machines a system of two, three, or more levers is employed to reduce the force between the specimen and the measuring weight. Probably the earliest machine of this class was that of Major Wade,[2] in which one end of the specimen was held in a fixed support, and the stretch was taken up by screwing up the fulcrum plate of one of the levers. In most multiple-lever machines, however, the fulcrums are fixed, and the stress is applied to one end of the specimen by hydraulic power or by screw gearing, which of course takes up the stretch, as in the single-lever machines already described. Mr. Kirkaldy, who was one of the earliest as well as one of the most assiduous workers in this field, applies in his 1,000,000 lb machine a horizontal hydraulic press directly to one end of the horizontal test-piece. The other end of the piece is connected to the short vertical arm of a bell-crank-lever; the long arm of this lever is horizontal, and is connected to a second lever to which weights are applied. In some of Messrs. Fairbanks's machines the multiple-lever system is carried so far that the point of application of the weight moves 24,000 times as far as the point of attachment to the test-piece. The same makers have employed a plan of adjusting automatically the position of the measuring weight, by making the scale lever complete an electric circuit when it rises or falls so that it starts an electric engine which runs the weight out or in.[3] Generally the measuring weight is adjusted by hand. In some, chiefly small, machines, the weight adjusts itself by means of another device. It is fixed at one point of a lever which is arranged as a pendulum, so that, when the test-piece is pulled by force applied at the other end, the pendulum lever is deflected from its originally vertical position and the weight acts with increasing leverage.

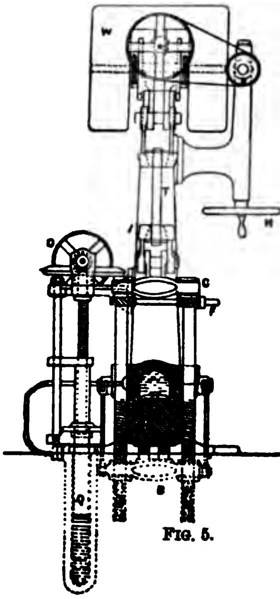

FIG. 5.

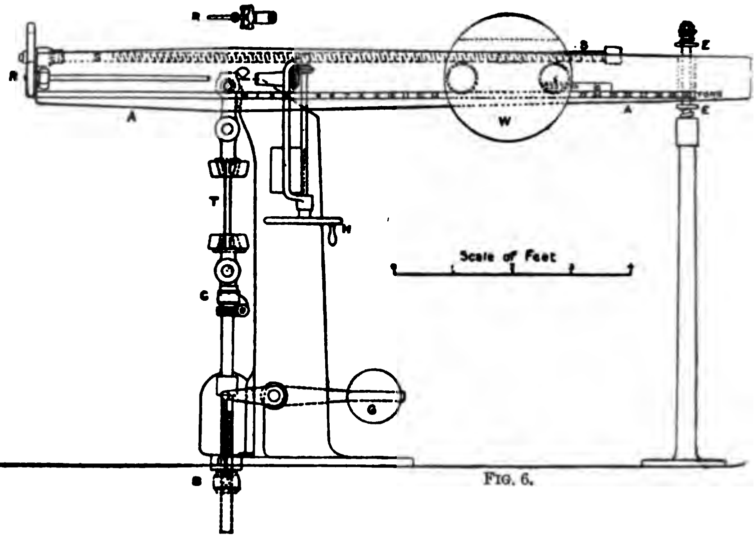

FIG. 6.

Wicksteed's Single-Lever Testing Machine.

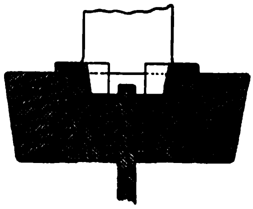

FIG. 7.

Multiple-lever machines have the advantage that the measuring weight is reduced to a conveniently small value, and that it can be easily varied to suit test-pieces of different strengths. On the other hand, their multiplicity of joints makes the leverage somewhat uncertain and increases friction. Another drawback is the inertia of the working parts. It is impossible to avoid oscillations of the levers; and, to prevent them from producing important errors in the recorded stress, the inertia of the oscillating system should be minimized. In a testing machine in which the specimen is directly loaded the inertia is simply that of the suspended weight M. In a lever machine, which multiplies the weight n times, the weight applied to the lever is reduced to M/n, but its inertia, when referred to the test-piece, is $(M/n) \times n^2$ or Mn. The inertia which is effective for producing oscillation is thus increased n times, so far as the weight alone is concerned, and this detrimental effect of leverage is increased by the inertia of the levers themselves. The effect will be more serious the greater is the leverage n.

22. Whitworth and others employ machines in which one end of the specimen is held in a fixed support; an hydraulic press acts on the other end, and the stress is calculated from the pressure of fluid in the press, this being observed by a pressure-gauge. Machines of this class are open to the obvious objection that the friction of the hydraulic plunger causes a large and very uncertain difference between the force exerted by the fluid on the plunger and the force exerted by the plunger on the specimen. It appears, however, that in the ordinary conditions of packing the friction is very nearly proportional to the fluid pressure, and its effect may therefore be allowed for with some exactness. The method is not to be recommended for work requiring precision, unless the plunger be kept in constant rotation on its own axis during the test, in which case the effects of friction are almost entirely eliminated.

Diaphragm testing machines.

23. In another important class of testing machines the stress (applied as before to one end of the piece, by gearing or by hydraulic pressure) is measured by connecting the other end to a flexible diaphragm, on which a liquid acts whose pressure is determined by a gauge. Fig. 8 shows a simple machine of this class (used in 1873 for testing wire

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[1] *Maschine zum Prüfen d. Festigkeit d. Materialen*, etc., Munich, 1882.

[2] *Report of Experiments on Metals for Cannon*, Philadelphia, 1856; also Anderson's *Strength of Materials*, p. 15.

[3] Abbott, *On Testing Machines*, New York, 1884, or *Van Nostrand's Engineering Mag.*, 1884.

by Sir W. Thomson and the late Prof. F. Jenkin). The wire is stretched by means of a screw at the top, and pulls up the lower side of a hydrostatic bellows; water from the bellows rises in the gauge-tube G, and its height measures the stress. Fig. 9 is Thomasset's testing machine, in which one end of the specimen is pulled by an hydraulic press A. The other end acts through a bell-crank lever B on a horizontal diaphragm C, consisting of a metallic plate and a flexible ring of india-rubber. The pressure on the diaphragm causes a column of mercury to rise in the gauge-tube D. The same principle is made use of in the testing machines of Chauvin and Marin-Darbel, Maillard,[1] and Bailey. It has found its most important application in the remarkable testing machine of Watertown arsenal, built in 1879 for the U. S. Government to the designs of Mr. A. H. Emery. This is a horizontal machine, taking specimens of any length up to 30 feet, and exerting a pull of 360 tons or a push of 480 tons by an hydraulic press at one end. The stress is taken at the other end by a group of four large vertical diaphragm presses, which communicate by small tubes with four similar small diaphragm presses in the scale case. The pressure of these acts on a system of levers which terminates in the scale beam. The joints and bearings of all the levers are made frictionless by using flexible steel connecting plates instead of knife-edges. The total multiplication at the end of the scale beam is 420,000.[2,3]

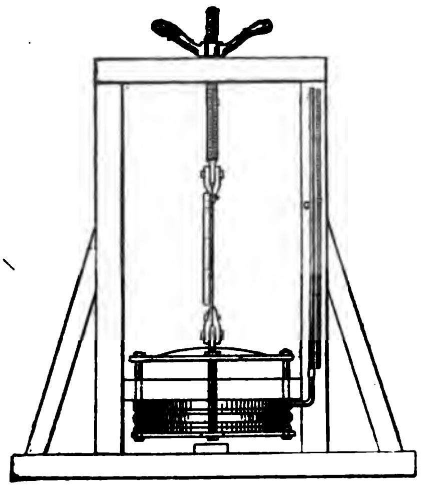

Fig. 8.—Hydraulic Machine for Testing Wire.

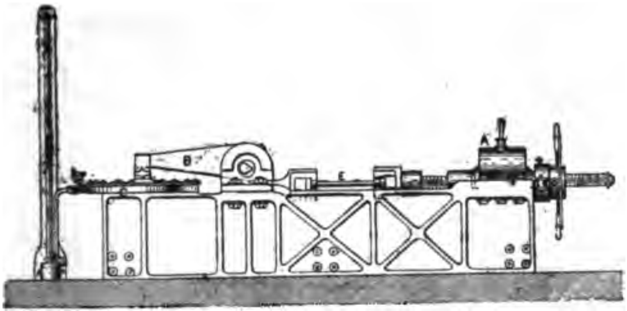

Fig. 9.—Thomasset's Testing Machine.

Watertown machine.

Stress-strain diagrams.

24. The results of tests are very commonly exhibited by means of stress-strain diagrams, or diagrams showing the relation of strain to stress. A few typical diagrams for wrought-iron and steel in tension are given in Fig. 10, the data for which are taken from tests of long rods by Mr. Kirkaldy.[4] Up to the elastic limit these diagrams show sensibly the same rate of extension for all the materials to which they refer. Soon after the limit of elasticity is passed, a point, which has been called by Prof. Kennedy the yield-point, is reached, which is marked by a very sudden extension of the specimen. After this the extension becomes less rapid; then it continues at a fairly regular and gradually increasing rate; near the point of rupture the metal again begins to draw out rapidly. When this stage is reached rupture will occur through the flow of the metal, even if the load be somewhat decreased. The diagram may in this way be made to come back towards the line of no load, by withdrawing a part of the load as the end of the test is approached (§ 29 below).

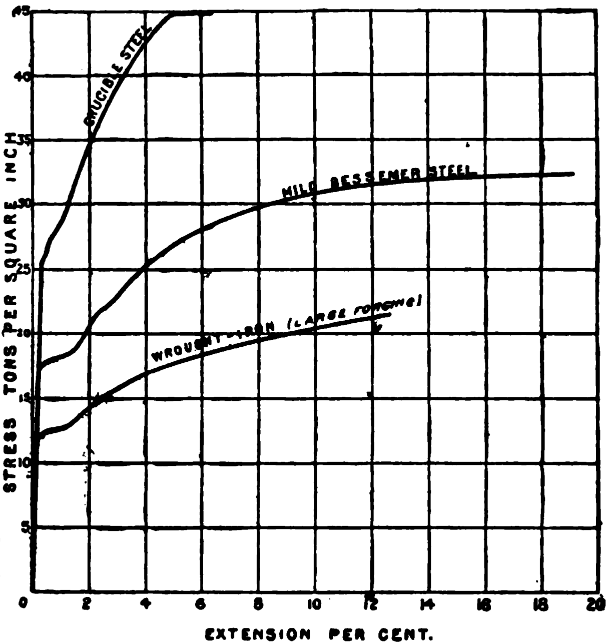

Fig. 10.

25. Fig. 11 is a stress-strain diagram for cast-iron in extension and compression, taken from Hodgkinson's experiments.[5] The extension was measured on a rod 50 feet long; the compression was also measured on a long rod, which was prevented from buckling by being supported in a trough with partitions. The full line gives the strain produced by loading; it is continuous through the origin, showing that Young's modulus is the same for pull and push. (Similar experiments on wrought-iron and steel in extension and compression have given the same result.) The broken line shows the set produced by each load. Hodgkinson found that some set could be detected after even the smallest loads had been applied. This is probably due to the existence of

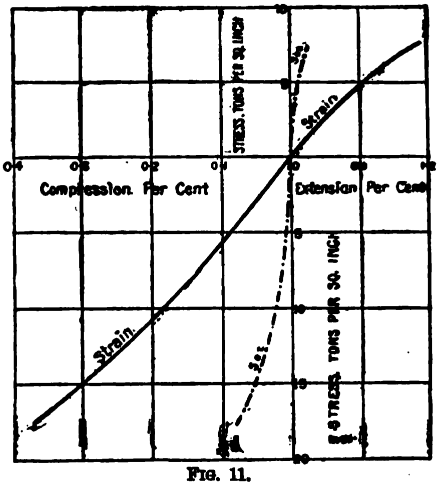

Fig. 11.

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[1] For descriptions of several of these machines, see a paper by MM. Denizeau and Lechien, *Mèmorial de l' Artillerie et de la Marine*, 1883.

[2] See *Report of the U. S. Board appointed to test Iron, Steel, and other Metals*, 2 vols., 1881. For full details of the Emery machine, see *Report of the U. S. Chief of Ordnance*, 1883, appendix 24.

[3] [For engraving and description of Emery's Testing-Machine, see p. 628.—Am. Ed.]

[4] *Experiments on the Mechanical Properties of Steel by a Committee of Civil Engineers*, London, 1868 and 1870.

[5] *Report of the Commissioners on the Application of Iron to Railway Structures*, 1849.

[Emery's novel testing machine is represented in the cut. In the award of a "grand medal of honor" by the Massachusetts Charitable Mechanics Association in 1881, for the "single exhibit most conducive to human welfare," the judges, who were appointed from and by the American Academy of Arts and Sciences, spoke of this mechanism, apart from its value for testing the strength of materials, "as a construction capable of several uses (which uses are claimed by the inventor). The first contrivance or gauge becomes of consequence because it can be applied to measure with accuracy many sorts of pressure, such as that of steam or that of the air. In like manner the weighing apparatus may, *mutatis mutandis*, be used as a delicate scale."

The horizontal machine shown in plan tests specimens, either for tension or compression, all lengths up to thirty feet, with any load from one pound to 800,000 pounds.

There are two main stationary screws (A), along which moves on wheels the straining press (B), which is put in position by geared rotating nuts that fix the press at any point suited to the length of the specimen. The liquid to operate the press passes from the Gauge case without pulsation through the valves in the scale case and swing-jointed pipes (C) to the straining press B. The specimen is griped at either end by holders (D), one of which is attached to the straining press, and the other to the scale-end of the machine where the load on the specimen of either tension or compression operates alike on the scale, being received directly on four hydraulic supports placed between the coupled beams E and F, which act one as the platform and the other as the bed of the scale according as the test is for compression or tension. When the strains to be measured are compression, the clamp-plates at G must be removed and screwed to the beam F and holder D, one above and the other below, while F then becomes the platform and E the bed of the scale, thus reversing the functions of the coupled beams when the test is for tension, from what they are when the strains are for compression.

The hydraulic supports have each a loose piston which sits upon a thin film of liquid between two diaphragms, and is a short cylinder stayed axially in its case by thin flexible diaphragms attached to its ends, the inner one sealing the chamber in which the liquid is confined. The piston moves without friction and imposes the strain of the specimen directly upon the liquid film beneath. There are four of these supports to receive the primal pressure of the strain which they transmit to four other small communicating hydraulic chambers in the scale-case (H), where the load is reduced in the proportion of the area of the piston of support to that of the chambers in the scale-case, where it acts on compound levers working upon specially devised fulcrums, which substitute for the knife edges customary in other scales a thin flexible plate wedged in slots upon the levers and acting without friction, back-lash or wear. The weights for these levers are in decimal series, the value of one being ten times that of the next adjoining. They are behind plate-glass and are operated quickly by a system of levers.

The motion of the indicator is 420,000 times that of the platform, and as this is only 1.6 inches the specimen would change its length less than .000004 inch to move the indicator over its full sweep, which greatly facilitates the accurate weighing of the load, as the indicator with any load on the specimen can be brought carefully to balance at 0 without sensible change in the length of the specimen.

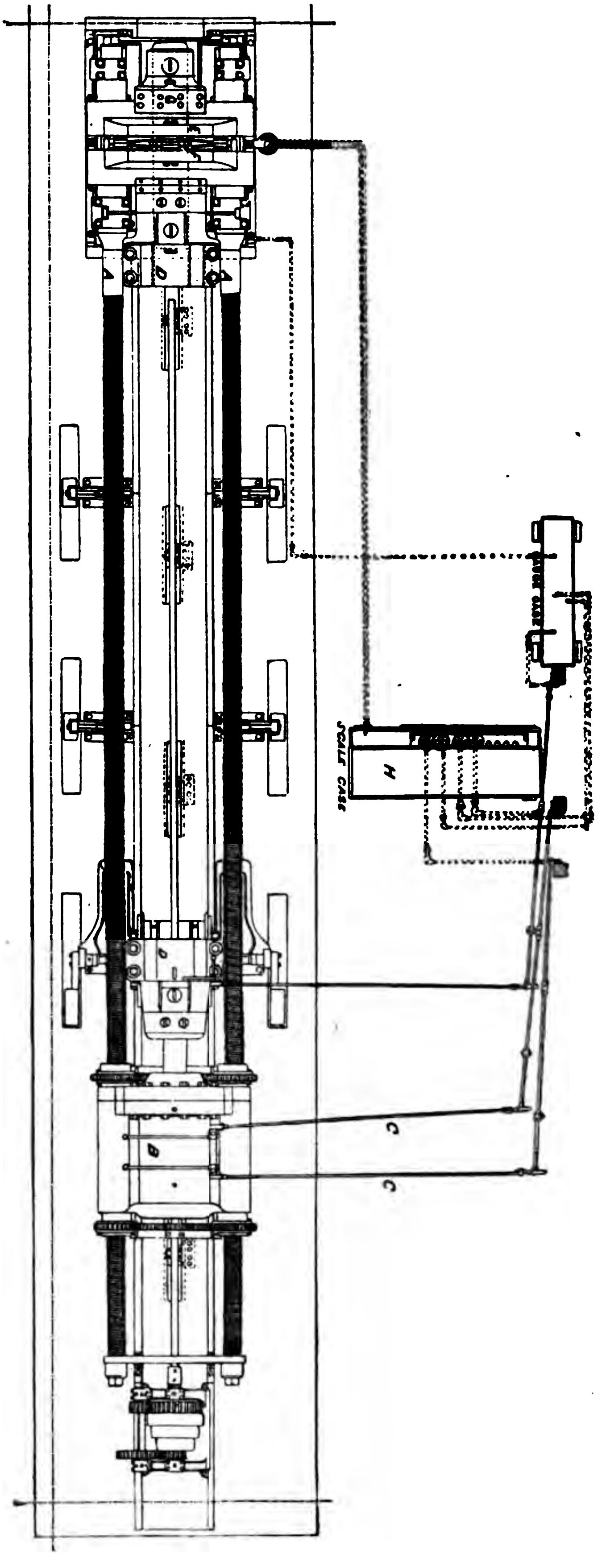
The horizontal machine has hydraulic holders with dies to seize round, flat or square specimens and in all cases to hold their axes parallel to that of the machine.

A vertical form of this machine is designed for testing transverse loads as well as tension and compression. In the former case the ordinates of the curve of flexion are measured directly without error from the yielding of the transverse beam or of other parts of the machine. As in the horizontal type of this mechanism, so here the straining-press is controlled by geared nuts which may be put and held at any desired point on stationary screws (A).

The tension holders have either two or four wedges to seize the specimen. These have polished cylindrical backs fitting in cylindrical seats whose axes are so inclined as to cause the wedges to draw together on the specimen by its own strain aided by an initial loadspring. The wedges are connected to a central guide-stem which forces them to move forward alike, thus keeping the axis of the specimen in the axis of the machine,—a thing of great importance, but accomplished in few if in any other machines having wedge-griping holders.

There is no shock on the scale-case or its contents from the breaking of the specimen. The motion of the indicator of the scales is from 40 to 100 times that of the beam or poise weights, which are put on or off very quickly by the use of levers made to operate them. They move but slightly, and give no troublesome oscillations to the levers.

The substance of this note and the accompanying cut have been furnished for this REPRINT by the inventor of the machine.—AM. ED.]



initial internal stress in the metal, produced by unequally rapid cooling in different portions of the cast bar. A second loading of the same piece showed a much closer approach to perfect elasticity. The elastic limit is, at the best, ill defined; but by the time the ultimate load is reached the set has become a more considerable part of the whole strain. The pull curves in the diagram extend to the point of rupture; the compression curves are drawn only up to a stage at which the bar buckled (between the partitions) so much as to affect the results.

Autographic recorders.

26. Testing machines are now frequently fitted with autographic appliances for drawing strain diagrams. When the load is measured by a weight travelling on a steelyard, the diagram may be drawn by connecting the weight with a drum by means of a wire or cord, so that the drum is made to revolve through angles proportional to the travel of the weight. At the same time another wire, fastened to a clip near one end of the specimen, and passing over a pulley near the other end, draws a pencil through distances proportional to the strain, and so traces a diagram of stress and strain on a sheet of paper stretched round the drum. Apparatus of this kind has been used by Messrs. Fairbanks, Unwin, Aspinall, and others.[1] In Mr. Wicksteed's autographic recorder the stress is determined by reference, not to the load on the lever, but to the pressure in the hydraulic cylinder by which stress is applied. The main cylinder is in communication with a small auxiliary hydraulic cylinder, the plunger of which is kept rotating to avoid friction at its packing. This plunger abuts against a spring, so that the distance through which it is pushed out varies with the pressure in the main cylinder. A drum covered with paper moves with the plunger under a fixed pencil, and is also caused to rotate by a wire from the specimen through distances which vary as the strain. The scale of loads is calibrated by occasional reference to the weighted lever.[2] In Prof. Kennedy's machine autographic diagrams are drawn by applying the stress to the test-piece through an elastic master-bar of larger section. The master-bar is never strained beyond its elastic limit, and within that limit its extension furnishes an accurate measure of the stress; this gives motion to a pencil, which writes on a paper moved by the extension of the test-piece.[3] In Prof. Thurston's pendulum machine for torsion tests, a cam attached to the pendulum moves a pencil through distances proportional to the stress, while a paper drum attached to the other end of the test-piece turns under the pencil through distances which vary as the angle of twist.[4]

Measurement of elastic strain.

27. The elastic extension or compression of a test-piece of ordinary dimensions is so small as to require for its measurement refined methods which are seldom employed in everyday practical testing. Measurements of this class must be made simultaneously on opposite sides of the test-piece, to guard against error through the bending of the piece. Microscopes and also various forms of micrometer calipers are used for the purpose.[5] A method capable of great delicacy, which has been used by Bauschinger[6] and others, is to measure the strain by light reflected from a pair of small mirrors attached to rollers which turn as the specimen extends or contracts. With apparatus of this kind it may be shown that iron, steel, or other materials with a well-defined yield-point begin to show a marked defect of elasticity at a somewhat lower stress. The true elastic limit comes considerably earlier in the test than the point which usually passes by that name.[7]

Viscosity.

28. In testing a plastic material such as wrought-iron or mild steel it is found that the behavior of the metal depends very materially on the time rate at which stress is applied. When once the elastic limit is passed the full strain corresponding to a given load is reached only after a perceptible time, sometimes even a long time. If the load be increased to a value exceeding the elastic limit, and then kept constant, the metal will be seen to draw out (if the stress be one of pull), at first rapidly and then more slowly. When the applied load is considerably less than the ultimate strength of the piece (as tested in the ordinary way by steady increment of load), it appears that this process of slow extension comes at last to an end. On the other hand, when the applied load is nearly equal to the ultimate strength, the flow of the metal continues until rupture occurs. Then, as in the former case, extension goes on at first quickly, then slowly, but, finally, instead of approaching an asymptotic limit, it quickens again as the piece approaches rupture. The same phenomena are observed in the bending of timber and other materials when in the form of beams. If, instead of being subjected to a constant load, a test-piece is set in a constant condition of strain, it is found that the stress required to maintain this constant strain gradually decreases.

29. The gradual flow which goes on under constant stress —approaching a limit if the stress is moderate in amount, and continuing without limit if the stress is sufficiently great—will still go on at a diminished rate if the amount of stress be reduced. Thus, in the testing of soft iron or mild steel by a machine in which the stress is applied by hydraulic power, a stage is reached soon after the limit of elasticity is passed at which the metal begins to flow with great rapidity. The pumps often do not keep pace with this, and the result is that, if the lever is to be kept floating, the weight on it must be run back. Under this reduced stress the flow continues, more slowly than before, until presently the pumps recover their lost ground and the increase of stress is resumed. Again, near the point of rupture, the flow again becomes specially rapid; the weight on the lever has again to be run back, and the specimen finally breaks under a diminished load. These features are well shown by Fig. 12, which is copied from the autographic diagram of a test of mild steel.[8]

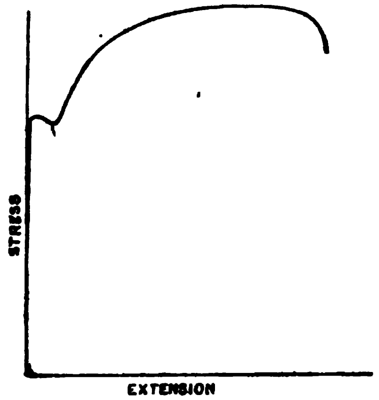


Fig. 12.—Autographic Diagram for a test of mild steel.

Hardening effect of permanent set.

Influence of time.

30. But it is not only through what we may call the viscosity of materials that the time rate of loading affects their behavior under test. In iron and steel, and probably in some other metals, time has another effect of a very remarkable kind. Let the test be carried to any point *a* (Fig. 13) past the original limit of elasticity. Let the load then be removed; during the first stages of this removal the material continues to stretch slightly, as has been explained above. Let the load then be at once replaced and loading continued. It will then be found that there is a new yield-point *b* at or near the value of the load formerly reached; up to this point there is little other than elastic strain. The full line *bc* in Fig. 13 shows the subsequent behavior of the piece. But now let the experiment be repeated on another sample, with this difference, that an interval of time, of a few hours or more, is allowed to elapse after the load is removed and before it is replaced. It will then be found that a process of hardening has been going on during this interval of rest; for, when the loading is continued, the new yield-point appears, not at *b* as formerly, but at a higher load *d*. Other evidence that a change has

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[1] For descriptions of these and other types of autographic recorder, see a paper by Prof. Unwin, "On the Employment of Autographic Records in Testing Materials," *Jour. Soc. Arts*, Feb., 1886; also Prof. Kennedy's comprehensive paper, "On the Use and Equipment of Engineering Laboratories," *Min. Proc. Inst. C. E.*, 1886, which contains much valuable information on the whole subject of testing and testing machines.

[2] *Proc. Inst. Mech. Eng.*, 1886. An interesting feature of this apparatus is a device for preventing error in the diagram through motion of the test-piece as a whole.

[3] *Proc. Inst. Mech. Eng.*, 1886; also *Min. Proc. Inst. C. E.*, vol. lxxxviii., 1886, pl. 1.

[4] Thurston's *Materials of Engineering*, part ii. For accounts of work done with this machine, see *Trans. Amer. Soc. Civ. Eng.*, from 1876; also, *Report* of the American Board, cited above.

[5] See a paper by Prof. Unwin. *Phil. Mag.*. March, 1887.

[6] *Mitth. aus dem Mech.-Tech. Lab. in München*, Heft 5.

[7] *Cf.* Bauschinger, *loc. cit.*; Kennedy, *loc. cit.*; Jenny, *Festigkeits Versuche*, Vienna, 1878.

[8] The increase of strain without increase of stress, which goes on without limit when a test-piece under tension approaches rupture, is a special case of the general phenomenon of "flow of solids," which has been exhibited, chiefly for compressive stresses, in a series of beautiful experiments by Tresca (*Mémoires sur l'Écoulement des Corps Solides*, also, *Proc. Inst. Mech. Eng.*, 1867 and 1878).

taken place is afforded by the fact that the ultimate extension is reduced and the ultimate strength is increased (*e*, Fig. 13).

31. A similar and even more marked hardening occurs when a load (exceeding the original elastic limit), instead of being removed and replaced, is kept on for a sufficient length of time without change. When loading is resumed a new yield-point is found only after a considerable addition has been made to the load. The result is, as in the former case, to give greater ultimate strength and less ultimate elongation. Fig. 14 exhibits two experiments of this kind, made with annealed iron wire. A load of 23½ tons per square inch was reached in both cases; *ab* shows the result of continuing to load after an interval of five minutes, and *acd* after an interval of 45½ hours, the stress of 23½ tons being maintained during the interval in both cases.

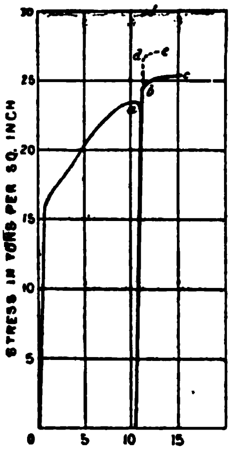

Fig. 13.

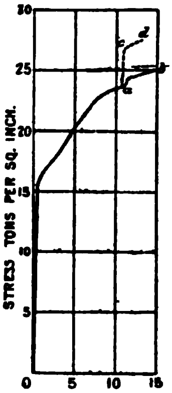

Fig. 14.

32. It must not be supposed that in a material hardened by strain the elasticity is perfect up to the yield-points which are shown in Fig. 13 at *b* and *d* or in Fig. 14 at *c*. In experiments made for this article, it has been found that, after a piece of very soft iron wire has been hardened (as in Fig. 14) by the continued application of a load which had caused stretching, if a small addition be made to the load (bringing it to a value between *a* and the new yield-point), although there is at first no apparent drawing out, nevertheless if time be given the wire begins again to draw, and a large amount of stretching at an increased pace may ensue. In this way wires have been broken with loads considerably short of those which would have been required had the process of loading, from the point *a* onward, been continued at a moderately rapid rate. A slow process of viscous deformation may in fact be occurring at the same time that the metal shows a quasi-elasticity with respect to rapid alteration of stress. Bauschinger's micrometric experiments have shown that after a piece has been hardened by rest the true limit of elasticity, or the point at which Hooke's law begins to fail, comes far short of the yield-point. He has also shown that a long interval of rest after the set has taken place produces a slow rise of the true limit of elasticity,[1] apparently a slower rise than the lapse of time causes in the yield-point itself.

33. In the testing of iron and steel the time during which any state of (pull) stress (exceeding the original elastic limit) exists affects the result in two somewhat antagonistic ways. It augments extension, by giving the metal leisure to flow. This may be called the viscous effect. But, on the other hand, it reduces the amount of extension which subsequent greater loads will cause, and it increases the amount of load required for rupture in the way which has just been described. This may be called the hardening effect. When a piece is broken by continuous gradual increment of load, these two effects are occurring at all stages of the test. If the viscous effect existed alone, or if the hardening effect were small, the material would show to greater advantage as regards elongation, and to less advantage as regards ultimate strength, the more slowly the load were applied. Tin and lead may be cited as materials for which this is the case. But when the hardening effect is relatively great, as in iron and steel, the material shows less elongation and a higher breaking strength the more slowly it is tested. An excellent illustration of this is given by the following experiment of Mr. Bottomley. Pieces of iron wire, annealed and of exceptionally soft quality, when loaded at the rate of 1 lb in 5 minutes, broke with 44½ lb and stretched 27 per cent. of their original length. Other pieces of the same wire, loaded at the rate of 1 lb in 24 hours, broke with 47 lb and stretched less than 7 per cent.[2] Again, it has been found that an excessively rapid application of stress (by the explosion of gun-cotton) makes soft steel stretch twice as much as in ordinary testing.[3] The case is very different, however, if the material has been previously hardened by strain. It does not appear that such variations in the rate of loading as are liable to occur in practical tests of iron or steel have much influence on the extension or the strength, great as the effects of time are when the metal is loaded either much more slowly or much more quickly. In Fig. 15 the results are shown of tests of two similar pieces of soft iron wire, one loaded to rupture in 4 minutes and the other at a rate about 5000 times slower.

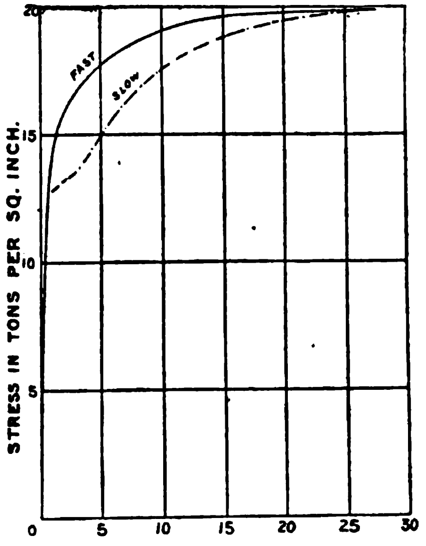

Fig. 15.

34. The hardening effect which intervals of rest from load or of constant load produce, once the primitive elastic limit is passed, has been examined by Beardsley.[4] Thurston,[4] Bauschinger,[5] Ewing[6], and others. The effect of even a few minutes' pause is perceptible, an hour or two of constant stress has a very marked influence, and after 24 hours or so there appears to be little further hardening. The American Board found that iron bars, previously stressed to about 50,000 lb per square inch, gained in strength, by intervals of rest from stress, to the extent of about 9 per cent. in one day, 16 per cent. in three days, and 18 per cent. in six months.[7]

35. It may be concluded that, when a piece of metal has in any way received a permanent set by stress exceeding its limits of elasticity, it is hardened, and (in some cases at least) its physical properties go on slowly changing for days or even months. Instances of the hardening effect of permanent set occur when plates or bars are rolled cold, hammered cold, or bent cold, or when wire is drawn. When a hole is punched in a plate the material contiguous to the hole is severely distorted by shear, and is so much hardened in consequence that when a strip containing the punched hole is broken by tensile stress the hardened portion, being unable to extend so much as the rest, receives an undue proportion of the stress, and the strip breaks with a smaller load than it would have borne had the stress been uniformly distributed. This bad effect of punching is especially noticeable in thick plates of mild steel. It disappears when a narrow ring of material surrounding the hole is removed by means of a rimer, so that the material that is left is homogeneous. Another remarkable instance of the same kind of action is seen when a mild-steel plate which

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[1] *Mitth. aus dem Mech.-Tech. Lab. in München*, Heft 13, 1886.

[2] *Proc. Roy. Soc.*, 1879, p. 221. See also ELASTICITY, § 80.

[3] See remarks by Col. Maitland, *Min. Proc. Inst. C. E.*, vol. lxxvi. p. 104.

[4] See *Report of the U. S. Board on Tests of Metals*, vol. 1. section 4.

[5] *Loc. cit.*

[6] *Proc. Roy. Soc.*, June, 1870. The autographic diagrams given in Figs. 13 and 14 are taken from these tests.

[7] *Loc. cit.*, p. 111.

is to be tested by bending has a piece cut from its edge by a shearing machine. The result of the shear is that the metal close to the edge is hardened, and, when the plate is bent, this part, being unable to stretch like the rest, starts a crack or tear which quickly spreads across the plate on account of the fact that in the metal at the end of the crack there is an enormously high local intensity of stress (see ELASTICITY, § 72). By the simple expedient of planing off the hardened edge before bending the plate homogeneity is restored, and the plate will then bend without damage.

Annealing.

Hardening and tempering of steel.

36. The hardening effect of strain is removed by the process of annealing, that is, by heating to redness and cooling slowly. In iron, very mild steel, and most other metals the rate of cooling is a matter of indifference; but in steel that contains more than about 0.2 per cent. of carbon another kind of hardening is produced if the metal, after being heated to redness, is cooled suddenly. When the proportion of carbon is considerably greater than this, steel may be rendered excessively hard and brittle ("glass-hard") by sudden cooling from a red heat. Further, by being subsequently heated to a moderate temperature, it may be deprived of some of this hardness and rendered elastic through a wide range of strain. This process is called the tempering of steel; its effects depend on the temperature to which the steel is heated after being hardened, and the grade of temper which is acquired is usually specified by the color (blue, straw, etc.) which appears on a clean surface of the metal during this heating, through the formation of a film of oxide. In the ordinary process of rolling plates or bars of iron or mild steel the metal leaves the rolls at so high a temperature that it is virtually annealed, or pretty nearly so.[1] The case is different with plates and bars that are rolled cold: they, like wire supplied in the hard-drawn state (that is, without being annealed after it leaves the draw-plate), exhibit the higher strength and greatly reduced plasticity which result from permanent set.

Contraction of section at rupture.

37. The extension which occurs when a bar of uniform section is pulled is at first general, and is distributed with some approach to uniformity over the length of the bar. Before the bar breaks, however, a large additional amount of local extension occurs at and near the place of rupture. The material flows in that neighborhood much more than in other parts of the bar, and the section is much more contracted there than elsewhere. The contraction of area at fracture is frequently stated as one of the results of a test, and is a useful index to the quality of materials. If a flaw is present sufficient to determine the section at which rupture shall occur the contraction of area will in general be distinctly diminished as compared with the contraction in a specimen free from flaws, although little reduction may be noted in the total extension of the piece. Local extension and contraction of area are almost absent in cast-iron and hard steel; on the other hand they are specially prominent in wrought-iron, mild steel, and other metals that combine plasticity with high tensile strength. An example is shown in Fig. 16, which is copied from a photograph of a broken test-piece of Whitworth soft fluid-compressed steel.

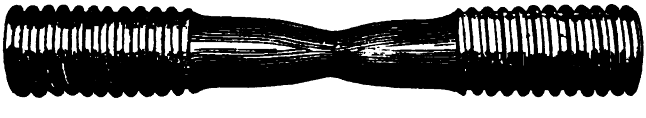

FIG. 16.

38. Experiments with long rods show that the general extension which occurs in parts of the bar not near the break is somewhat irregular;[2] it exhibits here and there incipient local stretching, which has stopped without leading to rupture. This is of course due in the first instance to want of homogeneity. It may be supposed that when local stretching begins at any point in the earlier stages of the test it is checked by the hardening effect of the strain, until, finally, under greater load, a stage is reached in which the extension at one place goes on so fast that the hardening effect cannot keep pace with the increase in intensity of stress which results from diminution of area; the local extension is then unstable, and rupture ensues. Even at this stage a pause in the loading, and an interval of relief from stress, may harden the locally stretched part enough to make rupture occur somewhere else when the loading is continued.

Influence of local stretching on total elongation.

39. Local stretching causes the percentage of elongation which a test-piece exhibits before rupture (an important quantity in engineers' specifications) to vary greatly with the length and section of the piece tested. It is very usual to specify the length which is to exhibit an assigned percentage of elongation. This, however, is not enough; the percentage obviously depends on the relation of the transverse dimensions to the length. A fine wire of iron or steel, say 8 inches long, will stretch little more in proportion to its length than a very long wire of the same quality. An 8-inch bar, say 1 inch in diameter, will show something like twice as much the percentage of elongation as a very long rod. The experiments of M. Barba[3] show that, in material of uniform quality, the percentage of extension is constant for test-pieces of similar form, that is to say, for pieces of various size in which the transverse dimensions are varied in the same proportion as the length. It is to be regretted that in ordinary testing it is not practicable to reduce the pieces to a standard form, with one proportion of transverse dimensions to length, since an arbitrary choice of length and cross-section gives results which are incapable of direct comparison with one another.

Influence on strength.

40. The form chosen for test-pieces in tension tests affects not only the extension but also the ultimate strength. In the first place, if there is a sudden or rapid change in the area of cross section at any part of the length under tension (as at AB, Fig. 17), the stress will not be uniformly distributed there. The intensity will be greatest at the edges A and B, and the piece will, in consequence, pass its elastic limit at a less value of the total load than would be the case if the change from the larger to the smaller section were gradual. In a non-ductile material, rupture will for the same reason take place at AB, with a less total load than would otherwise be borne. On the other hand, with a sufficiently ductile material, although the section AB is the first to be permanently deformed, rupture will preferably take place at some section not near AB, because at and near AB the contraction of sectional area which precedes rupture is partly prevented by the presence of the projecting portions C and D. Hence, too, with a ductile material samples such as those of Fig. 18, in which the part of smallest section between the shoulders or enlarged ends of the piece is short, will break with a greater load than could be borne by long uniform rods of the same section. In good wrought-iron and mild steel the flow of metal preceding rupture and causing local contraction of section extends over a length six or eight times the width of the piece; and, if the length throughout which the section is uniform be materially less than this, the process of flow will be rendered more difficult and the breaking load of the sample will be raised.[4]

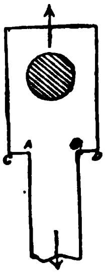

FIG. 17.

These considerations have of course a wider application than to the mere interpretation of special tests. An important practical case is that of riveted joints, in which the metal left between the rivet-holes is subjected to tensile stress. It is found to bear, per square inch, a greater pull than would be borne by a strip of the same plate, if the strip were tested in the usual way with uniform section throughout a length great enough to allow complete freedom of local flow.[5]

41. The tensile strength of long rods is affected by the

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[1] In several of Mr. Kirkaldy's papers, a comparison is given of the elastic limit, ultimate strength, and ultimate extension of samples which were annealed before testing, and of samples which were tested in the commercial state; in general the annealed samples are distinctly though not very materially, softer than the others (*On the Relative Properties of Wrought-Iron Plates from Essex and Yorkshire*, London, 1876; also *Experiments on Fagersta Steel*, London, 1878).

[2] See Kirkaldy's *Experiments on Fagersta Steel*, London, 1878; also *Report of the Steel Committee*, part 1.

[3] *Mém. de la Soc. des Ing. Civ.*, 1880; see also a paper by Mr. W. Hackney, "On the Adoption of Standard Forms of Test-Pieces," *Min. Proc. Inst. C.E.*, 1884.

[4] The greater strength of nicked or grooved specimens seems to have been first remarked by Mr. Kirkaldy (*Experiments on Wrought-Iron and Steel*, p. 74, also *Experiments on Fagersta Steel*, p. 27). See also a paper by Mr. E. Richards, on tests of mild steel, *Jour. Iron and Steel Inst.*, 1882.

[5] See Kennedy's "Reports on Riveted Joints," *Proc. Inst. Mech. Eng.*, 1881–5. In the case of mild steel plates a drilled strip may have as much as 12 per cent. more tensile strength per square inch than an undrilled strip. With punched holes, on the other hand, the remaining metal is much weakened, for the reason referred to in § 35.

Comparative strength of long and short rods.

length in a quite different way. With a perfectly homogeneous material, no difference should be found in the strength of rods of equal sectional area and of different lengths, provided the length of both were great enough to prevent the action described in § 40 from affecting the result. But, since no material is perfectly homogeneous, the longer rod will in general be the weaker, offering as it does more chances of a weak place; and the probable defect of strength in the long rod will depend on the degree of variability of the material. When this has been established by numerous tests of short samples, the strength which a rod of any assigned length may be expected to possess can be calculated by an application of the theory of probabilities. A theory of the strength of long bars has been worked out on this basis by Prof. Chaplin,[1] and has been experimentally confirmed by tests of long and short samples of wire. The theory does not apply when the length is so small that the action of § 40 enters into the case, and the experimental data on which it is based must be taken from tests of samples long enough to exclude that action.

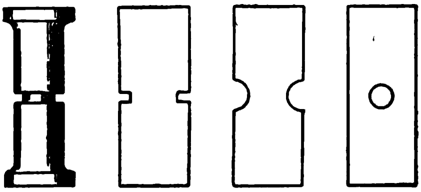
FIG. 18.

Fracture by tension.

42. In tension tests, rupture may occur, as in Fig. 19, by direct separation over a surface which is nearly plane and normal to the line of stress. This is usual in hard steel and other comparatively non-ductile materials. Or it may occur by shearing along an oblique plane, as in Fig. 20, which shows the fracture of a piece of steel softer than the specimen of Fig. 19. In very ductile samples these two modes of rupture are frequently found in combination, as in Fig. 21, where a central core is broken by direct tension while round it is a ring over which separation has taken place by shearing. In this instance the ring is in two parts, one above and one below the surface of rupture of the central flat core. In other instances, such as that of the sample shown in Fig. 16, the shorn ring forms a continuous cone or crater round a flat core.

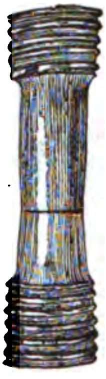
FIG. 19.

Fracture by compression.

43. In compression tests of a plastic material, such as mild steel, a process of flow may go on without limit; the piece (which must of course be short, to avoid buckling) shortens and bulges out in the form of a cask. This is illustrated by Fig. 22 (from one of Fairbairn's experiments), which shows the compression of a round block of steel (the original height and diameter of which are shown by the dotted lines) by a load equal to 100 tons per square inch of original sectional area. The surface over which the stress is distributed becomes enlarged, and the total load must be increased in a corresponding degree to maintain the process of flow.[2] The bulging often produces longitudinal cracks, as in the figure, especially when the material is fibrous as well as plastic (as in the case of wrought-iron). A brittle material, such as cast-iron, brick, or stone, yields by shearing on inclined planes as in Figs. 23 and 24, which are taken from Hodgkinson's experiments on cast-iron.[3] The simplest fracture of this kind is exemplified by Fig. 23, where a single surface (approximately a plane) of shear divides the compressed block into two wedges. With cast-iron the slope of the plane is such that this simple mode of fracture can take place only if the height of the block is not less than about ⅞ the width of the base. When the height is less the action is more complex. Shearing must then take place over more than one plane, as in Fig. 24, so that cones or wedges are formed by which the surrounding portions of the block are split off. The stress required to crush the block is consequently greater than if the height were sufficient for shearing in a single plane.

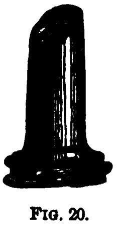
FIG. 20.

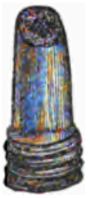
FIG. 21.

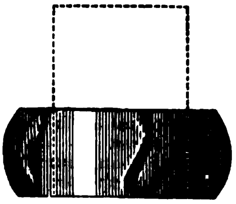
FIG. 22.

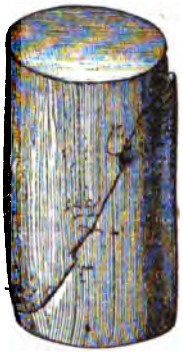
FIG. 23.

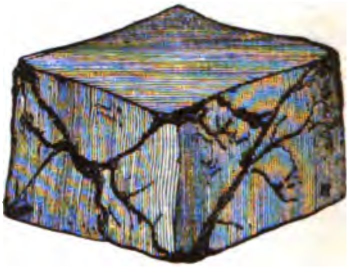
FIG. 24.

Plane of shear.

44. The inclination of the surfaces of shear, when fracture takes place by shearing under a simple stress of pull or push, is a matter of much interest, throwing some light on the question of how the resistance which a material exerts to stress of one kind is affected by the presence of stress of another kind,—a question scarcely touched by direct experiment. At the shorn surface there is, in the case of tension tests, a normal pull as well as a shearing stress, and in the case of compression tests a normal push as well as shearing stress. If this normal component were absent the material (assuming it to be isotropic) would shear in the surface of greatest shearing stress, which, as we have seen in § 5, is a surface inclined at 45° to the axis. In fact, however, it does not shear on this surface. Hodgkinson's experiments on the compression of cast-iron give surfaces of shear whose normal is inclined at about 55° to the axis of stress,[4] and Kirkaldy's, on the tension of steel, show that when rupture takes place by shear the normal to the surface is inclined at about 25° to the axis.[4] These results show that normal pull diminishes resistance to shearing and normal push increases resistance to shearing. In the case of cast-iron under compression, the material prefers to shear on a section where the intensity of shearing stress is only 0.94 of its value on the surface of maximum shearing stress (inclined at 45°), but where the normal push is reduced to 0.66 of its value on the surface of maximum shearing stress.

Fatigue of metals.

45. *Fatigue of Metals.*—A matter of great practical as well as scientific interest is the weakening which materials undergo by repeated changes in their state of stress. It appears that in some if not in all materials a limited amount of stress-variation may be repeated time after time without appreciable deterioration in the strength of the piece; in the balance-spring of a watch, for instance, tension and compression succeed each other some 150 millions of times in a year, and the spring works for years without apparent injury. In such cases the stresses lie well within the elastic limits. On the other hand, the toughest bar breaks after a small number of bendings to and fro, when these pass the elastic limits, although the stress may have a value greatly short of the normal ultimate strength. A laborious research by Wöhler,[5] extending over twelve years, has given much important information regarding the effects on iron and steel of very numerous repeated alternations of stress from positive to negative, or

Wöhler's experiments.

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[1] *Van Nostrand's Engineering Magazine*, December, 1880; *Proc. Engineers' Club of Philadelphia*, March, 1882.

[2] For example, see Fairbairn's experiments on steel, *Rep. Brit. Ass.*, 1867.

[3] *Report of the Royal Commissioners on the Application of Iron to Railway Structures*, 1849; see also *Brit. Ass. Rep.*, 1837.

[4] *Op. cit.*

[5] *Die Festigkeits-Versuche mit Eisen und Stahl*, Berlin, 1870, or *Zeitschr. für Bauwesen*, 1860-70; see also *Engineering*, vol. xi., 1871. For early experiments by Fairbairn on the same subject, see *Phil. Trans.*, 1864.

between a higher and a lower value without change of sign. By means of ingeniously contrived machines he submitted test-pieces to direct pull, alternated with complete or partial relaxation from pull, to repeated bending in one direction and also in opposite directions, and to repeated twisting towards one side and towards opposite sides. The results show that a stress greatly less than the ultimate strength (as tested in the usual way by a single application of load continued to rupture) is sufficient to break a piece if it be often enough removed and restored, or even alternated with a less stress of the same kind. In that case, however, the variation of stress being less, the number of repetitions required to produce rupture is greater. In general, the number of repetitions required to produce rupture is increased by reducing the range through which the stress is varied, or by lowering the upper limit of that range. If the greatest stress be chosen small enough, it may be reduced, removed, or even reversed many million times without destroying the piece. Wöhler's results are best shown by quoting a few figures selected from his experiments. The stresses are stated in centners per square zoll;[1] in the case of bars subjected to bending they refer to the top and bottom sides, which are the most stressed parts of the bar.

I. Iron bar in direct tension:

Stress. Max.	Stress. Min.	No. of Applications causing Rupture.	Stress. Max.	Stress. Min.	No. of Applications causing Rupture.
480	0	800	320	0	10,141,645
440	0	106,901	—	—	—
400	0	340,853	440	200	2,373,424
360	0	480,852	440	240	Not broken with 4 mills.

II. Iron bar bent by transverse load:

Stress. Max.	Stress. Min.	No. of Bendings causing Rupture.	Stress. Max.	Stress. Min.	No. of Bendings causing Rupture.
550	0	169,750	400	0	1,320,000
500	0	420,000	350	0	4,035,400
450	0	481,950	300	0	Not broken with 48 mills.

III. Steel bar bent by transverse load:

Stress. Max.	Stress. Min.	No. of Bendings causing Rupture.	Stress. Max.	Stress. Min.	No. of Bendings causing Rupture.
900	0	72,450	900	400	225,300
900	200	81,200	900	500	764,900—mean of 2 trials.
900	300	156,200	900	600	Not broken with 33½ mills.

IV. Iron bar bent by supporting at one end, the other end being loaded; alternations of stress from pull to push caused by rotating the bar:

Stress. From + to —	No. of Rotations causing Rupture.	Stress. From + to —	No. of Rotations causing Rupture.
320	56,430	220	3,632,588
300	99,000	200	4,917,992
280	183,145	180	19,186,791
260	479,490	160	Not broken with 132¼ millions.
240	909,810		

46. From these and other experiments Wöhler concluded that the wrought-iron to which the tests refer could probably bear an indefinite number of stress-changes between the limits stated (in round numbers) in the following table (the ultimate tensile strength was about 19½ tons per square inch):

	Stress in Tons per Sq. Inch.
From pull to push....................	+7 to −7
From pull to no stress..................	13 to 0
From pull to less pull	19 to 10½

Hence it appears that the actual strength of this material varies in a ratio which may be roughly given as 3 : 2 : 1 in the three cases of (*a*) steady pull, (*b*) pull alternating with no stress, very many times repeated, and (*c*) pull alternating with push, very many times repeated. Factors of safety applicable to the three cases might therefore rationally stand to one another in the ratio of 1 : 2 : 3. For steel Wöhler obtained results of a generally similar kind. His experiments were repeated by Spangenberg, who extended the inquiry to brass, gun-metal, and phosphor-bronze.[2] On the basis of Wöhler's results formulas have been devised by Launhardt, Weyrauch, and others to express the probable actual strength of metals under assigned variations of stress; these are, of course, of a merely empirical character, and the data are not yet extensive enough to give them much value.[3]

47. Wöhler's experiments, dealing, as all experiments must, with a finite number of stress-changes, leave it an open question whether there are any limits within which a state of stress might be indefinitely often varied without finally destroying the material. It is natural to suppose that a material possessing perfect elasticity would suffer no deterioration from stress-changes lying within limits up to which the elasticity is perfect. But these limits, if they exist at all, are probably very narrow. Indeed, in the case of iron, there is indirect evidence that all alteration of stress whatsoever affects the molecular structure in a way not consistent with the notion of perfect elasticity. When the state of stress in iron is varied, however slowly and however little, the magnetic and thermo-electric qualities of the metal are found to change in an essentially irreversible manner.[4] Every variation leaves its mark on the quality of the piece; the actual quality at any time is a function of all the states of stress in which the piece has previously been placed. It can scarcely be doubted that sufficiently refined methods of experiment would detect a similar want of reversibility in the mechanical effects of stress, even when alterations of stress occur slowly enough to escape the effects of viscosity which have been examined by Sir William Thomson and discussed under ELASTICITY (vol. vii. p. 695 *sq.*). In any case, the viscosity investigated by Thomson causes such stress-changes as occur rapidly to do work on the material, and the destructive effect of repeated changes may be due in great part to this cause. His experiments show that rapid stress-changes often repeated do produce a cumulative effect in reducing the modulus of elasticity; and it is very probable that this fatigue of elasticity is associated with fatigue of strength.

There are as yet no experiments showing how far fatigue of strength is affected by the frequency, as distinguished from the mere number, of the stress-changes, nor whether a period of rest, after fatigue has been induced, restores strength. That it does so may be conjectured from Thomson's discovery that rest restores elasticity after elastic fatigue. The conjecture is strengthened by Bauschinger's discovery that, after a permanent set has been produced and a period of rest follows, the apparent limit of elasticity (in the strict sense of that term) rises slowly with the lapse of time. Both questions are of obvious practical interest.[5]

48. When a strain is produced within the limits to which Hooke's law applies, the work done in producing it is half the product of the stress into the strain. A load applied to a piece suddenly, but without impact, does an amount of work in straining the piece which is measured by the weight of the load into the distance it sinks in consequence of the strain. Hence, provided this strain falls within the elastic limit, the strain and the stress are twice as great as the same load would produce when in equilibrium.

Strain produced by "live" load.

Instances of load applied with complete suddenness, and yet without shock, are rare; but it is a common case for loads to be applied so rapidly that the stress reaches a value intermediate between that due to a static load and the double stress due to the same load applied at once. Thus the Railway Commissioners found that certain bridges were deflected by a train passing at a speed of 50 miles per hour ⅐ more than by the same load at rest.[6] The fact that a "live" load produces greater stress than a dead load is of course to be distinguished from the question Wöhler's experiments deal with—the greater destructiveness of the intermitted or varied stress which a live load causes. In many cases engineers allow in one operation for these quite independent influences of a live load by choosing a higher factor of safety for the live than for the dead part of the whole load on a structure, or (what is the same thing) by multiplying the live load by a coefficient (often 1½), adding the product to the dead load, and treating the sum as if all were dead load.

49. A useful application of diagrams showing the relation of strain to stress is to determine the amount of work done in straining a piece in any assigned way. The term "resilience" is conveniently used to specify the amount of work done when

Resilience.

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[1] According to Bauschinger (*loc. cit.*, p. 44), the centner per square zoll in which Wöhler gives his results is equivalent to 6.837 kilos per square cm., or 0.0484 ton per square inch.

[2] *Ueber das Verhalten der Metalle bei weiderholten Anstrengungen*, Berlin, 1875.

[3] See Weyrauch, "On the Calculation of Dimensions as depending on the Ultimate Working Strength of Materials," *Min. Proc Inst. C. E.*, vol. lxiii. p. 275; also a correspondence in *Engineering*, vol. xxix., and Unwin's *Machine Design*, chap. ii.

[4] Ewing, *Phil. Trans.*, 1885, 1886.

[5] For interesting notices of the fatigue of metals in railway axles, bridge ties, etc., and results of experiments showing reduced plasticity in fatigued metal, see Mr. B. Baker's address to the Mechanical Section of the British Association, 1885. In most cases where the fatigue of metals occurs in engineering practice the phenomenon is complicated by the occurrence of blows or shocks whose energy is absorbed in producing strains often exceeding the elastic limits, sometimes of a very local character in consequence of the inertia of the strained pieces. Such shocks may cause an accumulation of set which finally leads to rupture in a way that is not to be confused with ordinary fatigue of strength. It appears that the effects of fatigue may be removed by annealing.

[6] *Report of Commissioners on the Application of Iron to Railway Structures*, 1849. A mathematical investigation of this effect of rolling load is given in an appendix to the Report.

the strain just reaches the corresponding elastic limit. Thus a rod in simple tension or simple compression has a resilience per unit of volume $=f^2/2E$, where f is the greatest elastic pull or push. A blow whose energy exceeds the resilience (reckoned for the kind of stress to which the blow gives rise) must in the most favorable case produce a permanent set; in less favorable cases local permanent set will be produced although the energy of the blow is less than the resilience, in consequence of the strain being unequally distributed. In a plastic material a strain exceeding the limit of elasticity absorbs a relatively large amount of energy, and generally increases the resilience for subsequent strains. Fracture under successive blows, as in the testing of rails by placing them as beams on two supports, and allowing a weight to fall in the middle from a given height, results from the accumulated set which is brought about by the energy of each blow exceeding the resilience.

Internal stress.

50. In an important paper[1] which is reprinted in the article Elasticity, and should be carefully studied in this connection, Prof. James Thomson has pointed out that the effect of any externally applied load depends, to a very material extent, on whether there is or is not initial internal stress, or, in other words, whether the loaded piece is initially in what Prof. Hearson has called a state of ease. Internal stress, existing without the application of force from without the piece, must satisfy the condition that its resultant vanishes over any complete cross-section. It may exist in consequence of set caused by previously applied forces (a case of which instances are given below), or in consequence of previous temperature changes, as in cast-iron, which is thrown into a state of internal stress by unequally rapid cooling of the mass. Thus in (say) a spherical casting an outside shell solidifies first, and has become partially contracted by cooling by the time the inside has become solid. The inside then contracts, and its contraction is resisted by the shell, which is thereby compressed in a tangential direction, while the metal in the interior is pulled in the direction of the radius. Allusion has already been made to the fact, pointed out by J. Thomson, that the defect of elasticity under small loads which Hodgkinson discovered in cast-iron is probably due to initial stress. In plastic metal a nearly complete state of ease is brought about by annealing; even annealed pieces, however, sometimes show, in the first loading, small defects of elasticity, which are probably due to initial stress, as they disappear when the load is reapplied.

Effect of temperature on strength.

51. Little is exactly known with regard to the effect of temperature on the strength of materials. Some metals, notably iron or steel containing much phosphorus, show a marked increase in brittleness at low temperatures, or "cold-shortness." Experiments on the tensile strength of wrought-iron and steel show in general little variation within the usual atmospheric range of heat and cold. The tensile strength appears to be slightly reduced at very low temperatures, and to reach a maximum when the metal is warmed to a temperature between 100° C. and 200° C. When the temperature exceeds 300° C. the tensile strength begins to fall off rapidly, and at 1000° C. it is less than one-tenth of the normal value.[2] Reference may be made, in this connection, to the effect which a "blue heat," or temperature short of red heat, is believed to have on the plasticity and strength of iron, and more especially of mild steel. It appears that steel plates and bars bent or otherwise worked at a blue heat not only run a much more serious risk of fracture in the process than when worked either cold or red-hot, but become so deteriorated that brittleness may afterwards show itself when the metal is cold.[3]

Experimental data.

52. The following table gives a few representative data regarding the strength of the more important materials used in engineering (the figures are gathered from the writings of Barlow, Hodgkinson, Kirkaldy, Thurston, Rankine, Unwin, Clark, and others).

	Ultimate Strength. Tons per Square Inch.			Elasticity. Tons per sq. in.	
	f_t	f_c	f_s	Youngs Modulus E.	Mod. of Rigidity C.
Cast-iron	5½ to 10½	25 to 65	9 to 13	5000 to 6000	1300 to 2500
" average	7	42	11		
" Am. (ordnance)	14	36 to 58	...		
" " strengthened by successive fusions	15 to 20	60 to 75	...		
Wrought-iron—					
Finest Lowmoor and Yorkshire plates ...	27 to 29 along the fibre			...	--
	24 across	fibre	18 to 22, or about ⅘ of f_t	12,000 to 13,000	5000
Staffordshire	26 along	"			
	24 across	"			
Bridge iron	22 along	"			
	19 across	"			
Bars, finest	27 to 29	...			
Ordinary good	25	20			
Soft Swedish	19 to 24	...			
Wrought-iron wire	25 to 50	...	...	...	--
" " av. about	35	...	...	...	--
Steel—					
Mild steel plates (Siemens or Bessemer)	26 to 32 aver'ge about 30	...	about ⅘ of f_t	12,000 to 13,000	5000 to 5200
Axle and rail steel (do)	30 to 45	...			
Crucible tool steel	40 to 65	...	...		
Steel castings	about 28	...	...		
Chrome steel	80	...	...		
Tungsten steel	72	...	...		
Whitworth's fluid-compressed steel (mild)	40	...	...		
" " (hard)	48 to 68	...	...		
Steel wire, ordin'y, ab't	70	...	...		
Tempered steel rope wire (highest)	124	...	...	13,000	--
Pianoforte steel wire...	150	...	...	13,000	--
Copper, cast	10 to 14	35	10 to 14	7000	--
" rolled	15 to 16	...	...	...	--
" wire, hard-drawn	28	...	...	8000	2800
Brass	8 to 13	5	...	5500	1500
" wire	22	...	...	6400	2200
Muntz metal	22	...	...	...	--
Gun metal	11 to 23	...	...	4500 to 6500	1700
Phosphor bronze	15 to 26	...	...	6000	2400
" " wire	38 to 70	...	...	...	--
Manganese bronze	28 to 32	...	...	...	--
Zinc, cast	2 to 3	...	...	...	--
" rolled	7 to 10	...	...	5500	--
Tin	2	...	...	...	--
Lead	0.9	3	...	1000	--
Timber—					
Oak	3 to 7	4	1	800	--
White pine	1½ to 3½	2½	...	600	--
Pitch pine	4	...	...	950	--
Riga fir	2½ to 5½	...	...	...	--
Ash	4 to 7	2 to 4	½	750	--
Beech	4 to 6	4	...	...	--
Teak	4 to 7	4	...	950	--
Spanish mahogany	4 to 7	3½	...	650	--
Stone—					
Granite	...	2½ to 5	...	...	--
Sandstone	...	1½ to 2½	...	...	--
Limestone	...	2 to 2½	...	...	--
Slate	...	1½ to 3	...	7000	--
Brick	...	½ to ¾	...	...	--

Graphic representation of distributed stress.

53. Space admits of no more than a short and elementary account of some of the more simple straining actions that occur in machines and engineering structures.

The stress which acts on any plane surface AB (Fig. 25), such as an imaginary cross-section of a strained piece, may be represented by a figure formed by setting up ordinates A*a*, B*b*, etc., from points on the surface, the length of these being made proportional to the intensity of stress at each point. This gives an ideal solid, which may be called the stress figure, whose height shows the distribution of stress over the surface which forms its base. A line drawn from *g*, the centre of gravity of the stress figure, parallel to the ordinates A*a*, etc., determines the point C, which is called the centre of stress, and is the point through which the resultant of the distributed stress acts. In the case of a uniformly distributed stress, *ab* is a plane surface parallel to AB, and C is the centre of gravity of the surface AB. When a bar is subjected to simple pull applied axially—that is to say, so that the resultant stress passes through the centre of gravity of every cross-section,—the stress may be taken as (sensibly) uniformly distributed over any section not near a place where the form of the cross-section changes, provided the bar is initially in a state of ease and the stress is within the limits of elasticity.

Centre of stress.

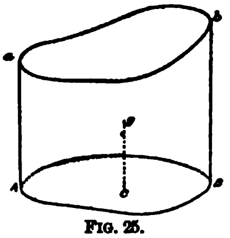

Fig. 25.

Uniformly varying stress.

54. Uniformly varying stress is illustrated by Fig. 26. It occurs (in each case for stresses within the elastic limit) in a bent beam, in a tie subjected to non-axial pull, and in a long strut or column where buckling makes the stress become non-axial. In uniformly varying stress the intensity p at any

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[1] *Camb. and Dub. Math. Journ.*, Nov., 1848.

[2] See *Report of a Committee of the Franklin Institute*, 1837; Fairbairn, *Brit. Ass. Rep.*, 1856; Styffe on *Iron and Steel*, trans. by C. P. Sandberg. Notices of these and other experiments will be found in Thurston's *Materials of Engineering*, ii. chap. x., and in papers by J. J. Webster, *Min. Proc. Inst. C.E.*, vol. lx., and A. Martens, *Zeitschr. des Ver. Deutsch. Ing.*, 1883.

[3] Stromeyer, "The Injurious Effect of a Blue Heat on Steel and Iron," *Min. Proc. Inst. C.E.*, vol. lxxxiv., 1886.

point P varies as the distance of P from a line MN, called the neutral axis, which lies in the plane of the stressed surface and at right angles to the direction AB, which is assumed to be that in which the intensity of stress varies most rapidly. There is no variation of stress along lines parallel to MN. If MN passes through C, the centre of gravity of the surface, as in Fig. 27, it may easily be shown that the total pull stress on one side of the neutral axis is equal to the total push stress on the other side, whatever be the form of the surface AB. The resultant of the whole stress on AB is in that case a couple, whose moment may be found as follows: Let dS be an indefinitely small part of the surface at a distance x from the neutral axis through C, and let p be the intensity of stress on dS. The moment of the stress on dS is $xpdS$. But $p = p_1x/x_1 = p_2x/x_2$ (see Fig. 27). The whole moment of the stress on AB is $\int xpdS = (p_1/x_1)\int x^2dS = p_1\mathrm{I}/x_1$ or $p_2\mathrm{I}/x_2$, where I is the moment of inertia of the surface AB about the neutral axis through C.

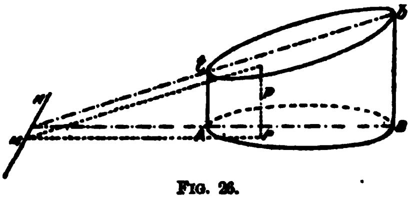

FIG. 26.

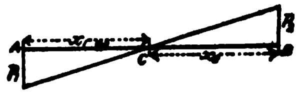

FIG. 27.

55. A stress such as that shown in Fig. 26 or Fig. 28 may be regarded as a uniformly distributed stress of intensity p_0 (which is the intensity at the centre of gravity of the surface C) and a stress of the kind shown in Fig. 27. The resultant is p_0S, where S is the whole area of the surface, and it acts at a distance CD from C such that the moment $p_0\mathrm{S}\,.\,\mathrm{CD} = (p_2 - p_0)\mathrm{I}/x_2 = (p_1 + p_0)\mathrm{I}/x_1$. Hence $p_2 = p_0(1 + x_2\mathrm{S}\,.\,\mathrm{CD/I})$, and $p_1 = p_0(1 - x_1\mathrm{S}\,.\,\mathrm{CD/I})$.

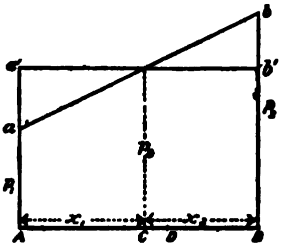

FIG. 28.

Simple bending.

56. Simple bending occurs when a beam is in equilibrium under equal and opposite couples in the plane of the beam. Thus if a beam (Fig. 29), supported at its ends, be loaded at two points so that $\mathrm{W}_1l_1 = \mathrm{W}_2l_2$, the portion of the beam lying between W_1 and W_2 is subjected to a simple bending stress. On any section AB the only stress consists of pull and push, and has for its resultant a couple whose moment $\mathrm{M} = \mathrm{W}_1l_1 = \mathrm{W}_2l_2$. This is called the *bending moment* at the section. If the stress be within the elastic limits it will be distributed as in Fig. 30, with the neutral axis at the centre of gravity of the section. The greatest intensities of push and of pull, at the top and bottom edge respectively, are (by § 54) $p_1 = \mathrm{M}y_1/\mathrm{I}$ and $p_2 = \mathrm{M}y_2/\mathrm{I}$, and the intensity at any point at a distance y above or below C is $p = \mathrm{M}y/\mathrm{I}$.

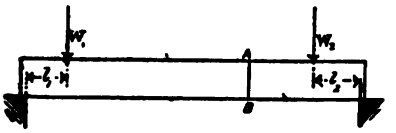

FIG. 29.

Bending beyond elastic limits.

57. Let the bending moment now be increased; non-elastic strain will begin as soon as either p_1 or p_2 exceeds the corresponding limit of elasticity, and the distribution of stress will be changed in consequence of the fact that the outer layers of the beam are taking set while the inner layers are still following Hooke's law. As a simple instance we may consider the case of a material strictly elastic up to a certain stress, and then so plastic that a relatively very large amount of strain is produced without further change of stress, a case not very far from being realized by soft wrought-iron, and mild steel. The diagram of stress will now take the form sketched in Fig. 31. If the elastic limit is (say) less for compression than for tension, the diagram will be as in Fig. 32, with the neutral axis shifted towards the tension side. When the beam is relieved from external load it will be left in a state of internal stress, represented, for the case of Fig. 31, by the dotted lines in that figure.

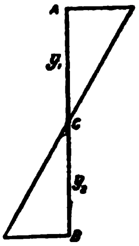

FIG. 30.

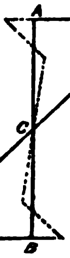

FIG. 31.

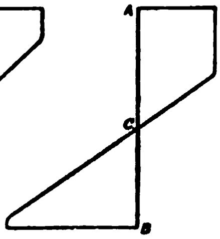

FIG. 32.

Modulus of rupture.

58. In consequence of the action which has been illustrated (in a somewhat crude fashion) by Figs. 31 and 32, the moment required to break the beam (M_1) cannot be calculated from the ultimate tensile or compressive strength of the material by using the formula $\mathrm{M}_1 = f_c\mathrm{I}/y_1$, or $\mathrm{M}_1 = f_c\mathrm{I}/y_2$. When experiments are made on the ultimate strength of bars to resist bending, it is not unusual to apply a formula of this form to calculate an imaginary stress f, which receives the name of the modulus of transverse rupture. Let the section be such that $y_1 = y_2$. Then the modulus of transverse rupture is defined as $f = \mathrm{M}_1y_1/\mathrm{I}$. This mode of stating the results of experiment on transverse strength is unsatisfactory, inasmuch as the modulus of rupture thus determined will vary with different forms of section. Thus a plastic material for which f_c and f_t are equal, if tested in the form of an I beam in which the flanges form practically the whole area of section, will have a modulus of rupture sensibly equal to f_t or f_c. On the other hand, if the material be tested in the form of a rectangular bar, the modulus of rupture may approach a value one and a half times as great. For in the latter case the distribution of stress may approach an ultimate condition in which half the section is in uniform tension f_t, and the other half in uniform compression of the same intensity. The moment of stress is then $\frac{1}{4} f_tbh^2$, b being the breadth and h the depth of the section; but by definition of the modulus of rupture f, $\mathrm{M} = \frac{1}{6} fbh_2$. In tables of the modulus of transverse rupture the values are generally to be understood as referring to bars of rectangular section. Values of this modulus for some of the principal materials of engineering are given in the article BRIDGES, vol. iv. p. 260.

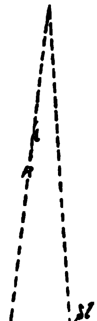

FIG. 33.

Strain produced by bending.

59. The strain produced by bending stress in a bar or beam is, as regards any imaginary filament taken along the length of the piece, sensibly the same as if that filament were directly pulled or compressed by itself. The resulting deformation of the piece consists, in the first place and chiefly, of curvature in the direction of the length, due to the longitudinal extension and compression of the filaments, and, in the second place, of transverse flexure, due to the lateral compression and extension which go along with their longitudinal extension and compression (see ELASTICITY, § 57). Let l_1, Fig. 33, be a short portion of the length of a beam strained by a bending moment M (within the limits of elasticity). The beam, which we assume to be originally straight, bends in the direction of its length to a curve of radius R, such that $\mathrm{R}/l = y_1/\delta l$, δl being the change of l by extension or compression, at a distance y_1 from the neutral axis. But $\delta l = lp_1/\mathrm{E}$ by § 10, and $p_1 = \mathrm{M}y_1/\mathrm{I}$. Hence $\mathrm{R} = \mathrm{EI/M}$. The transverse flexure

is not, in general of practical importance. The centre of curvature for it is on the opposite side from the centre for longitudinal flexure, and the radius is Rσ, where σ is the ratio of longitudinal extension to lateral contraction under simple pull.

Ordinary bending of beams.

60. Bending combined with shearing is the mode of stress to which beams are ordinarily subject, the loads, or externally applied forces, being applied at right angles to the direction of the length. Let AB, Fig. 34, be any cross-section of a beam in equilibrium. The portion V of the beam, which lies on one side of AB, is in equilibrium under the joint action of the external forces F_1, F_2, F_3, etc., and the forces which the other portion U exerts on V in consequence of the state of stress at AB. The forces F_1, F_2, F_3, etc., may be referred to AB by introducing couples whose moments are F_1x_1, F_2x_2, F_3x_3, etc. Hence the stress at AB must equilibrate, first, a couple whose moment is ΣFx, and, second, a force whose value is ΣF, which tends to shear V from U. In these summations regard must of course be had to the sign of each force; in the diagram the sign of F_3 is opposite to the sign of F_1 and F_2. Thus the stress at AB may be regarded as that due to a bending moment M equal to the sum of the moments about the section of the externally applied forces on one side of the section (ΣFx), and a shearing force equal to the sum of the forces about one side of the section (ΣF). It is a matter of convenience only whether the forces on V or on U be taken in reckoning the bending moment and the shearing force. The bending moment causes a uniformly varying normal stress on AB of the kind already discussed in § 56; the shearing force causes a shearing stress in the plane of the section, the distribution of which will be investigated later. This shearing stress in the plane of the section is (by § 6) accompanied by an equal intensity of shearing stress in horizontal planes parallel to the length of the beam.

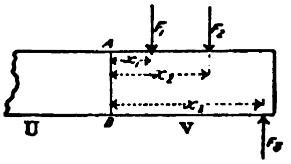

FIG. 34.

61. The stress due the bending moment, consisting of longitudinal push in filaments above the neutral axis and longitudinal pull in filaments below the neutral axis, is the thing chiefly to be considered in practical problems relating to the strength of beams. The general formula $p_1 = My/I$ becomes, for a beam of rectangular section of breadth b and depth h, $p_1 = 6M/bh^2 = 6M/Sh$, S being the area of section. For a beam of circular section it becomes $p_1 = 32M/\pi h^3 = 8M/Sh$. The material of a beam is disposed to the greatest advantage as regards resistance to bending when the form is that of a pair of flanges or booms at top and bottom, held apart by a thin but stiff web or by cross-bracing, as in I beams and braced trusses. In such cases sensibly the whole bending moment is taken by the flanges; the intensity of stress over the section of each flange is very nearly uniform, and the areas of section of the tension and compression flanges (S_1 and S_2 respectively) should be proportioned to the value of the ultimate strengths f_t and f_c, so that $S_1f_t = S_2f_c$. Thus for cast-iron beams Hodgkinson has recommended that the tension flange should have six times the sectional area of the compression flange. The intensity of longitudinal stress on the two flanges of an I beam is approximately M/S_1h and M/S_2h, h being the depth from centre to centre of the flanges.

Diagrams of bending moment and shearing force.

62. In the examination of loaded beams it is convenient to represent graphically the bending moment and the shearing force at various sections by setting up ordinates to represent the values of these quantities. Curves of bending moment and shearing force for a number of important practical cases of beams supported at the ends will be found in the article BRIDGES, with expressions for the maximum bending moment and maximum shearing force under various distributions of load. The subject may be briefly illustrated here by taking the case of a cantilever or projecting bracket—(1) loaded at the end only (Fig. 35); (2) loaded at the end and at another point (Fig. 36); (3) loaded over the whole length with a uniform load per foot run. Curves of bending moment are given in full lines and curves of shearing force in dotted lines in the diagrams.

The area inclosed by the curve of shearing force, up to any ordinate, such as ab (Fig. 37), is equal to the bending moment at the same section, represented by the ordinate ac. For let x be increased to $x + \delta x$, the bending moment changes to $\Sigma F(x + \delta x)$, or $\delta M = \delta x \Sigma F$. Hence the shearing force at any section is equal to the rate of change of the bending moment there per unit of the length, and the bending moment is the integral of the shearing force with respect to the length. In case of a continuous distribution of load, it should be observed that, when x is increased to $x + \delta x$, the moment changes by an additional amount which depends on $(\delta x)^2$ and may therefore be neglected.

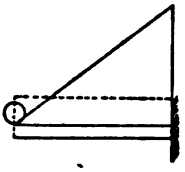

FIG. 35.

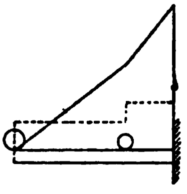

FIG. 36.

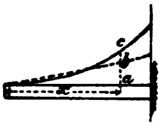

FIG. 37.

Distribution of shearing stress.

63. To examine the distribution of shearing stress over any vertical section of a beam, we may consider two closely adjacent sections AB and DE (Fig. 38), on which the bending moments are M and M + δM respectively. The resultant horizontal force due to the bending stresses on a piece ADHG inclosed between the adjacent sections, and bounded by the horizontal plane GH at a distance y_0 from the neutral axis, is shown by the shaded figure. This must be equilibrated by the horizontal shearing stress on GH, which is the only other horizontal force acting on the piece. At any height y the intensity of resultant horizontal stress due to the difference of the bending moments is $y\delta M/I$, and the whole horizontal force on GH is $\frac{\delta M}{I}\int_{y_0}^{y_1} yz\,dy$, z being the breadth. If q be the intensity of horizontal shearing stress on the section GH, whose breadth is z_0, we have

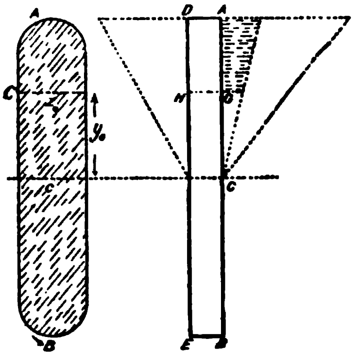

FIG. 38.

$$qz_0\delta x = \frac{\delta M}{I}\int_{y_0}^{y_1} yz\,dy.$$

But $\delta M/\delta x$ is the whole shearing force Q on the section of the beam. Hence

$$q = \frac{Q}{z_0 I}\int_{y_0}^{y_1} yz\,dy$$

and this is also the intensity of vertical shearing stress at the distance y_0 from the neutral axis. This expression may conveniently be written $q = QAy/z_0I$, where A is the area of the surface AG and y the distance of its centre of gravity from the neutral axis. The intensity q is a maximum at the neutral axis and diminishes to zero at the top and bottom of the beam. In a beam of rectangular section the value of the shearing stress at the neutral axis is q max. $= \frac{3}{2}Q/bh$. In other words, the maximum intensity of shearing stress on any section is $\frac{3}{2}$ of the mean intensity. Similarly, in a beam of circular section the maximum is $\frac{4}{3}$ of the mean. This result is of some importance in application to the pins of pin-joints, which may be treated as very short beams liable to give way by shearing.

In the case of an I beam with wide flanges and a thin web, the above expression shows that in any vertical section q is nearly constant in the web, and insignificantly small in the flanges. Practically all the shearing stress is born by the web, and its intensity is very nearly equal to Q divided by the area of section of the web.

Principal stresses in a beam.

64. The foregoing analysis of the stresses in a beam, which resolves them into longitudinal pull and push, due to bending moment, along with shear in longitudinal and transverse planes, is generally sufficient in the treatment of practical cases. If, however, it is desired to find the direction and greatest intensity of stress at any point in a beam, the planes of principal stress passing through the point must be found by an application of the general method given in the article ELASTICITY, chapter iii. In the present case the problem is exceptionally simple, from the fact that the stresses on two planes at right angles are known, and the stress on one of these planes is wholly tangential. Let AC (Fig. 39) be an indefinitely small portion of the horizontal section of a beam, on which there is only shearing stress, and let AB be an indefinitely small portion of the vertical section at the same place, on which there is shearing and normal stress. Let q be the intensity of the shearing stress, which is the same on AB and AC, and let p be the intensity of normal stress on AB; it is required to find a third plane BC, such that the stress on it is wholly normal, and to find r, the intensity of that stress. Let θ be the angle (to be determined) which BC makes with AB. Then the equilibrium of the triangular wedge ABC requires that

$$r\mathrm{BC}\cos\theta = p\,.\,\mathrm{AB} + q\,.\,\mathrm{AC},\ \text{and}\ r\mathrm{BC}\sin\theta = q\,.\,\mathrm{AB};$$

or $$(r-p)\cos\theta = q\sin\theta,\ \text{and}\ r\sin\theta = q\cos\theta\,.$$

Hence, $$q^2 = r(r-p),$$
$$\tan 2\theta = 2\,q/p,$$
$$r = \tfrac{1}{2}p \pm \sqrt{q^2 + \tfrac{1}{4}p^2}.$$

The positive value of r is the greater principal stress, and is of the same sign as p. The negative value is the lesser principal stress, which occurs on a plane at right angles to the former. The equation for θ gives two values corresponding to the two planes of principal stress. The greatest intensity of shearing stress occurs on the pair of planes inclined at 45° to the planes of principal stress, and its value is $\sqrt{q^2 + \tfrac{1}{4}p^2}$ (by § 5).

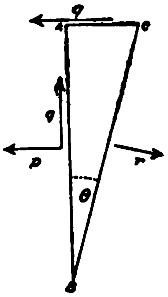

FIG. 39.

65. The above determination of r, the greatest intensity of stress due to the combined effect of simple bending and shearing, is of some practical importance in the case of the web of an I beam. We have seen that the web takes practically the whole shearing force, distributed over it with a nearly uniform intensity q. If there were no normal stress on a vertical section of the web, the shearing stress q would give rise to two equal principal stresses, of pull and push, each equal to q, in directions inclined at 45° to the section. But the web has further to suffer normal stress due to bending, the intensity of which at points near the flanges approximates to the intensity on the flanges themselves. Hence in these regions the greater principal stress is increased, often by a considerable amount, which may easily be calculated from the foregoing formula. What makes this specially important is the fact that one of the principal stresses is a stress of compression, which tends to make the web yield by buckling, and must be guarded against by a suitable stiffening of the web.

The equation for θ allows the lines of principal stress in a beam to be drawn when the form of the beam and the distribution of loads are given. An example has been shown in the article BRIDGES (§ 13, Fig. 12), vol. iv. p. 259.

Deflection of beams.

66. The deflection of beams is due partly to the distortion caused by shearing, but chiefly to the simple bending which occurs at each vertical section. As regards the second, which in most cases is the only important cause of deflection, we have seen (§ 59) that the radius of curvature R at any section, due to a bending moment M, is EI/M, which may also be written $\mathrm{E}y_1/p_1$. Thus beams of uniform strength and depth (and, as a particular case, beams of uniform section subjected to a uniform bending moment) bend into a circular arc. In other cases the form of the bent beam, and the resulting slope and deflection, may be determined by integrating the curvature throughout the span, or by a graphic process (see BRIDGES, § 25), which consists in drawing a curve to represent the beam with its curvature greatly exaggerated, after the radius of curvature has been determined for a sufficient number of sections. In all practical cases the curvature is so small that the arc and chord are of sensibly the same length. Calling i the angle of slope, and u the dip or deflection from the chord, the equation to the curve into which an originally straight beam bends may be written

$$\frac{du}{dx} = i;\ \frac{d^2u}{dx^2} = \frac{di}{dx} = \frac{\mathrm{EI}}{\mathrm{M}}\,.$$

Integrating this for a beam of uniform section, of span L, supported at its ends and loaded with a weight W at the centre, we have, for the greatest slope and greatest deflection, respectively, $i_1 = \mathrm{WL}^2/16\mathrm{EI}$, $u_1 = \mathrm{WL}^3/48\mathrm{EI}$. If the load W is uniformly distributed over L, $i_1 = \mathrm{WL}^2/24\mathrm{EI}$ and $u_1 = 5\mathrm{WL}^3/384\mathrm{EI}$. For other cases, see BRIDGES, § 24.

The additional slope which shearing stress produces in any originally horizontal layer is q/C, where q is, as before, the intensity of shearing stress and C is the modulus of rigidity. In a round or rectangular bar the additional deflection due to shearing is scarcely appreciable. In an I beam, with a web only thick enough to resist shear, it may be a somewhat considerable proportion of the whole.

Torsion of solid and hollow shafts.

67. *Torsion* occurs in a bar to which equal and opposite couples are applied, the axis of the bar being the axis of the couples, and gives rise to shearing stress in planes perpendicular to the axis. Let AB (Fig. 40) be a uniform circular shaft held fast at the end A, and twisted by a couple applied in the plane BB. Assuming the strain to be within the limits of elasticity, a radius CD turns round to CD′ and a line AD drawn at any distance r from the axis, and originally straight, changes into the helix AD′. Let θ be the angle which this helix makes with lines parallel to the axis, or in other words the angle of shear at the distance r from the axis, and let i be the angle of twist DCD′. Taking two sections at a distance dx from one another, we have the arc $\theta dx = r di$. Hence q, the intensity of shearing stress in a plane of cross-section, varies as r, since $q = \mathrm{C}\theta = \mathrm{C}r\dfrac{di}{dx}$.

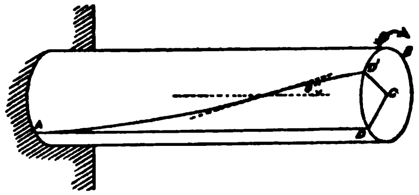

FIG. 40.

The resultant moment of the whole shearing stress on each plane of cross-section is equal to the twisting moment M. Thus $$\int 2\pi r^2 q\,dr = \mathrm{M}.$$

Calling r_1 the outside radius (where the shearing stress is greatest) and q_1 its intensity there, we have $q = rq_1/r_1$, and hence for a solid shaft, $q_1 = 2\mathrm{M}/\pi r_1^3$. For a hollow shaft with a central hole of radius r_2 the same reasoning applies; the limits of integration are now r_1 and r_2, and

$$q_1 = \frac{2\mathrm{M}r_1}{\pi(r_1^4 - r_2^4)}.$$

The lines of principal stress are obviously helices inclined at 45° to the axis.

If the shaft has any other form of section than a solid or symmetrical hollow circle, an originally straight radial line becomes warped when the shaft is twisted, and the shearing stress is no longer proportional to the distance from the axis. The twisting of shafts of square, triangular, and other sections has been investigated by M. de St. Venant (see ELASTICITY, § 66–71, where a comparison of torsional rigidities is given). In a square shaft (side $= h$) the stress is greatest at the middle of each side, and its intensity there[1] is $q_1 = \mathrm{M}/0.281h^3$.

For round sections the angle of twist per unit of length is $i = \dfrac{q_1}{\mathrm{C}r_1} = \dfrac{2\mathrm{M}}{\pi\mathrm{C}r_1^4}$ in solid and $\dfrac{2\mathrm{M}}{\pi\mathrm{C}(r_1^4 - r_2^4)}$ in hollow shafts.

68. In what has been said above it is assumed that the stress is within the limit of elasticity. When the twisting couple is increased so that this limit is passed, plastic yielding begins in the outermost layer, and a larger proportion of the whole stress falls to be borne by layers nearer the centre. The case is similar to that of a beam bent beyond the elastic limit, described in § 57. If we suppose the process of twisting to be continued, and that after passing the limit of elasticity the material is capable of much distortion without further increase of shearing stress, the distribution of stress on any cross section will finally have an approximately uniform value q', and the moment of torsion will be $\int_{r_2}^{r_1} 2\pi r^2 q'\,dr = \tfrac{2}{3}\pi q'(r_1^3 - r_2^3)$. In the case

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[1] Rankine, *Applied Mechanics*, § 324.

of a solid shaft this gives for M a value greater than it has when the stress in the outermost layer only reaches the intensity q', in the ratio of 4 to 3.[1] It is obvious from this consideration that the ultimate strength of a shaft to resist torsion is no more deducible from a knowledge of the ultimate shearing strength of the material than the ultimate strength of a beam to resist bending is deducible from a knowledge of f_t and f_c. It should be noticed also that as regards ultimate strength a solid shaft has an important advantage over a hollow shaft of the same elastic strength, or a hollow shaft so proportioned that the greatest working intensity of stress is the same as in the solid shaft.

69. *Twisting combined with Longitudinal Stress.*—When a rod is twisted and pulled axially, or when a short block is twisted and compressed axially, the greatest intensity of stress (the greater principal stress) is to be found by compounding the longitudinal and shearing stresses as in § 64. In a circular rod of radius r_1, a total longitudinal force P in the direction of the axis gives a longitudinal normal stress whose intensity $p_1 = \mathrm{P}/\pi r_1^2$. A twisting couple M applied to the same rod gives a shearing stress whose greatest intensity $q_1 = 2\mathrm{M}/\pi r_1^3$. The two together give rise to a pair of principal stresses of intensities $r = \mathrm{P}/2\pi r_1^2 \pm \sqrt{(2\mathrm{M}/\pi r_1^3)^2 + (\mathrm{P}/2\pi r_1^2)^2}$, their inclinations to the axis being defined by the equation $\tan 2\theta = 4\mathrm{M}/r_1\mathrm{P}$, and the term under the square root is the greatest intensity of shearing stress.

Torsion and bending of cranks.

70. *Twisting combined with Bending.*—This important practical case is realized in a crank-shaft (Fig. 41). Let a force P be applied at the crank-pin A at right angles to the plane of the crank. At any section of the shaft C (between the crank and the bearing) there is a twisting moment $\mathrm{M}_1 = \mathrm{P} \, . \, \mathrm{AB}$, and a bending moment $\mathrm{M}_2 = \mathrm{P} \, . \, \mathrm{BC}$. There is also a direct shearing force P, but this does not require to be taken into account in calculating the stress at points at the top or bottom of the circumference (where the intensity is greatest), since (by § 63) the direct shearing stress is distributed so that its intensity is zero at these points. The stress there is consequently made up of longitudinal normal stress (due to bending), $p_1 = 4\mathrm{M}_2/\pi r_1^3$, and shearing stress (due to torsion), $q_1 = 2\mathrm{M}_1/\pi r_1^3$. Combining these, as in § 64, we find for the principal stresses $r = 2(\mathrm{M}_2 \pm \sqrt{\mathrm{M}_1^2 + \mathrm{M}_2^2})/\pi r_1^3$, or $r = 2\mathrm{P}(\mathrm{BC} \pm \mathrm{AC})/\pi r_1^3$. The greatest shearing stress is $2\mathrm{P} \, . \, \mathrm{AC}/\pi r_1^3$, and the axes of principal stress are inclined so that $\tan 2\theta = \mathrm{M}_1/\mathrm{M}_2 = \mathrm{AB}/\mathrm{BC}$. The axis of greater principal stress bisects the angle ACB.

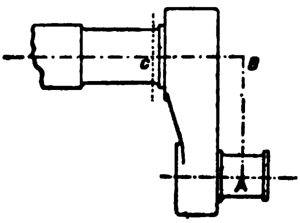

FIG. 41.

Strength of struts.

71. *Long Columns and Struts—Compression and Bending.*—A long strut or pillar, compressed by forces P applied at the ends in the direction of the axis, becomes unstable as regards flexure when P exceeds a certain value. Under no circumstances can this value of P be exceeded in loading a strut. But it may happen that the intensity of stress produced by smaller loads exceeds the safe compressive strength of the material, in which case a lower limit of load must be chosen. If the applied load is not strictly axial, if the strut is not initially straight, if it is subject to any deflection by transverse forces, or if the modulus of elasticity is not uniform over each cross-section,—then loads smaller than the limit which causes instability will produce a certain deflection which increases with increase of load, and will give rise to a uniformly varying stress of the kind illustrated in Figs. 26 and 28. We shall first consider the ideal case in which the forces at the ends are strictly axial, the strut perfectly straight and free from transverse loads and perfectly symmetrical as to elasticity. Two conditions have to be distinguished—that in which the ends are left free to bend, and that in which the ends are held fixed. In what follows, the ends are supposed free to bend. The value of the load which causes instability will be found by considering what force P applied to each end would suffice to hold an originally straight strut in a bent state, supposing it to have received a small amount of elastic curvature in any way. Using u as before to denote the deflection at any part of the length, the bending moment is Pu, and (taking the origin at the middle of the chord) the equation to the elastic curve is

$$\frac{d^2u}{dx^2} = \frac{-\mathrm{P}u}{\mathrm{EI}},$$

from which, for a strut of uniform section, $u = u_1 \cos x\sqrt{\mathrm{P}/\mathrm{EI}}$, u_1 being the deflection at the centre. Now $u = 0$ when $x = \frac{1}{2}\mathrm{L}$ (the half length), and therefore $\frac{1}{2}\mathrm{L}\sqrt{\mathrm{P}/\mathrm{EI}} = \frac{1}{2}\pi$ or an integral multiple of $\frac{1}{2}\pi$. The smallest value ($\frac{1}{2}\pi$) corresponds to the least force P. Thus the force required to maintain the strut in its curved state is $\mathrm{P} = \pi^2\mathrm{EI}/\mathrm{L}^2$, and is independent of u_1. This means that with this particular value of P (which for brevity we shall write P_1) the strut will be in neutral equilibrium when bent; with a value of P less than P_1 it will be stable; with a greater value it will be unstable. Hence a load exceeding P_1 will certainly cause rupture. The value $\pi^2\mathrm{EI}/\mathrm{L}^2$ applies to struts with round ends, or ends free to turn. If the ends are fixed the effective length for bending is reduced by one half, so that P_1 then is $4\pi^2\mathrm{EI}/\mathrm{L}^2$. When one end is fixed and the other is free P_1 has an intermediate value, probably about $9\pi^2\mathrm{EI}/4\mathrm{L}^2$.

72. The above theory, which is Euler's, assigns P_1 as a limit to the strength of a strut on account of flexural instability; but a stress less than P_1 may cause direct crushing. Let S be the area of section, and f_c the strength of the material to resist crushing. Thus a strut which conforms to the ideal conditions specified above will fail by simple crushing if $f_c\mathrm{S}$ is less than P_1, but by bending if $f_c\mathrm{S}$ is greater than P_1. Hence with a given material and form of section the ideal strut will fail by direct crushing if the length is less than a certain multiple of the least breadth (easily calculated from the expression for P_1), and in that case its strength will be independent of the length; when the length is greater than this the strut will yield by bending, and its strength diminishes rapidly as the length is increased.

But the conditions which the above theory assumes are never realized in practice. The load is never strictly axial, nor the strut absolutely straight to begin with, nor the elasticity uniform. The result is that the strength is in all cases less than either $f_c\mathrm{S}$ or P_1. The effect of deviations from axiality, from straightness, and from uniformity of elasticity may be treated by introducing a term expressing an imaginary initial deflection, and in this way Euler's theory may be so modified as to agree well with experimental results on the fracture of struts,[2] and may be reconciled with the observed fact that the deflection of a strut begins gradually and passes through stable values before the stage of instability is reached. In consequence of this stable deflection the stress of compression on the inside edge becomes greater than P/S, the stress on the outside edge becomes less than P/S, and may even change into tension, and the strut may yield by one or the other of these stresses becoming greater than f_c or f_t respectively. As regards the influence of length and moment of inertia of section on the deflection of struts, analogy to the case of beams suggests that the greatest deflection consistent with stability will vary as L^2/b, b being the least breadth, and the greatest and least stress, at opposite edges of the middle section, will consequently be

$$p_1 = \frac{\mathrm{P}}{\mathrm{S}}\left(1 \pm \frac{a\mathrm{L}^2}{b^2}\right).$$

where a is a coefficient depending on the material and the form of the section. This gives, for the breaking load, $\mathrm{P} = \mathrm{S}f_c/(1 + a\mathrm{L}^2/b^2)$ or $-\mathrm{S}f_t/(1 - a\mathrm{L}^2/b^2)$, the smaller of the two being taken.

This formula, which is generally known as Gordon's, can be made to agree fairly with the results of experiments on struts of ordinary proportions, when the values of f as well as a are treated as empirical constants to be determined by trial with struts of the same class as those to which the formula is to be applied. Gordon's formula may also be arrived at in another way. For very short struts we have seen that the breaking load is $f_c\mathrm{S}$, and for very long struts it is $\pi^2\mathrm{EI}/\mathrm{L}^2$. If we write $\mathrm{P} = f_c\mathrm{S}/(1 + f_c\mathrm{SL}^2/\pi^2\mathrm{EI})$, we have a formula which gives correct values in these two extreme cases, and intermediate values for struts of medium length. By writing this $\mathrm{P} = f\mathrm{S}/(1 + c\mathrm{SL}^2/\mathrm{I})$, and treating f and c as empirical constants, we have Gordon's formula in a slightly modified shape. Gordon's formula is largely used: it is, however, essentially empirical, and it is only by adjustment of both constants that it can be brought into agreement with experimental results.[1] For values of the constants, see BRIDGES. In the case of fixed ends, c is to be divided by 4.

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[1] See ELASTICITY, §§ 10-20.

[2] See papers by Profs. Ayrton and Perry, *The Engineer*, Dec. 10 and 24, 1886, and by T. C. Fidler, *Min. Proc. Inst. C.E.*, vol. lxxxvi. p. 261.

73. *Bursting Strength of Circular Cylinders and Spheres.*—

Strength of shells to resist bursting.

Space remains for the consideration of only one other mode of stress, of great importance from its occurrence in boilers, pipes, hydraulic and steam cylinders, and guns. The material of a hollow cylinder, subjected to pressure from within, is thrown into a stress of circumferential pull. When the thickness t is small compared with the radius R, we may treat this stress as uniformly distributed over the thickness. Let p be the intensity of fluid pressure within a hollow circular cylinder, and let f be the intensity of circumferential stress. Consider the forces on a small rectangular plate (Fig. 42), with its sides parallel and perpendicular to the direction of the axis, of length l and width $R\delta\theta$, $\delta\theta$ being the small angle it subtends at the axis. Whatever forces act on this plate in the direction of the axis are equal and opposite. The remaining forces, which are in equilibrium, are P, the total pressure from within, and a force T at each side due to the circumferential stress. $P = plR\delta\theta$ and $T = flt$. But by the triangle of forces (Fig. 43) $P = T\delta\theta$. Hence $f = pR/t$.

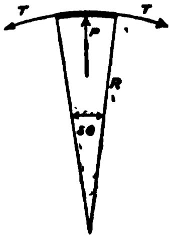

FIG. 42.

The ends of the cylinder may or may not be held together by longitudinal stress in the cylinder sides; if they are, then, whatever be the form of the ends, a transverse section, the area of which is $2\pi Rt$, has to bear a total force $p\pi R^2$. Hence, if f' be the intensity of longitudinal stress, $f' = pR/2t = \frac{1}{2}f$.

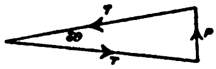

FIG. 43.

74. A thin hollow sphere under internal pressure has equal circumferential pull in all directions. To find its value consider the plate of Fig. 42. There are now four equal forces T, on each of the four sides, to equilibrate the radial force P. Hence $P = 2T\delta\theta$ and $f = pR/2t$.

75. When the thickness is not small compared with the radius, the radial pressure is transmitted from layer to layer with reduced intensity, and the circumferential pull diminishes towards the outside.

Thick cylinder.

In the case of a thick cylinder with free ends[2] we have to deal at any point with two principal stresses, radial and circumferential, which may be denoted by p and p' respectively. Supposing (as we may properly do in dealing with a cylinder which is not very short) that a transverse section originally plane remains plane, the longitudinal strain is uniform. Since there is no longitudinal stress this strain is due entirely to the lateral action of the stresses p and p', and its amount is $(p + p')/\sigma E$. Hence at all points $p + p' = \text{constant}$.[3] Further, by considering the equilibrium of any thin layer, as we have already considered that of a thin cylinder, we have $\frac{d}{dr}(pr) = p'$.

These two equations give by integration, $p = C + C'/r^2$, and $p' = C - C'/r^2$.

If r_1 be the external and r_2 the internal radius, and p_0 the pressure on the inner surface, the conditions that $p = p_0$ when $r = r_2$ and $p = 0$ when $r = r_1$ give $C = -p_0r_2^2/(r_1^2 - r_2^2)$ and $C' = -Cr_1^2$. Hence the circumferential stress at any radius r is $p' = -p_0r_2^2(1 + r_1^2/r^2)/(r_1^2 - r_2^2.)$ At the inside, where this is greatest, its value is $-p_0(r_1^2 + r_2^2)/(r_1^2 - r_2^2)$,—a quantity always greater than p_0, however thick the cylinder is.

In the construction of guns various devices have been used to equalize the circumferential tension. With cast guns a chilled core has been employed to make the inner layers solidify and cool first, so that they are afterwards compressed by the later contraction of the outer layers. In guns built up of wrought-iron or steel hoops the hoops are bored small by a regulated amount and are shrunk on over the barrel or over the inner hoops. In Mr. Longridge's system, now under trial, the gun is made by winding steel wire or ribbon, with suitable initial tension, on a central barrel.

76. The circumferential stress at any point of a thick hollow sphere exposed to internal fluid pressure is found, by a process like that of the last paragraph, to be $-p_0r_2^3(1 + r_1^3/2r^3)/(r_1^3 - r_2^3)$, which gives, for the greatest tension, the value.

$$-p_0(r_1^3 + 2r_2^3)/2(r_1^3 - r_2^3)$$

(J. A. E.)

STRICKLAND, AGNES (1806–1874), a popular historical writer, was born in 1806, the third daughter of Thomas Strickland, of Roydon Hall, Suffolk. Her first literary efforts were historical romances in verse in the style of Walter Scott,—*Worcester Field* (published without date), *Demetrius and other Poems* (1833.) From this she passed to prose histories, written in a simple style for the young. A picturesque sketch of the *Pilgrims of Walsingham* appeared in 1835, two volumes of *Tales and Stories from History* in the following year. Then with the assistance of her sister she projected a more ambitious work, *The Lives of the Queens of England*, from Mathilda of Flanders to Queen Anne. The first volume appeared in 1840, the twelfth and last in 1849. Miss Strickland was a warm partisan on the side of royalty and the church, but she made industrious study of "official records and other public documents," gave copious extracts from them, and drew interesting pictures of manners and customs. While engaged on this work she found time to edit (in 1843) the *Letters of Mary, Queen of Scots*, whose innocence she championed with enthusiasm. In 1850 she followed up her *Queens of England* with the *Lives of the Queens of Scotland*, completing the series in eight volumes in 1859. Unresting in her industry, she turned next to the *Bachelor Kings of England*, about whom she published a volume in 1861. The *Lives of the Seven Bishops* followed in 1866—after a longer interval, part of which was employed in producing an abridged version of her *Queens of England*. Her last work was the *Lives of the Last Four Stuart Princesses*, published in 1872. In 1871 she obtained a civil list pension of £100 [$486] in recognition of her merits. She died at Roydon Hall on the 8th of July, 1874.

A *Life* by her sister, Jane Margaret Strickland, appeared in 1887.

STRIEGAU, an industrial town of Prussia, in the province of Silesia, is situated on a small tributary of the Weistritz, 30 miles to the southwest of Breslau. In 1880 it contained 11,470 inhabitants, 6928 of whom were Protestants and 4379 Roman Catholics. Their chief occupations are tanning and the manufacture of albums, portfolios, and other articles in leather. Granite is quarried in the neighborhood, and a trade is carried on in grain. It was near Striegau that Frederick the Great gained the important victory usually named after the village of Hohenfriedberg (June 4, 1745).

STROMBOLI. See LIPARI ISLANDS.

STRONTIUM, a metallic chemical element intermediate in its character between barium and calcium, with which it forms a natural "triad." Though widely diffused as a frequent companion of calcium (including oceanic), it occurs nowhere in abundance[4]. Its most important mineral forms are the sulphate, $SrSO_4$, known as *Cœlestine* (from the sky-blue color of certain varieties), and the carbonate, $SrCO_3$, called *Strontianite* because it was discovered first at Strontian, in Argyllshire, Scotland. Crawford and (independently of him) Cruickshanks in 1790 were the first to recognize the latter mineral as a thing of its own kind and different from witherite ($BaCO_3$). Hope in 1793 proved it to be the carbonate of a new earth, which discovery was confirmed by Klaproth.

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[1] For experiments on the breaking strength of struts, see papers by Hodgkinson, *Phil. Trans.*, 1840; Berkeley, *Min. Proc. Inst. C. E.*, vol. xxx.; Christie, *Trans. Amer. Soc. Civ. Eng.*, 1884.

[2] This condition is realized in practice when the fluid causing internal pressure is held in by a piston, and the stress between this piston and the other end of the cylinder is taken by some other part of the structure than the cylinder sides.

[3] The solution which follows in the text is applicable even when there is longitudinal stress, provided that the longitudinal stress is uniformly distributed over each transverse section. If we call this stress p'', the longitudinal strain is $p''/E + (p + p')/\sigma E$. Since the whole strain is uniform, and p'' is uniform, the sum of p and p' is constant at all points, as in the case where the ends are free.

[4] [The sulphate is abundant on Strontian or Green Island in Lake Erie.—AM. ED.]

Regarding metallic strontium, see CHEMISTRY, vol. v., p. 455. For the making of strontium preparations strontianite, of course, is the handier raw material, being readily convertible into (for instance) nitrate by treatment with dilute nitric acid. From the nitrate the oxide, SrO, is obtained by prolonged calcination at ultimately a bright red heat, as a grayish-white absolutely infusible and non-volatile mass, which acts violently on water with formation of the hydrate, $Sr(OH)_2$, which latter readily takes up $8H_2O$ of water to form crystals soluble in fifty parts of cold and far less of boiling water. An impure oxide is obtainable directly from strontianite by strong ignition with charcoal; and from such crude oxide pure crystals of the hydrate are easily produced by obvious operations.

In the working up of cœlestine the first step is to reduce it to sulphide, SrS, by means of charcoal at a red heat. The sulphide when boiled with water is decomposed thus:

$$2SrS + 2H_2O = \underset{\text{Hydrate.}}{SrOH_2O} + \underset{\text{Sulph-hydrate.}}{SrSH_2S}.$$

Both products dissolve in the hot water; from the solution the S of the SrH_2S_2 is easily eliminated, by treatment with oxide of copper or oxide of zinc, as insoluble metallic sulphide; the filtrate on cooling gives crystals of pure hydrate. From it any strontia salt of course is easily made by means of the respective acid; in many cases the salt wished for can be obtained similarly from the sulphide.

Nitrate of strontia from hot solutions crystallizes in anhydrous octahedra, SrN_2O_6, soluble in about ½ part of boiling and in 5 parts of cold water. From colder solutions hydrated crystals $SrN_2O_6 + 4H_2O$, separate out. The anhydrous salt is used largely by pyrotechnists for the making of "red fire."

The hydroxide some years ago promised to play an important part in the sugar industry as a precipitant for the cane-sugar known to be present largely in uncrystallizable molasses (see SUGAR), but the process so far has failed to take root in industry.

Analysis.—To detect strontium in a salt-solution, we first eliminate the heavy metals by the successive application of sulphuretted hydrogen (and free acid) and of sulphide of ammonium in the presence of ammonia and sal-ammoniac. From the filtrate carbonate of ammonia (in the heat) precipitates only the barium, strontium, and calcium as carbonates, which are filtered off and washed with hot water. The analysis of the precipitate is difficult but any strontia in it is easily detected by means of the spectroscope (see SPECTROSCOPY).

STROPHANTHUS, a genus of plants of the natural order *Apocyneæ*, deriving its name from the long twisted thread-like segments of the corolla, which in one species attain a length of 12 or 14 inches. The genus at present comprises about 18 species confined to tropical Africa and Asia, only one species, indigenous to the former continent, being known outside the tropics. Several of the African species furnish the natives of the countries in which they grow with the principal ingredient in their arrow poisons. The inée or onaye poison of the Gaboon, the kombé poison of equatorial North Africa, the arquah poison of the banks of the Niger, and the wanika poison of Zanzibar are all derived from members of this genus. The exact species used in each case cannot be said to be accurately known. There is little doubt, however, that *S. hispidus*, D. C., is the one most frequently employed.

Two of the arrow poisons have been chemically and physiologically examined. The kombé poison was subjected to some preliminary experiments in 1862 by Prof. Sharpey, but was more fully examined a few years subsequently by Prof. T. R. Fraser. From the investigations of the latter[1] it appears that the kombé arrow poison, when given in fatal doses, paralyzes the action of the heart. In minute doses, however, it possesses a tonic action on that organ. Since the practical value of strophanthus as a medicinal agent has been pointed out by Prof. Fraser, it has been used with considerable success in some forms of heart-disease. The chemical examination showed that its activity is due to a glucoside, which has been named strophanthin. The wanika arrow poison has been examined physiologically by Dr. Sydney Ringer and chemically by Mr. A. W. Gerrard. Its active principle, a glucoside, was found to resemble strophanthin in its action. Chemically also, as obtained by Mr. Gerrard, it seems to be identical with strophanthin.[2] It is soluble in alcohol and water, but insoluble in ether and chloroform; it evolves ammonia when heated with soda-lime, but gives only a slight brown coloration when treated with strong sulphuric acid.

Both *S. hispidus* and *S. Kombe* have hairy seeds with a slender thread-like appendage, terminating in a feathery tuft of long silky hairs, the seeds of the former being coated with short appressed brown hairs, and those of the latter with white hairs; but in the species used at Delagoa Bay and called "umtsuli" the thread-like appendage of the seed is absent. According to information furnished by Messrs. T. Christy & Company, of London, and obtained from a correspondent on the Zanzibar coast, the natives pound the seeds into an oily mass, which assumes a red color, portions of this mass being smeared on the arrow immediately behind the barb.

See *Icones Plantarum*, No. 4, 1870; Pelikan, *Arch. Gen de Médicine*, July, 1865, p. 115; Van Hasselt, *Arch. Neerl. des Sc.* [2], vii., 1872, p. 161; *Arch. de Physiol.*, No. 5, 1872, p. 526; *Rapport sur l'Inaye*, Paris, 1877, 8vo.

STROUD, a market-town of Gloucestershire, is situated on the Swindon and Gloucester branch of the Great Western Railway, on a branch of the Midland Railway, and on the Thames and Severn Junction Canal, 10 miles south of Gloucester and 30 north-east of Bristol. It is picturesquely situated on an eminence environed by higher hills, but is built in a somewhat straggling and irregular fashion. Among the principal buildings are the town-hall, built in the reign of Elizabeth, the Lansdown hall (1879), the Badbrook hall (1869), with reading-room and large room for concerts, the subscription rooms (1834), and the hospital, erected in 1875 at a cost of £8754 [$42,544.44], to replace the dispensary erected in 1823. The town is the principal seat of the west of England cloth manufacture, and possesses very extensive mills. There are also silk mills, scarlet-dye works, breweries, logwood-crushing mills, and flour-mills. Stroud at the time of the Norman survey was part of Bisley parish, from which it was separated in 1304. The local board was established in 1857. The population of the urban sanitary district (area 999 acres) in 1871 was 7082, and in 1881 it was 7848.

STRUENSEE, JOHANN FRIEDRICH, COUNT (1737-1772), Danish statesman, was of German extraction, and was born August 5, 1737, at Halle, where his father Adam Struensee, of some eminence as a hymn writer, was pastor. He graduated M.D. at Halle in 1756, and obtained the office of physician to the town of Altona through the influence of his father, who had removed thither. On account, however of a change in his religious views he quarrelled with his father, and for some time he led an unsettled life, until in 1768 he was appointed personal physician to the young king, Christian VII. of Denmark, whom he accompanied on a tour through England, France, Holland, and Germany. The influence he exercised over the almost imbecile king awakened at first the jealousy of the queen, Caroline Matilda, a granddaughter of George II., but, having had occasion to attend her for a severe malady, he won her complete confidence also, and became equally the favorite of both. When therefore in 1770 he was appointed master of requests, he virtually took the government of the kingdom into his own hands, and on the 20th September the council of state was superseded. Though acting as an absolutist, his sympathies were democratic, and he used his position to promote the general benefit of the people and to curb the influence of the nobility. The extent of his reforms, and the suddenness with which they were introduced, had all the practical effect of a revolution. They included the enfranchisement of the peasants, complete religious toleration, the abolition of commercial restrictions, the reorganization of the army, and the introduction of examinations for public offices. His reforms were received with consternation, and a conspiracy was entered into to effect his overthrow. The queen dowager persuaded Christian VII. that Struensee was carrying on an intrigue with the queen, and had entered into a plot to assassinate him, in order that he might rule as regent. He and his friend Count Brandt were consequently arrested on 20th February, 1772. The attempt to prove that he had been unfaithful in his duty as minister to the king failed, but he did not deny the *liaison* with the queen, and he and Count Brandt were both beheaded and quartered on the 28th April (see Denmark, vol. vii. p. 76).[1]

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[1] See *Proc. Roy. Soc. Edin.*, 1869-1870, p. 99; reprinted in *Jour. Anat. and Physiol.*, vol. vii. pp. 140-155.

[2] *Pharm. Jour.* [3], xi. pp. 834, 835.

See *Leben und Begebenheiten der Grafen Struensee und Brandt*, 1772; *Memoirs of an Unfortunate Queen*, London, 1776; Höst, *Struensee og hans Ministerium*, Copenhagen, 1824; Jenssen-Tusch, *Die Verschwörung gegen die Königin Karoline Mathilde und die Grafen Struensee und Brandt, nach bisher ungedrückten Originalacten*, Leipsic, 1864; Wraxall, *Life and Times of Queen Caroline*, 1864; K. Wittich, *Struensee*, Leipsic, 1879.

STRUVE, Friedrich Georg Wilhelm (1793–1864), astronomer, was born at Altona on April 15, 1793. In 1808 he entered the university of Dorpat, where he first studied philology, but soon turned his attention to astronomy. In 1813 he was appointed observer in the new university observatory and a few years later professor of astronomy. He remained in Dorpat, occupied with researches on double stars and in geodetic work, till 1839, when he removed to Pulkova, near St. Petersburg, as director of the new Central Observatory. Here he continued his activity until he was obliged to retire (in 1861) owing to failing health. He died at St. Petersburg on November 23, 1864.

Struve's name is best known by his observations of double stars, which he carried on for many years. These bodies had first been regularly measured by W. Herschel, who discovered that many of them formed systems of two stars revolving round their common centre of gravity. After him J. Herschel (and for some time South) had observed them, but their labors were eclipsed by the systematic and more extensive ones of Struve. With the 9½-inch refractor at Dorpat he discovered a great number of double stars, and published in 1827 a list of all the known objects of this kind (*Catalogus Novus Stellarum Duplicium*). His micrometric measurements of 2714 double stars were made from 1824 to 1837, and are contained in his principal work *Stellarum Duplicium et Multiplicium Mensuræ Micrometricæ* (St. Petersburg, 1837, fol.; a convenient summary of the results is given in vol. i. of the *Dunecht Observatory Publications*, 1876). The places of the objects were at the same time determined with the Dorpat meridian circle (*Stellarum Fixarum Imprimis Duplicium et Multiplicium Positiones Mediæ*, St. Petersburg, 1852, fol.). At Pulkova he determined anew the constant of aberration, but was chiefly occupied in working out the results of former years' work and in the completion of the geodetic operations in which he had been engaged during the greater part of his life. He had commenced them with a survey of Livonia (1816–19), which was followed by the measurement of an arc of meridian of more than 3½° in the Baltic provinces of Russia (*Beschreibung der Breitengradmessung in den Ostseeprovinzen Russlands*, 2 vols., 4to, Dorpat, 1831). This work was afterwards extended by Struve and General Tenner into a measurement of a meridional arc from the north coast of Norway to Ismail on the Danube (*Arc du Méridien de 25° 20′ entre le Danube et la Mer Glaciale*, 2 vols., and 1 vol. plates, St. Petersburg, 1857–60, 4to).

STRY, or Stryj, a town of Galicia, Austria, is pleasantly situated on a tributary of the Dniester, about 40 miles to the south of Lemberg. In 1880 it contained 12,625 inhabitants, chiefly engaged in tanning and the manufacture of matches. In 1886, however, the town was almost wholly destroyed by fire, and its population was greatly reduced by the wholesale migration and deaths from privation consequent upon this calamity.

STRYCHNINE. See Poisons, vol. xix. p. 290, and Nux Vomica, vol. xvii. p. 706.

STRYPE, John (1643–1737), historian and biographer, was the son of John Strype or Van Stryp, a native of Brabant, who to escape religious persecution went to England, and settled near London, in a locality afterwards known as Strype's Yard, formerly in the parish of Stepney, but subsequently annexed to that of Christ Church, Spitalfields. Here he carried on the business of a merchant and silk throwster. The son was born 1st November, 1643. He was educated at St. Paul's School, and on 5th July, 1662, entered Jesus College, Cambridge. Thence he proceeded to Catherine Hall, where he graduated B.A. in 1665 and M.A. in 1669. On the 14th July of the latter year he was preferred to the curacy of Theydon-Bois, Essex, and a few months afterwards was chosen curate and lecturer of Low Leyton in the same county. On account of the smallness of the salary, the patron allowed the people to choose their own minister, the vacancy in the vicarage remaining unfilled during the life of Strype. He was never instituted or inducted, but in 1674 he was licensed by the bishop of London to preach and expound the word of God, and to perform the full office of priest and curate during the vacancy of the vicarage. In his later years he obtained from Archbishop Tenison the sinecure of Tarring, Sussex, and he discharged the duties of lecturer at Hackney till 1724. When he became infirm he took up his residence with Mr. Harris, an apothecary at Hackney, who had married his daughter, and died there 11th December, 1737, at the advanced age of ninety-four.

At an early period of his life Strype obtained access to the papers of Sir Michael Hicks, secretary to Lord Burghley, from which he made extensive transcripts; he also carried on an extensive correspondence with Archbishop Wake and Bishops Burnet, Atterbury, and Nicholson. The materials thus obtained formed the basis of his historical and biographical works, which relate chiefly to the period of the Reformation. The greater portion of his original materials have been preserved, and are included in the Lansdowne manuscripts in the British Museum. His works can scarcely be entitled original compositions, his labor having consisted chiefly in the arrangement of his materials, but on this very account they are of considerable value as convenient books of reference, easier of access and almost as trustworthy as the original documents. Besides a number of single sermons published at various periods, he was the author of an edition of Lightfoot's *Works*, vol. ii., 1684; *Memorials of Archbishop Cranmer*, 1694; *Life of Sir Thomas Smith*, 1698; *Life and Actions of John Aylmer, Bishop of London*, 1701; *Life of Sir John Cheke, with his Treatise on Superstition*, 1705; *Annals of the Reformation in England*, 4 vols., vol. i. 1709 (reprinted 1725), vol. ii. 1725, vol. iii. 1728, vol. iv. 1731; 2d ed. 1735, 4 vols.; 3d ed. 1736-38, 4 vols.; *Life and Actions of Edmund Grindal, Archbishop of Canterbury*, 1710, *of Matthew Parker, Archbishop of Canterbury*, 1711, and *of John Whitgift, Archbishop of Canterbury*, 1718; *An Accurate Edition of Stow's Survey of London*, 1720, 2 vols., fol., the standard edition of Stow and of great value, although its interference with the original text is a method of editing which can scarcely be reckoned fair to the original author; and *Ecclesiastical Memorials*, 1721, 3 vols.; 1733, 3 vols.; new ed. 1816. His *Historical and Biographical Works* were published in 10 vols., with a general index, 1820–40.

STUART, Stewart, or Steuart, the surname of a family who became heirs to the Scottish and ultimately to the English crown. Their descent is traced to a Norman baron Alan, whose eldest son William became progenitor of the earls of Arundel, and whose two younger sons Walter and Simon came to Scotland, Walter being appointed high steward of David I., who conferred on him various lands in Renfrewshire, including Paisley, where he founded the abbey in 1160. Walter, his grandson, third steward, was appointed by Alexander II. justiciary of Scotland, and, dying in 1246, left four sons and three daughters. The third son Walter obtained by marriage the earldom of

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[1] Carl Gustav Struensee von Carlsbach, elder brother of Johann Friedrich, born at Halle 18th August, 1735, attained high eminence in the service of Prussia. He was ennobled in 1789, became minister of finance and president of the excise department in 1791, and died at Berlin 17th October, 1804.

Menteith, which ultimately came by marriage to Robert, duke of Albany, third son of Robert II. Alexander, fourth steward, the eldest son of Walter, third steward, inherited by his marriage with Jean, granddaughter of Somerled, the islands of Bute and Arran, and on 2d October, 1263, defeated Haco at Largs. He had two sons, James and John. The latter, who commanded the men of Bute at the battle of Falkirk in 1298, had seven sons: (1) Sir Alexander, whose grandson became in 1389 earl of Angus, the title afterwards passing in the female line to the Douglases, and in 1761 to the duke of Hamilton; (2) Sir Alan of Dreghorn, ancestor of the earls and dukes of Lennox, from whom Lord Darnley, husband of Queen Mary, and also Arabella Stuart, were descended; (3) Sir Walter, who obtained the barony of Garlies, Wigtownshire, from his uncle John Randolph, earl of Moray, and was the ancestor of the earls of Galloway, younger branches of the family being the Stewarts of Tonderghie, Wigtownshire, and also those of Physgill and Glenturk in the same county; (4) Sir James, who fell at Dupplin in 1332, ancestor of the lords of Lorn, on whose descendants were conferred at different periods the earldoms of Athole, Buchan, and Traquair, and who were also the progenitors of the Stewarts of Appin, Argyllshire, and of Grandtully, Perthshire; (5) Sir John, killed at Halidon Hill in 1333; (6) Sir Hugh, who fought under Edward Bruce in Ireland; and (7) Sir Robert of Daldowie, ancestor of the Stewarts of Allanton and of Coltness. James Stewart, the eldest son of Alexander, fourth steward, succeeded his father in 1283, and, after distinguishing himself in the wars of Wallace and of Bruce, died in 1309. His son Walter, sixth steward, who had joint command with Douglas of the left wing at the battle of Bannockburn, married Marjory, daughter of Robert the Bruce, and during the latter's absence in Ireland was intrusted with the government of the kingdom. He died in 1326, leaving an only son, who as Robert II. ascended the throne of Scotland in 1370 (see vol. xxi. p. 512). Sir Alexander Stewart, earl of Buchan, fourth son of Robert II., who earned by his ferocity the title of the "Wolf of Badenoch," inherited by his wife the earldom of Ross, but died without legitimate issue, although from his illegitimate offspring were descended the Stewarts of Belladrum, of Athole, of Garth, of Urrard, and of St. Fort. On the death of the "Wolf of Badenoch" the earldom of Buchan passed to his brother Robert, duke of Albany, also earl of Fife and earl of Menteith, but these earldoms were forfeited on the execution of his son Murdoch in 1425, the earldom of Buchan again, however, coming to the house of Stewart in the person of James, second son of Sir James Stewart, the black knight of Lorn, by Johanna, widow of King James I. From Murdoch, duke of Albany, were descended the Stewarts of Ardvoirlich and other families of the name in Perthshire, and also the Stuarts of Inchbreck and Laithers, Aberdeenshire. From a natural son of Robert II. were descended the Steuarts of Dalguise, Perthshire, and from a natural son of Robert III. the Shaw Stewarts of Blackhall and Greenock. The direct male line of the royal family terminated with the death of James V. in 1542, whose daughter Mary was the first to adopt the spelling "Stuart." Mary was succeeded in her lifetime in 1567 by her only son James VI., who through his father Lord Darnley was also head of the second branch, there being no surviving male issue of the family from progenitors later than Robert II. In James V., son of James IV. by Margaret, daughter of Henry VII., the claims of the English junior branch became merged in the Scottish line, and on the death of Queen Elizabeth of England, last surviving offshoot of Henry VIII., James VI. of Scotland, lineally the nearest heir, was proclaimed king of England, in accordance with a declaration of Elizabeth that no minor person should ascend the throne, but her cousin the king of Scots. The accession of James was however, contrary to the will of Henry VIII., which favored the Suffolk branch, whose succession would probably have marvellously altered the complexion of both Scottish and English history. As it was, the only result of that will was a tragedy initiated by Elizabeth, but consummated by James, so as to clothe his memory with deep disgrace. In the Scottish line the nearest heir after James VI., both to the Scottish and English crowns, was Arabella Stuart, only child of Charles, earl of Lennox, younger brother of Lord Darnley,—Lady Margaret Douglas, the mother of Darnley and his brother, having been the daughter of Archibald, sixth earl of Angus by Margaret, queen dowager of James IV. James VI. (I. of England) was thus nearest heir of the junior English branch by a double descent, Arabella Stuart being next heir by a single descent. On account of the descent from Henry VII., the jealousy of Elizabeth had already caused her to imprison Arabella's mother (Elizabeth, daughter of Sir William Cavendish) on learning that she had presumed to marry Lennox. The daughter's marriage she was determined by every possible means to prevent. She objected when King James proposed to marry her to Lord Esme Stuart, whom he had created duke of Lennox, but when the appalling news reached her that Arabella had actually found a lover in William Seymour, grandson of Catherine Grey, heiress of the Suffolk branch, she was so deeply alarmed and indignant that she immediately ordered her imprisonment. This happened immediately before Elizabeth 's death, after which she obtained her release. Soon after the accession of James a conspiracy, of which she was altogether ignorant, was entered into to advance her to the throne, but this caused no alteration in her treatment by James, who allowed her a maintenance of £800 [$3888] a year. In February, 1610, it was discovered that she was engaged to Seymour, and although she then promised never to marry him without the king's consent, the marriage took place secretly in July following. In consequence of this her husband was sent to the Tower, and she was placed in private confinement. Though separated, both succeeded in escaping simultaneously, on 3d June, 1611; but, less fortunate than her husband, who got safe to the Continent, she was captured at the Straits of Dover, and shut up in the Tower. Her hopeless captivity deprived her of her reason before her sorrows were ended by death, 27th September, 1615.

By the usurpation of Cromwell the Stuarts were excluded from the throne from the defeat of Charles I. at Naseby in 1645 until the restoration of his son Charles II. in 1661. Carlyle refers to the opinion of genealogists that Cromwell "was indubitably either the ninth or the tenth or some other fractional part of half a cousin of Charles Stuart," but this has been completely exploded by Walter Rye in the *Genealogist* ("The Steward Genealogy and Cromwell's Royal Descent," new ser., vol. ii. pp. 34–42). On the death of Charles II. without issue in 1685, his brother James, duke of York, ascended the throne as James II., but he so alienated the sympathies of the nation by his unconstitutional efforts to further the Catholic religion that an invitation was sent to the prince of Orange to come "to the rescue of the laws and religion of England." Next to the son of James II., still an infant under his father's control, Mary, princess of Orange, eldest daughter of James II., had the strongest claim to the crown; but neither were the claims of the prince, even apart from his marriage, very remote, since he was the son of Mary, eldest daughter of Charles I. The marriage had strengthened the claims of both, and they were proclaimed joint sovereigns of England on 12th February, 1689, Scotland following the example of England on the 11th April. They had no issue, and the Act of Settlement passed in 1701, excluding Catholics from the throne, secured the succession to Anne, second daughter of James II., and on her death without issue to the Protestant

House of Hanover, descended from the princess Elizabeth, daughter of James I., wife of Frederick, count palatine of the Rhine. On the death of Anne in 1714, George, elector of Hanover, eldest son of Sophia, electress of Hanover (only surviving child of the princess Elizabeth), and Ernest, youngest son of George, duke of Brunswick, consequently became sovereign of Great Britain and Ireland, and, notwithstanding somewhat formidable attempts in behalf of the elder Stuart line in 1715 and 1745, the Hanoverian succession has remained uninterrupted, and has ultimately won universal assent. The female line of James II. ended with the death of his daughter, Queen Anne. James, called James III. by the Jacobites and the Old Pretender by the Hanoverians, had two sons,—Charles Edward, the Young Pretender, who died without legitimate issue in 1780, and Henry, titular duke of York, commonly called Cardinal York, at whose death in 1807 the male line of James II. came to an end. He was also the last lineal male representative of any of the crowned heads of the race, so far as either England or Scotland was concerned, and excepting of course the Hanoverian line. In the female Stuart line there are, however, still nearer heirs to the throne than those of the Hanoverian line, viz., the descendants of Henrietta, duchess of Orleans, daughter of Charles I., represented now only in Maria Theresa, married to Prince Louis Leopold of Bavaria, and their nine children. The male representation of the family, being extinct in the royal lines, is claimed by the earls of Galloway and also by the Stewarts of Castlemilk, but the claims of both are more than doubtful.

See Sir George Mackenzie's *Defence of the Royal Line of Scotland*, 1685, and *Antiquity of the Royal Line of Scotland*, 1686; Crawfurd's *Genealogical History of the Royal and Illustrious Family of the Stuarts*, 1710; Duncan Stewart's *Genealogical Account of the Surname of Stewart*, 1739; Andrew Stuart's *Genealogical History of the Stuarts*, 1798; Stothert's *House of Stuart*, privately printed, 1855; *An Abstract of the Evidence to prove that Sir William Stewart of Jedworth, the Paternal Ancestor of the Present Earl of Galloway, was the Second Son of Sir Alexander Stewart of Darnley*, 1801; Townsend's *Descendants of the Stuarts*, 1858; Bailey, *The Succession to the English Crown*, 1879. (T. F. H.)

STUART, GILBERT (1755–1828), a distinguished American portrait-painter, was born in Narragansett, Rhode Island, U. S., December 3, 1755. His father, a native of Perth, Scotland, and the son of a Presbyterian minister, had set up a snuff-mill in Narragansett, in company with another Scotsman, Dr. Thomas Moffatt, and was known as the "snuff-grinder." The father removed early to Newport, where his son had the advantage of good instruction. He began to draw early, but none of his sketches have been preserved. His first known pictures are of two Spanish dogs, and two portraits, the latter painted when he was thirteen years old, and now in the Redwood Library, Newport. In 1770–71 he received some instruction from a Scottish artist named Cosmo Alexander, who took him to Scotland with him; but, this patron dying soon after his arrival, Stuart, after struggling for a while at the university of Glasgow, had to work his way home in a collier. In the spring of 1775 he sailed again for England, and became the pupil and assistant of Benjamin West, with whom he painted until 1785, when he set up a studio of his own. One of his best pictures of this period is a full-length portrait of W. Grant of Congalton skating in St. James's Park, now at Moor Court, Stroud, in the possession of Lord Charles Pelham Clinton. Two fine half-lengths by Stuart are in the National Gallery—his preceptor Benjamin West and the engraver Woolett. Stuart married in London and remained there, with the exception of a short visit to Dublin in 1788, until 1792, when he returned to America. Early in 1795 Stuart painted his first head of Washington. This portrait exhibits the right side of the face, and, although the least familiar, is undoubtedly the truest of the three portraits of Washington from his hand. The second was a full-length for the marquis of Lansdowne, and the third a vignette head now belonging to the Athenæum in Boston, U. S. These last two show the left side of the face, and, although they are the readily recognized "Stuart's Washington," are unsatisfactory as portraits and inferior as works of art. There are sixty-one replicas of these three pictures, and they have been engraved more than two hundred times. In the catalogue of Stuart's works are recorded seven hundred and fifty-four portraits. Stuart remained in Philadelphia, where he painted many of the prominent men of the country, until 1803, when he removed to Washington; two years later he went to Boston, where he died July 27, 1828.

Stuart's pictures have been little injured by time, which is doubtless owing to his use of pure colors and to his manner of employing them. His practice was to lay all the tints in their places separately and distinctly alongside of each other before any blending was used, and then they were united by means of a large soft brush and without corrupting their freshness. It is this method that gives the firmness and solidity to his flesh work. A marked feature of Stuart's work is the total absence of all lines, his work being painted in with the brush from the beginning. It is this process that gives to his modelling its strength and rotundity. Stuart was pre-eminent as a colorist, and his place, judged by the highest canons in art, is unquestionably among the few recognized masters of portraiture.

STUART, JOHN M'DOUALL (1818–1866), a South-Australian explorer, was born in England in 1818 and arrived in the colony about 1839. He accompanied Captain Sturt's 1844–45 expedition as draughtsman, and between 1858 and 1862 he made six expeditions into the interior, the last of which brought him on July 24 to the shores of the Indian Ocean at Port Darwin, the first to have crossed the island continent from south to north. It was this transcontinental expedition which led to the territorial rights, and, in defiance of geographical position, the name of South Australia being extended over so much of central and north Australia. Stuart was rewarded with £3000 [$14,580] and a grant of 1000 square miles of grazing country in the interior rent free for seven years. His name is perpetuated by Central Mount Stuart. He died in England, June 5, 1866.

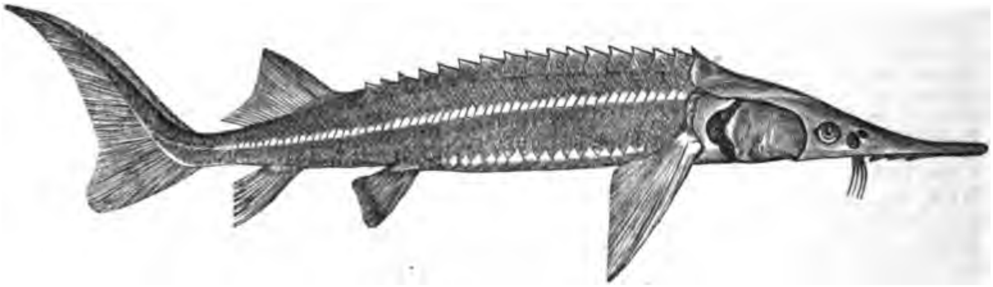
STUHLWEISSENBURG (Hung. *Székes-Fehérvár;* Lat. *Alba Regia*), the capital of the county of Fehér, and in former times also of Hungary, is situated in 47° 11′ N. lat. and 18° 25′ E. long., in a fertile plain. It is the see of one of the oldest bishoprics in the country, and has a number of religious charities, convents, and nunneries, a seminary, a gymnasium, and a real school. It was the coronation and burial place of the Hungarian kings from the 10th to the 16th century, but has sunk into comparative insignificance. A few years ago some very remarkable excavations were made here. The town is now chiefly agricultural; its fairs, especially for horses, are famous. The population (1885) numbers 27,000.

STURGEON. Sturgeons (*Acipenser*) are a small group of fishes, of which some twenty different species are known, from European, Asiatic, and North American rivers. The distinguishing characters of this group, as well as its position in the system, have been sufficiently indicated in the article ICHTHYOLOGY (vol. xii. p. 725). They pass a great part of the year in the sea, but periodically ascend large rivers, some in spring to deposit their spawn, others later in the season for some purpose unknown; only a few of the species are exclusively confined to fresh water. None occur in the tropics or in the southern hemisphere.

Sturgeons are found in the greatest abundance in the rivers of southern Russia, more than ten thousand fish being sometimes caught at a single fishing-station in the fortnight during which the up-stream migration lasts. They occur in less abundance in the fresh waters of North America, where their capture is not confined to the rivers, the majority being caught in shallow portions of the shores of the great lakes. In Russia the fisheries are of immense value; yet but little is known of the sturgeon's habits, life, and early stages of development or growth. Early in summer the fish migrate into the rivers or towards the shores of fresh-water lakes in large shoals for breeding purposes. The ova are very small, and so numerous that one female has been calculated to produce about three millions in one season. The ova of some species have been observed to hatch within a very few days after exclusion. Probably the growth of the young is very rapid, but we have no knowledge as to the length of time for which the fry remain in fresh water before their first migration to the sea. After they have attained maturity their growth appears to be much slower, although continuing for many years. Frederick the Great attempted to introduce the sterlet into Prussia, and placed a number of this fish in the Görland Lake in Pomerania about 1780; some of these were found to be still alive in 1866, and therefore had reached an age of nearly ninety years. Prof. Von Baer also states, as the result of direct observations made in Russia, that the hausen (*Acipenser huso*) attains to an age of from 200 to 300 years. Sturgeons ranging from 8 to 11 feet in length are by no means scarce, and some species grow to a much larger size.

Sturgeons are ground-feeders. With their projecting wedge-shaped snout they stir up the soft-bottom, and by means of their sensitive barbels detect shells, crustaceans, and small fishes, on which they feed. Destitute of teeth, they are unable to seize larger prey.

In countries like England, where few sturgeons are caught, the fish is consumed fresh, the flesh being firmer than that of ordinary fishes, well-flavored, though somewhat oily. The sturgeon is included as a royal fish in an Act of King Edward II., which assigns to the sovereign all wrecks and whales, although it probably but rarely graces the royal table of the present period, or even that of the lord mayor of London, who can claim all sturgeons caught in the Thames above London Bridge. Where sturgeons are regularly caught in large quantities, as on the rivers of southern Russia and on the great lakes of North America, their flesh is dried, smoked, or salted. The ovaries, which are of large size, are prepared for caviare; for this purpose they are beaten with switches, and then pressed through sieves, leaving the membranous and fibrous tissues in the sieve, whilst the eggs are collected in a tub. The quantity of salt added to them before they are finally packed varies with the season, scarcely any being used at the beginning of winter. Finally one of the best sorts of isinglass is manufactured from the air-bladder. After it has been carefully removed from the body, it is washed in hot water, and cut open in its whole length, to separate the inner membrane, which has a soft consistency, and contains 70 per cent. of glutin.



The Sterlet.

The twenty species of sturgeons (*Acipenser*) are nearly equally divided between the Old and New Worlds. The more important are the following:

(1) The Common Sturgeon of Europe (*Acipenser sturio*) occurs on all the coasts of Europe, but is absent in the Black Sea. Almost all the British specimens of sturgeon belong to this species; it crosses the Atlantic and is not rare on the coasts of North America. It reaches a large size (a length of 12 feet), but is always caught singly or in pairs, so that it cannot be regarded as a fish of commercial importance. The form of its snout varies with age (as in the other species), being much more blunt and abbreviated in old than in young examples. There are 11-13 bony shields along the back and 29-31 along the side of the body.

(2) *Acipenser güldenstädtii* is one of the most valuable species of the rivers of Russia, where it is known under the name "Ossétr"; it is said to inhabit the Siberian rivers also, and to range eastwards as far as Lake Baikal. It attains to the same large size as the common sturgeon, and is so abundant in the rivers of the Black and Caspian Seas that more than one-fourth of the caviare and isinglass manufactured in Russia is derived from this species.

(3) *Acipenser stellatus*, the "Seuruga" of the Russians, occurs likewise in great abundance in the rivers of the Black Sea and of the Sea of Azoff. It has a remarkably long and pointed snout, like the sterlet, but simple barbels without fringes. Though growing only to about half the size of the preceding species, it is of no less value, its flesh being more highly esteemed, and its caviare and isinglass fetching a higher price. In 1850 it was reported that more than a million of this sturgeon are caught annually.

(4) The sturgeon of the great lakes of North America, *Acipenser rubicundus*, with which, in the opinion of American ichthyologists, the sea-going sturgeon of the rivers of eastern North America, *Acipenser maculosus*, is identical, has of late years been made the object of a large and profitable industry at various places on Lakes Michigan and Erie; the flesh is smoked after being cut into strips and after a slight pickling in brine; the thin portions and offal are boiled down for oil; nearly all the caviare is shipped to Europe. One firm alone uses from ten to eighteen thousand sturgeons a year, averaging fifty pounds each. The sturgeons of the lakes are unable to migrate to the sea, whilst those below the Falls of Niagara are great wanderers; and it is quite possible that a specimen of this species said to have been obtained from the Firth of Tay was really captured on the coast of Scotland.

(5) *Acipenser huso*, the "Hausen" of Germany, is recognized by the absence of osseous scutes on the snout and by its flattened, tape-like barbels. It is one of the largest species, reaching the enormous length of 24 feet and a weight of 2000 pounds. It inhabits the Caspian and Black Seas and the Sea of Azoff, whence in former years large shoals of the fish entered the large rivers of Russia and the Danube. But its numbers have been much thinned, and specimens of 1200 pounds in weight have now become scarce. Its flesh, caviare, and air-bladder are of less value than those of the smaller kinds.

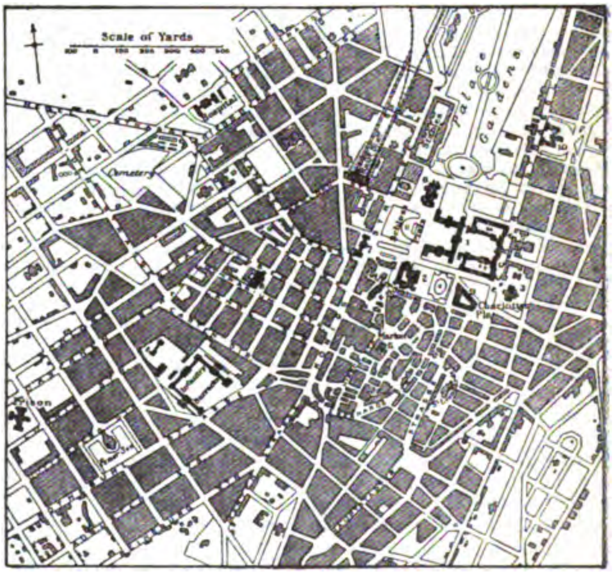
(6) The Sterlet (*Acipenser ruthenus*) is one of the smaller species, which likewise inhabits both the Black and Caspian Seas, and ascends rivers to a greater distance from the sea than any of the other sturgeons; thus, for instance, it is not uncommon in the Dannube at Vienna, but specimens have been caught as high up as Ratisbon and Ulm. It is more abundant in the rivers of Russia, where it is held in high esteem on account of its excellent flesh, contributing also to the best kinds of caviare and isinglass. As early as last century attempts were made to introduce this valuable fish into Prussia and Sweden, but without success. The sterlet is distinguished from the other European species by its long and narrow snout and fringed barbels. It rarely exceeds a length of three feet.

Sturgeons with the snout prolonged in an extraordinary manner, so as to form a long spade-like or conical process (*Spatularia*, *Polyodon*, *Psephurus*), occur in the Mississippi and the great rivers of China and Central Asia. None of them have been made objects of trade, but special interest is attached to them from a geographical as well as palæontological point of view, the two genera last named being represented as far back as the Lias by an allied fossil genus, *Chondrosteus*, and all affording a striking proof of the close affinity of the North-American and North-Asiatic faunas of the recent period.

STURM, Jacques Charles François (1803–1855), the discoverer of the algebraic theorem which bears his name, was born in Geneva in 1803. Originally tutor to the son of Madame de Stael, he subsequently resolved, in conjunction with his school-fellow Colladon, to try his fortune in the French metropolis. Sturm soon made the acquaintance of the foremost mathematicians in the capital, and obtained employment on the *Bulletin Universel.* On the discovery of his important theorem regarding the determination of the number of real roots of a numerical equation which are included between given limits, on 23d May, 1829, he rapidly rose to fortune and public honors. He was chosen a member of the French Academy in 1836, became "repetiteur" in 1838, and in 1840 professor in the Polytechnic School, and finally succeeded Poisson in the chair of mechanics in the Faculty of Science at Paris. He presented numerous memoirs to the Academy, of which his admirers have said, with some pardonable exaggeration, that an impartial posterity will place them by the side of the finest memoirs of Lagrange. Sturm died at Paris on the 18th December, 1855.

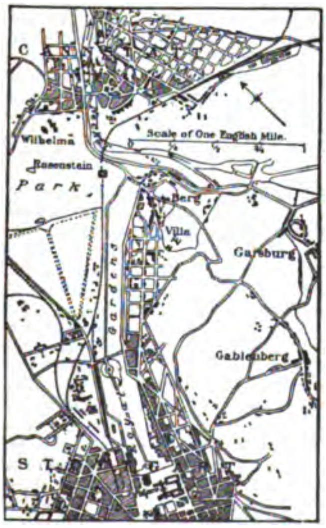
STURT, Charles (d. 1869), a distinguished South-Australian explorer, was born in England, and at an early age entered the army, in which he reached the rank of captain. Having landed in Australia with his regiment (the 39th), he became interested in the geographical problems which at that time were exciting general attention. A first expedition (1828) led to the discovery of the Darling river; and a second, from which the explorer returned almost blind, made known the existence of Lake Alexandrina. For some time Captain Sturt was surveyor-general of South Australia, and he afterwards filled the post of colonial secretary. The first session of the South-Australian legislature (1851) voted him a pension of £600 [$2916]. From his third journey (1844–45), in which terrible hardships had to be endured, he returned quite blind, and he never altogether recovered his sight. He died at Cheltenham, England, June 16, 1869.

STUTTGART, the capital of Würtemburg, lies in the small valley of the Nesenbach, just above its confluence with the Neckar, near the centre of the kingdom and about 115 miles west-by-north of Munich. It is charmingly situated among vine-clad and wooded hills, and stands at a height of nearly 900 feet above the sea. The town is intersected from southwest to northeast by the long and handsome Königs-Strasse, dividing it into an upper and lower half. In all its main features it is essentially a modern town, and few of its principal buildings are older than the present century. Many of its modern edifices are, however, of considerable architectural importance, and the recent revival of the Renaissance style is perhaps nowhere better illustrated than at Stuttgart. The lower or south-eastern half contains both the small group of streets belonging to old Stuttgart and also the most important part of the new town. A large proportion of the most prominent buildings are clustered round the spacious Schloss-Platz, on or near which are the following edifices: the new palace, an imposing structure of the 18th century, finished in 1806; the old palace, a building of the 16th century, with a picturesque arcaded court; the Königsbau, a huge modern building, with a fine colonnade, containing ball and concert rooms, shops, etc.; the so-called Akademie, formerly (1775–94) the seat of the Carls-Schule, where Schiller received part of his education, and now occupied by the king's private library and by guard-rooms; the new courts of justice; the palaces of the crown prince and of Prince William; the Stiftskirche, or collegiate church, a fine specimen of 15th century Gothic; the extensive royal stables; the new post-office; the theatre, and the central railway station, one of the handsomest structures of the kind in Germany. In the centre of the Schloss-Platz is the lofty jubilee column erected in memory of King William I.; in the court-yard of the old palace is a bronze equestrian statue of Count Eberhard with the Beard, and adjacent is a fine statue, designed by Thorwaldsen, of Schiller, who was a native of Würtemberg. Among the other principal buildings are the polytechnic and architectural schools, the Late Gothic Leonhardskirche and Spitalkirche, the fine modern Gothic church of St. John, the new Roman Catholic church, the neat little English church, the synagogue, and several handsome villas and mansions, chiefly in the resuscitated Renaissance style.



Plan of Stuttgart.

1. Palace.
2. Old Palace.
3. Prinzessen Palais.
4. Collegiate Church.
5. Town-house.
6. Theatre.
7. Crown-Prince's Palace.
8. Hospital Church.
9. Orphanage.
10. Museum of Art.



Environs of Stuttgart.

The art collections of Stuttgart are numerous and valuable. The museum of art comprises a picture gallery, an almost unique collection of casts of Thorwaldsen's works, and a cabinet of engravings. The royal library contains about 350,000 printed volumes,[1] including what is said to be the largest collection of Bibles in the world, and also 4000 MSS., many of great rarity. To these may be added the industrial museum, the cabinet of coins, the museum of natural history, the fine collection of majolica in the new palace, and the museum of antiquities. The city also contains numerous excellent educational establishments, though the state university is not here but at Tübingen, and its conservatorium of music has long been renowned. Stuttgart is the centre of the publishing trade of South Germany, and has a busy industry in everything connected with the production of books. In various other industrial departments it also takes a high place, its manufactures including machinery, textile fabrics, pianos, and other musical instruments, artists' colors, chemicals, sugar, and chocolate. Its trade is considerable. The population of Stuttgart in 1885 was 125,510, showing an increase of 7 per cent. since 1880. Four-fifths of these are Protestants. The town proper contains about 110,000 inhabitants, while the above total is made up by adding the populations of the suburban villages of Berg, Gablenberg, and Heslach. Stuttgart is the headquarters of the 13th corps of the German army, and contains a comparatively large garrison, for which accommodation is provided in three extensive barracks within the town and on the outskirts.

To the northeast of the new palace lies the beautiful palace park, embellished with statuary and artificial sheets of water, and extending nearly all the way to Cannstatt, a distance of over two miles. Cannstatt, a town with (1880) 16,205 inhabitants, is not officially incorporated with Stuttgart, but may be looked on as practically forming part of it. Its beautiful situation on the Neckar, its tepid saline and chalybeate springs, and its educational advantages attract numerous visitors. In the environs of Stuttgart and Cannstatt lie Rosenstein, the Solitude, Hohenheim, the Wilhelma, and other royal chateaus.

Stuttgart seems to have originated in a stud ("Stuten Garten") of the early counts of Würtemberg, and the first mention of it occurs in a document of 1229. Its importance is of comparatively modern growth, and in early Würtemberg history we find it overshadowed by Cannstatt, the central situation of which, on the Neckar, seemed to mark it out as the natural capital of the country. After the destruction of the castle of Würtemberg Count Eberhard, however, transferred his residence to Stuttgart (1320), and in 1482 it became the recognized capital of all the Würtemberg territories. Even as capital its growth was slow, and it enjoys little prominence in history. At the beginning of the present century it did not contain 20,000 inhabitants, and its real advance begins with the reign of King William I. (1816–1864), who exerted himself in every way to improve and beautify his capital. In 1849 Stuttgart was the place of meeting of the so-called "Rump Parliament" (Rumpfparlament). Among its eminent natives are Hegel (b. 1770), the philosopher, and Hauff (b. 1802), the poet and story-teller.

STYRAX. See STORAX.

STYRIA (Germ. *Steiermark* or *Steyermark*), a duchy and crownland in the Cis-Leithan part of the Austrian empire, is bounded on the north by Upper and Lower Austria, on the E. by Hungary, on the S. by Croatia and Carniola, and on the W. by Carinthia and Salzburg. Its area is 8630 square miles. Almost the entire district is mountainous, being occupied by various chains and ramifications of the eastern Alps; and though Northern (or Upper) and Southern (or Lower) Styria are distinguished, the latter is low only in a relative sense. The North Limestone Alps touch Styria to the north of the Enns, beginning with the huge Dachstein (9830 feet), which rises on the northwest border of the duchy. To the south of the Enns the central chain of the Alps traverses Styria from southwest to northeast in two huge ranges, separated by the valleys of the Mur and the Mürz, and conveniently grouped under the name of Styrian Alps. The more northerly of these two branches, forming a prolongation of the Tauern ridge, is the loftier, and culminates in the Hochgolling (9392 feet), the highest summit in Styria. The lower branch to the south is broken by the valley of the Mur, which turns abruptly to the right at its confluence with the Mürz, and still farther to the northeast is crossed by the Semmering Pass. To the south of the Drave the duchy is traversed by the Karawanken Mountains (highest peak, the Stou, 7346 feet), forming a continuation of the Carnic Alps. The mountains decrease in height from west to east, and the southeast part of Styria may be described as hilly rather than mountainous. There is nowhere level ground enough to form a plain in the proper acceptation of the term, but some of the valleys contain a good deal of fertile land. The rivers of Styria all drain into the Danube; the Save and the Traun are the most important of those not already mentioned. There are numerous small mountain lakes. The climate, of course, varies with the configuration of the surface, and there is a mean annual difference of about 7° Fahr. between the temperature of the northwest and the southeast.

In spite of the irregular nature of the surface, but little of the soil can be called unproductive. About 21.40 per cent. is under tillage, 12.75 in meadow, and 16.75 in pasture, while nearly a half of the total area is covered with fine forests. The chief crops are oats, maize, rye, wheat, buckwheat, potatoes, and flax. Wine is produced in the valleys of Lower Styria, where large quantities of chestnuts are also grown. In the mountains dairy-farming is successfully carried on in the Alpine fashion, and good horses are reared in the valley of the Enns. Sheep are comparatively few, but there are large numbers of goats and swine, while poultry-rearing and bee-keeping are very general in the Slavonic districts to the south. Some fairly successful attempts have also been made to breed silkworms. Trout and other fish are abundant in the rivers and mountain lakes, and chamois are hunted among the higher Alps.

The great wealth of Styria, however, lies underground. Its extensive and important iron mines yield nearly one-third of the iron ore raised in the Austrian empire, and its other mineral resources include brown coal, pit-coal, copper, zinc, lead, graphite, a little gold and silver, nickel, alum, cobalt, salt, dyer's earth, potter's clay, marble, and good mill and building stones. The best known of its numerous mineral springs are the thermal springs of Tüffer, the alkaline springs of Rohitsch, and the brine springs of Aussee.

The chief industry of Styria is determined by its mineral richness, and iron-foundries, machine-shops, and manufactures of various kinds of iron and steel goods are very numerous. A special branch is the making of scythes and sickles, which are sent out of the country in large quantities. Among its other industrial products are glass, paper, cement, oil and perfumery, shoes, cotton goods, chemicals, and gunpowder. Linen-weaving is prosecuted as a household industry. An active trade is carried on in the above-named manufactures, and in brown coal, cattle, wine, and fruit. In addition to three navigable rivers (Drave, Save, Mur), the traffic of the duchy is facilitated by 600 miles of railway.

The population of Styria in 1880 was 1,213,597, equivalent to 140 per square mile, a proportion which, while not high in itself, is considerably above the rate in the other mountainous regions of the empire. Nearly the whole of these profess the Roman Catholic faith, the Protestants numbering only 8000 and the Jews about 1000. Two-thirds of the inhabitants are German; the remainder, chiefly found in the south parts of the duchy, in the valleys of the Drave and Save, are Slavs (Slovenes). About 65 per cent. are supported by agricultural pursuits, including forestry. The education of the crownland centres in the university of Gratz, which is attended by about 1200 students. The capital and seat of the administration is Gratz (100,000 inhabitants), which is also the headquarters of the third corps of the Austrian army; the only other town of any size is Marburg (17,600). The provincial estates consist of 63 members, including the two Roman Catholic bishops, the rector of the university, 12 representatives of the large landowners, 23 of the peasants, 19 of the towns, and 6 of the chambers of commerce. Styria sends 23 members to the imperial parliament.

In the Roman period Styria, which even thus early was famed for its iron and steel, was inhabited by the Celtic Taurisci, and divided geographically between Noricum and Pannonia. Subsequently it was successively occupied or traversed by Visigoths, Huns, Ostrogoths, Langobardi, Franks, and Avars. Towards the end of the 6th century the last named began to give way to the Slavs (Vinds), who ultimately made themselves masters of the entire district. Styria was included in the conquests of Charlemagne, and was henceforth comprised in the German marks erected against the Avar and the Slav. At first the identity of Styria is lost in the great duchy of Carinthia, corresponding more or less closely to the Upper Carinthian mark. This duchy, however, afterwards fell to pieces, and a distinct mark of Styria was recognized, taking its name from the margrave Ottocar of Steier (1056). A century or so later it was created a duchy. In 1192 the duchy of Styria came by inheritance to the house of Austria, and from that time it shared the fortunes of Upper and Lower Austria, passing like them to the Hapsburgs in 1282. The Protestant Reformation met an early and general welcome in Styria, but the dukes took the most stringent measures to stamp it out, offering their subjects recantation or expatriation as the only alternatives. At least 30,000 Protestants preferred exile, and it was not till about 100 years ago that religious liberty was recognized. The modern history of Styria has been similar to that of the other Austrian crownlands, and calls for no special remark.

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[1] [For statistics of this library see vol. xiv p. 549.—AM. ED.]

STYX, a river which the Greeks fabled to flow in the world of the dead. Homer speaks of it as a river of Hades by which the gods swore their most solemn oaths, and he couples it with the Cocytus and the Pyriphlegethon, the river of wailing and the river of burning fire. Hesiod says that Styx was a daughter of Ocean, and that, when Zeus summoned the gods to Olympus to help him to fight the Titans, Styx was the first to come and her children with her; hence as a reward Zeus ordained that the most solemn oath of the gods should be by her and that her children (Emulation, Victory, Power, and Force) should always live with him. In another passage he says that Styx (whom, somewhat contradictorily, he describes as abhorred by the immortal gods) dwells far off from the gods in a beautiful house overarched with rocks and supported by tall silver pillars, which may be meant as a description of a stalactitic cave. Again Hesiod tells us that if any god, after pouring a libation of the water of Styx, forswore himself, he had to lie in a trance for a year without speaking or breathing, and that for nine years afterwards he was excluded from the society of the gods. In historical times the Styx was identified with a lofty waterfall near Nonacris in Arcadia. Pausanias describes the cliff over which the water falls as the highest he had ever seen, and indeed the fall is the highest in Greece. The scenery is wild and desolate. The water descends in two slender cascades, which, after winding among the rocks, unite and fall into the river Akrata (the ancient Crathis). The ancients regarded the water as poisonous, and thought that it possessed the power of breaking or dissolving vessels of every material, with the exception of the hoof of a horse or ass, or (according to others) of horn. The Arcadians used to swear by it on important occasions. The people in the neighborhood still hold that the water is unwholesome, and that no vessel will hold it. They call it the Black Water or the Terrible Water.

Considering the prominence given by the ancients to an oath by the water of Styx, and comparing the effect supposed to follow from breaking that oath with the destructive power supposed to be possessed by the water, we are tempted to conjecture that drinking the water was originally a necessary part of the oath,—that in fact in the stories of the Styx we have traditions of an ancient poison ordeal such as is commonly employed amongst barbarous peoples as a means of eliciting the truth (see Ordeal).

See Leake, *Travels in the Morea*, iii. p. 156 *sq.*; M. G. Clarke, *Peloponnesus*, p. 302 *sq.*; Curtius, *Peloponnesos*, i. p. 195 *sq.*; Wordsworth, *Greece*, p. 384.

SUAKIN, or Suwakim, more correctly Sawákin, the chief port of the Soudan on the Red Sea and the starting-place of caravans for Kassala and Berber, occupies a small island, placed in a deep bay in 19° 5′ N. lat. The custom-house and Egyptian Government offices present a good frontage to the sea, and the principal houses are stately white structures, three stories high, not unlike those of Jiddah. With these, however, are intermingled shapeless huts, each with its courtyard walled in with mats. There are also the usual Greek drinking-shops, with their dirty loungers in coats and fez-caps, and a short street of coffee-houses and shops. The mosques are not remarkable. Passing through the bazaar and turning to the right past the tomb of Sheikh 'Alí, one comes to an open space at the head of the recent causeway which unites the island to the mainland town of Al-Kaff (Al-Keif). The main street of Al-Kaff is (or was before the recent war) the busy centre of life and movement, while the side streets are occupied by smiths, forging lanceheads and knives; leather workers, who drive a brisk trade in the amulets—passages of the Koran sewn up in leather cases—which the natives wear on their arms or round their necks; and hairdressers, greasing and powdering with the dust of a red wood the bushy locks of the Hadendoa dandies. Beyond the town is a suburb of straw huts with their simple furniture of a bedstead, a few dishes, and a rubbing stone for the millet which with milk forms the chief food of the natives. Here too are the booths of the silversmiths, who make bracelets, anklets, ear and nose rings, for the women. The Hadendoa, a tall stalwart race, picturesquely draped in huge wrappers, to which the women add a petticoat, are most numerous on the mainland. The population of the island is mixed, with a large infusion of Arab blood. The export trade of Suakin before the revolt of the Soudan yielded a customs revenue of £60,000 [$291,600] a year, the chief articles besides the ivory, which was a Government monopoly, being gum, cotton, sesame, senna, and hides. The total yearly trade was estimated at a million sterling.

The environs of Suakin, though not so absolutely desert as the opposite Arabian coast, are less wooded than some points (*e.g.*, Sheikh Barghút) which lie as conveniently for the inland trade. The island is without water and the harbor indifferent; yet the settlement is ancient. Here as at Massowah traders were presumably attracted by the advantages of an island site which protected them from the nomads. The country inland from all this coast belonged in the Middle Ages to the Boja (Bejah), a rude pastoral race who appear to be identical with the Blemmyes of classical writers and of whom Hadendoa, Bishárín, and Abábdah are the modern representatives. The trading places seem to have been always in the hands of foreigners since Ptolemais Theron was established by Ptolemy Philadelphus for intercourse with the elephant hunters. After Islam many Arabs settled on the coast and mixed with the heathen Boja, whose rule of kinship and succession in the female line helped to give the children of mixed marriages a leading position (Makrízí, *Khitat*, i. 194 *sq.*, translated in Burckhardt's *Travels in Nubia*, App. iii.). Thus in 1330 Ibn Batúta found a son of the emir of Mecca reigning in Suakin over the Boja, who were his mother's kin. Makrízí says that the chief inhabitants were nominal Moslems and were called Hadárib. The emir of the Hadárib was still sovereign of the mainland at the time of Burckhardt's visit (1814), though the island had an aga appointed by the Turkish pasha of Jiddah. The place was settled by the Turks under Selim the Great, but Turkish (or Egyptian) control over the mainland was not effective till the Egyptian conquest of the Soudan. Till the suppression of the slave trade, Suakin was an important slave port; of late years slaves have been secretly run across the Red Sea from less frequented points on the coast. But legitimate commerce was rapidly growing before the revolt of the Soudan, and the port was visited by English, Egyptian, and Italian steamers.

SUARDI, Bartolommeo, usually known as Bramantino from his master Bramante, was a distinguished painter and architect of the Milanese school. He was specially famed for his knowledge of perspective, and Lomazzo (*Tratt. d. Pitt.*, iii. 1) praises him highly for the deceptive realism of his painting. The dates of his birth and death are unknown, but he was probably quite young when, about 1495, he visited Rome in company with his master Bramante; there he is said to have been employed as a painter by the pope, and he evidently spent much time in studying the remains of classical buildings in Rome. A number of measured drawings by his hand are still preserved in the Brera library at Milan. Vasari mentions that he had seen a book of drawings by Bramantino of the early Lombardic churches of Northern Italy, such as S. Ambrogio at Milan and S. Pietro in Ciel d'Oro at Pavia,—a remarkable thing at a time when these noble structures were usually despised as being barbarous in style. The greater part of Bramantino's frescos are now lost, partly because he was specially employed to paint the external façades of houses and public buildings, such as the mint at Milan. One, however, still exists over the doorway of S. Sepolcro, a highly foreshortened figure of Christ, with the Madonna and Saints. He also painted some angels which still exist in the church of S. Eustorgio, also in Milan. In 1513 he received eighty gold crowns [$89.55] for a Pietà and Saints painted in the sacristy for the Cistercian monks of Chiaravalle, near Milan. In 1525 he was appointed architect and painter to Francesco II. of Milan, and he was employed as military engineer to reconstruct the walls of the city, which was then threatened by the army of Charles V. The church of S. Satiro in Milan is usually attributed to Bramantino, but it appears to have been mainly designed by Bramante. Bramantino died between 1530 and 1536. He left an able pupil called Agostino di Milano, who worked chiefly as an architect.

SUAREZ, Francisco (1548–1617), Spanish theologian and philosopher, was born at Granada on the 5th of January, 1548. After completing his studies at the university of Salamanca, he entered the Society of Jesus in 1564. The accounts of his early years represent him as backward in his development, and it was not without difficulty that he obtained admission to the order. Under the direction of Father Rodriguez, however, he threw off his mental slough and discovered powers of mind of the highest order. He is said to have habitually devoted seventeen hours a day to study, and wonders are reported of his prodigious memory. He was soon appointed to teach philosophy at Segovia, and he afterwards taught theology at Valladolid, at Alcala, at Salamanca, and at Rome successively. After taking his doctorate at Evora, he was named by Philip II. principal professor of theology in the university of Coimbra. Suarez may be considered almost the last eminent representative of scholasticism, and his works in twenty-three folio volumes treat, after the scholastic method and with scholastic comprehensiveness, all the main subjects of mediæval philosophy and theology. In philosophical doctrine he adhered to a moderate Thomism. On the question of universals he endeavored to steer a middle course between the pantheistically inclined realism of Duns Scotus and the extreme nominalism of William of Occam. The only veritable and real unity in the world of existences is the individual; to assert that the universal exists separately *ex parte rei* would be to reduce individuals to mere accidents of one indivisible form. Suarez maintains that, though the humanity of Socrates does not differ from that of Plato, yet they do not constitute *realiter* one and the same humanity; there are as many "formal unities" (in this case, humanities) as there are individuals, and these individuals do not constitute a factual, but only an essential or ideal unity ("ita ut plura individua, quæ dicuntur esse ejusdem naturæ, non sint unum quid vera entitate quæ sit in rebus, sed solum fundamentaliter vel per intellectum"). The formal unity, however, is not an arbitrary creation of the mind, but exists "in natura rei ante omnem operationem intellectus." In theology, Suarez attached himself to the doctrine of Molina, the celebrated Jesuit professor of Evora. Molina tried to reconcile the doctrine of predestination with the freedom of the human will by saying that the predestination is consequent upon God's foreknowledge of the free determination of man's will, which is therefore in no way affected by the fact of such predestination. God gives to all men grace sufficient for their salvation, but some co-operate freely with this grace, while others resist it. Suarez endeavored to reconcile this view with the more orthodox doctrines of the efficacy of grace and special election, maintaining that, though all share in an absolutely sufficient grace, there is granted to the elect a grace which is so adapted to their peculiar dispositions and circumstances that they infallibly, though at the same time quite freely, yield themselves to its influence. This mediatizing system was known by the name of "congruism." Suarez is probably more important, however, as a philosophical jurist than as a theologian or metaphysician. In his extensive work *Tractatus de Legibus ac Deo Legislatore* (reprinted, London, 1679) he is to some extent the precursor of Grotius and Pufendorf. Though his method is throughout scholastic, he covers the same ground, and Grotius speaks of him in terms of high respect. The fundamental position of the work is that all legislative as well as all paternal power is derived from God, and that the authority of every law resolves itself into His. Suarez conclusively refutes the patriarchal theory of government and the divine right of kings founded upon it,—doctrines popular at that time in England and to some extent on the Continent. Adam, he remarks, possessed only a domestic or patriarchal, not a political authority. Power by its very nature belongs to no one man but to a multitude of men; and the reason is obvious, since all men are born equal. It has been pointed out that this accords well with the Jesuit policy of depreciating the royal while exalting the papal prerogative. But Suarez is much more moderate on this point than a writer like Mariana, approximating to the modern view of the rights of ruler and ruled. In 1613, at the instigation of Pope Paul V., Suarez wrote a treatise dedicated to the Christian princes of Europe, entitled *Defensio Catholicæ Fidei contra Anglicanæ Sectæ Errores*. This was directed against the oath of allegiance which James I. exacted from his subjects. James caused it to be burned by the common hangman, and forbade its perusal under the severest penalties, complaining bitterly at the same time to Philip III. that he should harbor in his dominions a declared enemy of the throne and majesty of kings. In France extracts from the treatise were condemned to the flames by the parlement of Paris on similar grounds. Suarez died after a few days' illness on 25th September, 1617, at Lisbon, whither he had gone to be present at an ecclesiastical conference.

The collected works of Suarez have been printed at Mainz and Lyons (1630) and at Venice (1740), also more recently at Besançon (1856–62) and in the collection of the Abbé Migne. His life has been written by Deschamps (*Vita Fr. Suaresii*, Perpignan, 1671). The chief modern authorities are K. Werner's *Franz Suarez u. die Scholastik der letzten Jahrhunderts* (Ratisbon, 1861) and the third volume of Stöckl's *Geschichte der Philosophie des Mittelalters*.

SUBIACO, a town of Italy, in the province of Rome, 25 miles east of Tivoli and 42 from the capital, is picturesquely situated on the right bank of the Teverone. It has iron-works and paper-mills, and in 1881 the population of the town was 6503 (commune, 7017), having decreased from 7452 in 1868.

Subiaco, the *Sublaqueum* of the Romans, was so called from its position under the artificial lakes constructed in connection with one of the villas of the emperor Nero. In all probability there was no town in ancient times, and the modern town of Subiaco appears to have grown up subsequent to the establishment of the Benedictine monasteries in this neighborhood. Of these the most remarkable are Santa Scolastica,[1] which was built by the abbot Honoratus, and by the 11th century ranked as a regular principality; and Sacro Speco, which has gathered its curious cluster of buildings round the cave in which St. Benedict himself found an asylum (see vol. iii. p. 481). The points of most interest in the town, which still bears on the whole a clearly mediæval impress, are associated with Pope Pius VI. It was Pius who restored and extended the great castle, erected in 1068 by Abbot John V., and long used as a summer residence by the popes; and it was he who built the costly church of Sant' Andrea. His visit to the town in 1789 is commemorated by a triumphal arch. The first book printed in Italy was the Subiaco *Lactantius* of 1465.

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[1] For the Santa Scolastica library, see LIBRARIES, vol. xiv. p. 529.

SUBLEYRAS, Pierre (1699–1749), French painter, who passed nearly his whole life at Rome, was born at Uzès (Gard) in 1699. He left France for Italy in 1728, having carried off the great prize. He there painted for the canons of Asti Christ's Visit to the House of Simon the Pharisee (Louvre, engraved by Subleyras himself), a large work, which made his reputation and procured his admission into the Academy of St. Luke. Cardinal Valenti Gonzaga next obtained for him the order for Saint Basil and the Emperor Valens (small study in Louvre), which was executed in mosaic for St. Peter's. Benedict XIV. and all the princes of Rome sat to him, and the pope himself commanded two great paintings—the Marriage of St. Catherine and the Ecstasy of St. Camilla—which he placed in his private apartment. For various religious corporations at Milan, Perugia, and other places, and for various great persons many important altar-pieces were also executed; but Subleyras shows greater individuality in his curious genre pictures, which he produced in considerable number (Louvre). It is in his illustrations of La Fontaine and Boccaccio that his true relation to the modern era comes out; and his drawings from nature are often admirable for their grave sobriety of treatment (see one of a man draped in a heavy cloak in the British Museum). Exhausted by overwork, Subleyras tried a change to Naples, but returned to Rome at the end of a few months to die (28th May, 1749). His wife, the celebrated miniature painter, Maria Felice Tibaldi, was sister to the wife of Trémollière.

SUCCESSION DUTY is a sum paid to the state by a person benefited by the succession to certain kinds of property. Legacies were first taxed in 1780. It was not until 1853 that a tax was levied upon succession to real property, or succession under any instrument other than a will by which property is enjoyed in succession to a deceased person. The duty is paid on succession to both real and personal property, in fact, in almost all cases which do not fall within the Legacy Duty Acts. The Succession Duty Act, 1853 (16 and 17 Vict. c. 51), defines succession as "every past or future disposition of property by reason whereof any person has or shall become beneficially entitled to any property, or the income thereof, upon the death of any person dying after the time appointed for the commencement of this Act, either immediately or after any interval, either certainly or contingently, and either originally or by way of substitutive limitation, and every devolution by law of any beneficial interest in property, or the income thereof, upon the death of any person dying after the time appointed for the commencement of this Act to any other person in possession or expectancy." There are certain exemptions, the most important being successions of a husband or wife, successions where the whole value is under £100 [$486], individual successions under the value of £20 [$97.20], and legacies and shares of personal estate chargeable under the Legacy Duty Acts. The duties levied vary from 1 to 10 per cent., according to the degree of consanguinity between the predecessor and the successor. Leasehold property and personalty directed to be converted into real estate are liable to succession and not to legacy duty. Special provision is made for the collection of the duty in the case of joint tenants, in the case where the successor is also the predecessor, and in other dispositions of a special nature. The duty is a first charge on property; but, if the property be parted with before the succession duty be paid, the liability of the successor appears to be transferred to the alienee. A *bona fide* purchaser is protected by a receipt for duty, notwithstanding any suppression or misstatement in the account on the footing of which the duty was assessed, or any insufficiency of such assessment. It is usual in requisitions on title before conveyance to demand for the protection of the purchaser the production of receipts for succession duty. Recent legislation has made some amendments in the law. By 43 Vict. c. 14, s. 11, succession duty may be commuted in certain cases by the Commissioners of Inland Revenue. 44 Vict. c. 12, s. 36, relieves from payment of succession duty on personal estate not exceeding £300 [$1458] by payment of a sum of thirty shillings [$7.29] on the affidavit or inventory. Section 41 exempts from payment of the 1 per cent. duty in respect of property for which stamp duty has been paid on the affidavit or inventory. Up to 1885 certain property vested in bodies corporate and unincorporate escaped liability to succession duty. 48 and 49 Vict. c. 51, s. 11, now imposes on such bodies (with considerable exceptions) a duty at the rate of 5 per cent. on the annual value, income, or profits of the succession. All the Acts which have been cited extend to the United Kingdom.

In the United States succession duty is regulated by tit. xxxv. ch. 10 of the Revised Statutes. The duty varies from 1 to 6 per cent., according to the degree of consanguinity.[1]

SUCHET, Louis Gabriel, Duc d'Albufera (1770–1826), marshal of France, one of the most brilliant of Napoleon's generals, was the son of a silk manufacturer at Lyons, where he was born on 2d March, 1770. He originally intended to follow his father's business; but the Revolution of 1789 altered the bent of his ambition, and, having in 1792 served as volunteer in the cavalry of the national guard at Lyons, he manifested military abilities which secured his rapid promotion. As *chef de bataillon* he was present at the siege of Toulon in 1793, where he took General O'Hara prisoner. During the Italian campaign of 1796 he distinguished himself in most of the important contests and was severely wounded at Cerea on 11th October. In October, 1797, he was appointed to the command of a demi-brigade, and in the following year his services in Switzerland were recognized by his promotion to the rank of general of brigade. He then went to Egypt, but soon afterwards was recalled, and in August made chief of the staff to Brune, to whom he rendered invaluable assistance in restoring the efficiency and discipline of the army in Italy. In July, 1799, he was made general of division to Joubert in Italy, and, after being continued in the same office by his successors, was in 1800 named by Masséna his second in command. Soon afterwards he had an opportunity of manifesting those qualities which entitle him to rank among the most daring and clever tacticians of his time; his dexterous resistance to the superior forces of the Austrians with the left of Masséna, when the right and centre were shut up in Genoa, not only prevented the invasion of France from this direction but powerfully contributed to the success of Napoleon's strategy of crossing the Alps, which culminated in the battle of Marengo on 14th June. He took a prominent part in all the subsequent events of the Italian campaign till the peace of Lunéville, 9th February, 1801. In the campaigns of 1805 and 1806 he greatly increased his reputation, more especially at Austerlitz, Saalfeld, Jena, Pultusk, and Ostrolenka. He obtained the title of count on 19th March, 1808, and, after taking part in the siege of Saragossa, was named generalissimo of the army of Aragon and governor of the province, which, by wise administration no less than by his brilliant valor, he in two years brought into complete submission. He annihilated the army of Blake at Maria on 14th June,

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[1] [The United States succession tax was repealed to take effect 1st October, 1870. Such taxes are now controlled entirely by the several States. See *Revised Statutes* as above.—Am. Ed.]

1809, and on 22d April, 1810, inflicted a severe defeat on O'Donnell. After being made marshal of France, 8th July, 1811, he in 1812 achieved the conquest of Valencia, for which he was rewarded with the title of Duc d'Albufera. By Louis XVIII. he was on 4th June made a peer of France, but, having assisted Napoleon during the "hundred days," he was deprived of his peerage on 24th July, 1815. He died near Marseilles on 3d January, 1826. Suchet was the author of *Mémoires sur ses Campagnes en Espagne*, 2 vols., 1829–34.

See C.-H. Barault-Roullon, *Le Maréchal Suchet*, Paris, 1854; T. Choumara, *Considérations militaires sur les mémoires du Maréchal Suchet*, Paris, 1840.

SU-CHOW. There are in China three cities of this name which deserve mention. (1) Su-chow, formerly one of the largest cities in the world, and still in 1880 credited with a population of 500,000, in the province of Kiang-su, on the great Imperial Canal, 55 miles west-northwest of Shanghai. The site is practically a cluster of islands to the east of Lake Tai-hu, and streams and canals give communication with most parts of the province. The walls are about 10 miles in circumference and there are four large suburbs. Su-chow is a great commercial and manufacturing centre, the silk manufacture being represented by a greater variety of goods than are produced anywhere else in the empire; and the publication of cheap editions of the Chinese classics is carried to great perfection. There is a Chinese proverb to the effect that to be perfectly happy a man ought to be born in Su-chow, live in Canton, and die in Lian-chow. The great nine-storied pagoda of the northern temple is one of the finest in the country. In 1860 Su-chow was captured by the Taipings, and, when in 1865 it was recovered by the valor and enterprise of General Gordon, the city, which had formerly been famous for its large and handsome buildings, was almost reduced to a heap of ruins. Of the original splendor of the place some idea may be gathered from the beautiful native plan on a slab of marble preserved since 1247 in the temple of Confucius and reproduced in Yule's *Marco Polo*, vol. i. Su-chow was founded in 484 by Ho-lu-Wang, whose grave is covered by the artificial "Hill of the Tiger" in the vicinity of the town. The literary and poetic designation of Su-chow is Ku-su, from the great tower of Ku-su-tai, built by Ho-lu-Wang. (2) Su-chow, formerly Tsiu-tsuan-tsiun, a free city in the province of Kan-suh, in 39° 48′ 3″ N. lat. (according to Sosnofskii), just within the extreme northwest angle of the Great Wall, near the gate of jade. It is the great centre of the rhubarb trade, and used to be the residence, alternately with Lian-chow-fu, of the governor of the province. Completely destroyed in the Dungan insurrection (1865–72), it was recovered by the Chinese in 1873 and has been rebuilt. (3) Su-chow, a commercial town situated in the province of Sze-chuen at the junction of the Min river with the Yang-tse-kiang, in 28° 46′ 50″ N. lat.

SUCKER. See Lump-sucker.

SUCKLING, Sir John (1609–1642), one of the most admired poets and men of fashion at the court of Charles I., and an active spirit in politics as well as in fashionable gayeties, belonged to a Norfolk family. His father was a high official under James I. and a comptroller of the household under Charles I.; finance seems to have been his strong point, and he managed his own affairs so well as to accumulate a considerable fortune, of which the poet was left master at the age of eighteen. His earliest biographers fixed his birth in 1613, and founded on this a reputation for extraordinary precocity in school learning. Mr. Alfred Suckling, who edited his works in 1836, corrected this error, ascertaining that he was born at Whitton in Middlesex and baptized on 10th February, 1609. He was sent to Trinity College, Cambridge, in 1623, at what was then the usual age, and thereafter travelled on the Continent, as was also the custom for youths of his birth. Returning to London, he did not long remain inactive at court, but sought experience as a soldier, volunteering into the force raised by the marquis of Hamilton for the support of Gustavus Adolphus in the Palatinate. He reached Germany in July, 1631, and was back at Whitehall in May, 1632; but during this time he saw a good deal of hard service, being present at the battle of Leipsic and the sieges of Crossen, Guben, Glogau, and Magdeburg. Reappearing at court, he at once became a prominent figure. "He had the peculiar happiness of making everything that he did become him." He was ready of wit, handsome of person, wealthy and generous, a leader in all pastimes, the best bowler and the best card-player at court. His happy skill in verse was only one of the distinctions of a man who excelled in everything; but, as it happened, both the king and the queen had literary tastes, and he aimed at distinction in poetry with the ardent thoroughness which seems to have been part of his character. He became eminent at court just at the time when masques, after being the rage for a few years, had reached the height of their splendor and were beginning to pall; and it occurred to him to apply to the ordinary drama the improved scenery which the taste for masques had developed. We can trace in his plays both the taste for spectacular effect and the admiration for the wit of Shakespeare which he shared with his royal master. *Aglaura* was the first of them, and is said to have been the first play produced with elaborate stage scenery. It was produced first at Christmas in 1637, with a tragic ending, then reproduced at the following Easter with ingenious changes in the fifth act which made it end happily. With all its clever play on words and images, and its natural felicity of diction, it is not an interesting drama to read; the characters have no body or vitality. But it is full of incident, as if the dramatist were revelling in the newly discovered power of shifting the scenes, and making the most of his advantage in having the co-operation of Inigo Jones. His comedy the *Goblins* is much happier, and there the frequent changes of scene are used with great skill to maintain the liveliness of the action. Suckling produced another tragedy in 1639, *Brennoralt;* it has more body than its predecessor, but shows no mastery of passion or tragic character. He began still another tragedy, the *Sad One*, but was abruptly stopped in his literary career by the beginning of a tragedy in real life, the quarrel between Charles and his subjects. Suckling took a prominent part for a time on the Royalist side. When war was levied on the Scottish Covenanters in 1639, Suckling raised a troop of a hundred horse at his own expense and accompanied them on the bloodless expedition to the border. He was elected member for Bramber to the Long Parliament which met in November, 1640; but in May of the following year he got into trouble in connection with a plot for the escape of Strafford from the Tower and a project for calling in French aid, was charged with high treason, and fled beyond sea. The circumstances of his short life in exile are obscure. He continued to attract attention, and many pamphlets about him were circulated, one in particular describing how he eloped with a lady to Spain and fell into the clutches of the Inquisition. The tradition is that he committed suicide in Paris some time before the end of 1642. Suckling's reputation as a poet rests not upon his plays but upon his minor pieces. They have wit and fancy and at times exquisite felicity of diction. The happiest as a whole is the *Ballad upon a Wedding*. "Prithee, why so pale, fond lover?" is an occasional song in *Aglaura*.

A collection of Suckling's poems was first published in 1646 with the title *Fragmenta Aurea*. The so-called *Selections* published by Mr. Alfred Suckling in 1836 is really a full edition of his poems, letters, and plays, which was re-edited, with slight additions, by Mr. W. C. Hazlitt in 1874.

SUCRE, the capital of Bolivia, formerly known as Chuquisaca, but renamed in honor of General Sucre, the first president of the republic. Lying in 19° 2′ 45″ S. lat. and 65° 17′ W. long., at a height of 9183 feet above the sea, in a valley which drains southwards to the Pilcomayo (see PLATE RIVER), it enjoys an agreeable climate and has its markets well supplied with fruits and vegetables. The city is the seat of the archbishopric of La Plata and Charcas, founded in 1609, and contains a magnificent cathedral and several imposing churches and convents. For a long time the university and colleges of Chuquisaca were among the most frequented in South America, and they are still of some note. The inhabitants, who are mainly of Indian origin, are variously stated to number 24,000 (Ondarza) and 12,000 (*Almanac de Gotha*).

The Spanish city of Chuquisaca was founded in 1539 on the site of a Peruvian town, whose original name survived the Spanish designation of Ciudad la Plata. It became in 1609 the seat of the supreme court of justice for the South American colonies—"Real Audiencia de la Plata y Charcas"—Charcas being the name of a native tribe often given to the Chuquisaca district, and even to the city (Maria de las Charcas).

SUDÁN. See SOUDAN.

SUDBURY, an ancient borough and market town of England, chiefly in Suffolk, but partly in Essex, is situated on the river Stour, forming the boundary between the two counties, and on a branch of the Great Eastern Railway, 19 miles south of Bury St. Edmunds and 58 northeast of London. It is well built and well paved and contains a number of good houses. It is chiefly interesting from its three parish churches of All Saints, St. Peter's, and St. Gregory's. All Saints, dating from 1150 and consisting of chancel, nave, aisles, and tower, is chiefly Perpendicular,—the chancel, however, being Decorated. It possesses a fine oaken pulpit of 1490. The church was restored in 1882. St. Peter's is Perpendicular, with a unique coved nave roof. St. Gregory's, once collegiate, in the Perpendicular style, was partly built by Simon Tybald, archbishop of Canterbury, who was beheaded by Wat Tyler's mob. He established also a college for secular priests, of which a gateway still remains. The grammar-school was founded by William Wood, in 1491. The principal modern buildings are the town-hall, the corn exchange, the literary and mechanics' institute, and St. Leonard's hospital. The town owed its early importance to the introduction of woollen manufactures by the Flemings at the instance of Edward III., but this was afterwards replaced by silk crape, jacquard satin, etc.; the manufacture has now greatly declined. Cocoa-nut matting is an important manufacture, and there are also flour-mills, malt-kilns, lime-works, and brick and tile yards. A declining trade is carried on by the river, which is navigable up to the town. The area of the municipal borough is 1459 acres, and includes, besides the parishes of All Saints, St. Gregory, and St. Peter, Ballingdon cum Brundon in Essex and St. Bartholomew. The population in 1871 was 6908, and 6584 in 1881.

Sudbury is supposed to have been in early times the chief town in Suffolk, and to have received its name in contradistinction to Norwich in Norfolk. By the Conqueror it was given to Richard de Clare, and from the earls of that name it obtained important privileges. It is a borough by prescription, but obtained its first charter from Mary in 1554. It obtained others from Cromwell and James II., and its governing charter is that of Charles II. From the reign of Elizabeth it sent one member to parliament until it was disfranchised in 1844.

SUDRAS. See BRAHMANISM, vol. iv. p. 183 *sq.*, and CASTE.

SUE, JOSEPH MARIE (1804–1859), generally known as EUGÈNE SUE, French novelist, ranked by some as the chief practitioner of the melodramatic style in fiction, was born at Paris on 10th December, 1804. Unlike most voluminous writers of light literature, Sue was a man of fortune. He was the son of a surgeon in Napoleon's army, and is said to have had the empress Josephine for godmother. But in later life he became something very different from a Bonapartist, and his residence in Savoy for the last years of his life was due to his having been banished from France after the *coup d'état*. Until his father's death in 1828 Sue pursued the same profession and was present as a surgeon both in the campaign undertaken by France in 1823 for the re-establishment of royal power in Spain and at the battle of Navarino (1828). His naval experiences supplied much of the materials of his first novels, *Kernock le Pirate*, *Attar-Gull*, *La Salamandre*, *La Coucaratcha*, and others, which were composed at the height of the romantic movement of 1830, and displayed its Byronic enthusiasm, its fancy for outlandish subjects and names, and (in a very full measure) its extravagance. Then he took to more serious work, writing a naval history of France of no merit. His next venture was the historical or quasi-historical novel, in which style he composed *Jean Cavalier* (1840), besides other stories of adventure. About this time he was strongly affected by the socialist ideas of the day, and his attempt to display these in fiction produced (with others) his most famous and perhaps best works,—*Les Mystères de Paris* (1842) and *Le Juif Errant* (1844–45). These were among the most popular specimens of the *roman-feuilleton*, then at the height of its popularity. The political and philosophical or pseudo-philosophical "purpose" continuing to gain more and more ground on the novelist's art, he followed these up with divers singular and not very edifying books, such as *Les Sept Péchés Capitaux*, *Les Mystères du Peuple*, and several others, all on a very large scale, though the number of volumes—ten, twelve, and sometimes even sixteen—gives rather an exaggerated idea of their length. Some of his books, especially the *Wandering Jew* and the *Mysteries of Paris*, were dramatized by himself, usually in collaboration with others. His popularity was immense, and, despite gross faults both of art and of morality (the latter somewhat exaggerated in general estimation, at least when the work of his successors is compared), he deserved that popularity in part. By an accident, which is noteworthy in the case of other pairs of novelists (notably in those of Thackeray and Dickens, and earlier of Fielding and Richardson), his period of greatest success and popularity coincided with that of another writer, and he has been even recently, and by not despicable authorities, compared with and exalted above Alexandre Dumas. This is entirely unjust, for Sue has neither Dumas's wide range of subject, nor his genial humanity of tone, nor his interest of character, nor, above all, his faculty of conducting the story by means of lively dialogue; he has, however, a command of terror which Dumas seldom or never attained, and which, melodramatic as he is, sometimes comes within measurable distance of the sublime, while his "purpose" gives him a certain energy not easily to be found elsewhere in novel-writing. From the purely literary point of view his style is undistinguished, not to say bad, and his construction loose and prolix. After the revolution of 1848 he sat for Paris (the Seine) in the assembly from April, 1850, until his exile as above mentioned. This exile rather stimulated than checked his literary production. The works of his last days, however (the chief of which is perhaps *Le Diable Médecin*), are on the whole much inferior to those of his middle period. Sue died at Annecy (Savoy) on 3d August, 1859.

SUETONIUS. Caius Suetonius Tranquillus was one of the many second-rate authors and men of letters who lived in the early period of the Roman empire. He was the contemporary of Tacitus and the younger Pliny, and his literary work seems to have been chiefly done in the reigns of Trajan and Hadrian. His father was an officer in the army and military tribune in the XIIIth legion, and he himself began life as an advocate. To us he is known as the biographer of the twelve Cæsars, from Caius Julius down to Domitian. These lives are valuable as covering a good deal of ground where we are without the guidance of Tacitus. As Suetonius was the emperor Hadrian's private secretary, he must have had access to many important documents. It would seem from occasional references which he makes to himself in the course of the work that he was a youngish man in the reign of Domitian, and so would have had opportunities of conversing with men who had lived in the days of Tiberius, Caligula, Claudius, Nero, and had been present at the scenes of civil war and anarchy which followed the reign of the last-named. The most interesting fact about Suetonius is that he was a friend and correspondent of the younger Pliny, and the fact certainly tells in his favor. Several of Pliny's letters are addressed to him, and they all imply esteem and intimate friendship. Sometimes we find Pliny putting in a good word for him, as, for instance, on one occasion doing his best to help him in buying a small property at a fair price, not very far from Rome, with a house of moderate size and land enough to amuse but not to engross a man of scholarly tastes (i. 24). In another letter (v. 10) he playfully rallies him on his dilatoriness in publishing his works. Pliny does not mention the subject of these works. Again he recommends him to the favorable notice of the emperor Trajan "as a most upright, honorable, and learned man, whom persons often remember in their wills because of his merits," and he begs that he may be made legally capable of inheriting these bequests, for which under a special enactment Suetonius was, as a childless married man, disqualified. Trajan granted Pliny's request (x. 94, 95). Hadrian's biographer, Spartianus, tells us that Suetonius had his private secretaryship taken from him because he and some others of the imperial officials were not sufficiently observant of court etiquette towards the emperor's wife during his absence in Britain.

The *Lives of the Cæsars* has always been a popular work, at least with scholars, and has been frequently edited, as well as translated into most modern languages, the latest English translation being that of Thomson in 1796. The lives of the first six Cæsars are much fuller than those of the last six; this shows that he was an industrious compiler rather than an original historian. He gives us no picture of the society of the time, no hints as to the general character and tendencies of the period. It is the emperor, the emperor only, who is always before us, and yet after all the portrait is but a sorry performance, drawn without any real historical judgment or insight. It is the personal anecdotes he tells us, several of which are very amusing, that give his lives their chief interest; but he panders rather too much to a taste for scandal and gossip. A good many of his scandalous stories about the emperors may be and probably are fictions, but at any rate they reflect the gossip of the time. Still we owe him thanks for having thrown some light on an important period, parts of which are very obscure.

Suetonius is said to have been a voluminous writer, and among his works Suidas mentions treatises on the *Roman Year*, *Cicero's Republic*, *The Kings*, *The Pedigree of Illustrious Romans*, and *Rome, its Institutions and Customs*, with several others,—works, it would seem, of learned research. Under his name have come down to us *Lives* of Terence, Juvenal, Horace, Persius, Lucan, and his friend the younger Pliny; but the genuineness of these is highly questionable, and that of the last is hardly worth considering. There is also a work entitled *De illustribus grammaticis*,—a "grammaticus" being what we should call "a professor of language and literature."

SUEUR, EUSTACHE LE (1617-1655), one of the founders of the French academy of painting, was born 19th November, 1617, at Paris, where he passed his whole life, and where he died on 30th April, 1655. His early death and retired habits have combined to give an air of romance to his simple history, which has been decorated with as many fables as that of Claude. We are told that, persecuted by Lebrun, who was jealous of his ability, he became the intimate friend and correspondent of Poussin, and it is added that, brokenhearted at the death of his wife, Le Sueur retired to the monastery of the Chartreux and died in the arms of the prior. All this, however, is pure fiction. The facts of Le Sueur's life are these: He was the son of Cathelin Le Sueur, a turner and sculptor in wood, who placed his son with Vouet, in whose studio he rapidly distinguished himself. Admitted at an early age into the guild of master-painters, he left them to take part in establishing the academy of painting and sculpture, and was one of the first twelve professors of that body. Some paintings, illustrative of the Hypnerotomachia Polyphili, which were reproduced in tapestry, brought him into notice, and his reputation was further enhanced by a series of decorations (Louvre) in the mansion of Lambert de Thorigny, which he left uncompleted, for their execution was frequently interrupted by other commissions. Amongst these were several pictures for the apartments of the king and queen in the Louvre, which are now missing, although they were entered in Bailly's inventory (1710); but several works produced for minor patrons have come down to us. In the gallery of the Louvre are the Angel and Hagar, from the mansion of De Tonnay Charente; Tobias and Tobit, from the Fieubet collection; several pictures executed for the church of Saint Gervais; the Martyrdom of St. Lawrence, from Saint Germain de l'Auxerrois; two very fine works from the destroyed abbey of Marmoutiers; St. Paul preaching at Ephesus,—one of Le Sueur's most complete and thorough performances, painted for the goldsmiths' corporation in 1649; and his famous series of the Life of St. Bruno, executed in the cloister of the Chartreux. These last have more personal character than anything else which Le Sueur produced, and much of their original beauty survives in spite of injuries and restorations and removal from the wall to canvas. The Louvre also possesses many fine drawings (reproduced by Braun), of which Le Sueur left an incredible quantity, chiefly executed in black and white chalk. His pupils, who aided him much in his work, were his wife's brother, Th. Goussé, and three brothers of his own, as well as Claude Lefebvre and Patel the landscape painter. Most of his works have been engraved, chiefly by Picart, B. Audran, Seb. Leclerc, Drevet, Chauveau, Poilly, and Desplaces. Le Sueur's work lent itself readily to the engraver's art, for he was a charming draughtsman; he had a truly delicate perception of varied shades of grave and elevated sentiment, and possessed the power to render them. His graceful facility in composition was always restrained by a very fine taste, but his works often fail to please completely, because, producing so much, he had too frequent recourse to conventional types, and partly because he rarely saw color except with the cold and clayey quality proper to the school of Vouet; yet his St. Paul at Ephesus and one or two other works show that he was not naturally deficient in this sense, and whenever we get direct reference to nature—as in the monks of the St. Bruno series—we recognize his admirable power to read and render physiognomy of varied and serious type.

See Guillet de St. Georges, *Mém. inéd.*; C. Blanc, *Histoire des Peintres*; Vitet, *Catalogue des Tableaux du Louvre*; D'Argenville, *Vies des Peintres*.

SUEZ (SUWEIS), the port of Egypt on the Red Sea and southern terminus of the Suez Canal (see below), situated at the head of the Gulf of Suez in 29° 58′ 37″ N. lat. and 32° 31′ 18″ E. long. (see vol. iv. pl. XXXVI.). The new harbors and quays are about 2 miles south of the town, with which they are connected by an embankment and railway, crossing a shallow which is dry at low water; the terminal lock of the freshwater canal is on the north of the town near the English hospital and the storehouses of the Peninsular and Oriental Company. The site is naturally an absolute desert, and till the water of the Nile was introduced by the freshwater canal in 1863 the water-supply of

Suez was brought across the head of the gulf from the "wells of Moses" on the Arabian coast, or else carried on camels, an hour's journey, from the fortified brackish well of Bir Suweis. Thus, in spite of its favorable position for commerce, Suez before the canal was but a small place. While the canal was in progress the population rose from 5000 to 15,000, but has since declined. The canal, in fact, carries traffic past Suez rather than to it; and with its mean bazaar and mosques and mongrel population the town makes an unfavorable impression on the visitor, save for the imposing view over the gulf, with the Sinai Mountains on its eastern and Mount ʻAtaka on its western shore.

A canal from the Nile to the Red Sea, the indispensable condition for the existence of a prosperous trading station at Suez, appears to have existed in very early times. Classical writers say that it was first planned by Sesostris (Rameses II.), and again undertaken by Darius I., but first completed by the Ptolemies (Arist., *Meteor.*, i. 14; Strabo, xiv. 25). The town at its terminus was Arsinoe or Cleopatris. The work was renewed by Trajan under the name *Augustus amnis*, but the trade from the East with Egypt still went mainly overland from Myus Hormus or from Berenice on the Red Sea, below the Gulf of Suez, to Coptus in Upper Egypt. Instead of Arsinoe later writers name the port of Clysma, which the Arabs corrupted into Kolzum, calling the Red Sea the Sea of Kolzum. On the Moslem conquest of Egypt the canal was restored, and is said to have remained open more than a century, till the time of Mansúr. According to Masʻúdí (*Morúj*, iv. 98), Hárún al-Rashíd projected a canal across the isthmus of Suez, but was persuaded that it would be dangerous to lay open the coasts of Arabia to the Greek navy. Kolzum retained some trade long after the closing of the canal, but in the 13th century it lay in ruins, and the neighboring Suez, which had taken its place, was, as Yákút tells us, little better than a ruin. From Mokaddasi, p. 196, it may be inferred that the name of Suez originally denoted Bir Suweis. Throughout the Middle Ages, as in Roman times, the main route from Cairo to the Red Sea was up the Nile to Kús, and then through the desert to Aidháb. With the Ottoman conquest Suez became more important as a naval and trading station. Ships were built there from the 16th century onwards, and in the 18th century an annual fleet of nearly twenty vessels (Niebuhr) sailed from it to Jiddah, the port of correspondence with India. When the French occupied the town in 1798, and Bonaparte was full of his canal project, Suez was much decayed, and the conflicts which followed on its occupation in 1800 by an English fleet laid a great part of the town in ruins. The overland mail route from England to India by way of Suez was opened in 1837. The regular Peninsular and Oriental steamer service began a few years later, and in 1857 a railway was opened from Cairo through the desert. This line is now abandoned in favor of the railway which follows the canal from Suez to Ismailia, and then ascends the Wády Tumeilát to Zakázík, whence branches diverge to Cairo and Alexandria.

SUEZ CANAL. The great engineering features have been already treated of under CANAL (vol. iv. pp. 697-99). The opening of the canal to a great extent revolutionized the main lines of international traffic. More especially it has restored to the Mediterranean countries a share in the commerce of the world such as they have not possessed since the beginning of the modern period. In doing so it has naturally caused the decay of certain stations (such as St. Helena) on the ocean highways previously in vogue. In the case of sailing vessels, however, the winds at the Red Sea entrance of the canal are so frequently contrary that much of the advantage of the shortness of route is lost, and these vessels consequently still take the old-fashioned détours. Traffic, too, in the canal has so greatly increased that in 1886 a vessel was considered fortunate that got through in forty-eight hours. In 1882 shipowners having expressed dissatisfaction with the condition of the service, schemes for rival canals were started,—one for a fresh-water canal from Alexandria to Cairo and thence to Suez by way of Tel-el-Kebir, and another for a canal from Alexandria to Mansurah and Ismailia, and then parallel to the original canal to Suez, and a third for the construction of a second Suez canal, to be finished in 1888. These proposals all fell to the ground; but at length, in 1886, it was determined to widen the existing canal so as to accommodate the increased traffic, and the works are now in progress. Originally constructed by French capital, the Suez Canal has passed more and more into the financial ownership as well as under the political protection of England. In 1875 the British Government purchased 176,602 shares from the khedive of Egypt at the price of £3,976,582 [$19,326,188.52], or, including commission and expenses, £4,076,622 [$19,812,382.92], and exchequer bonds were issued to the value of £4,000,000 [$19,440,000]. By opening up a passage by which the faunal forms of the Red Sea and of the Mediterranean may respectively advance north and south into regions from which they have hitherto been excluded, the canal has produced some curious results, which have been lately investigated by Dr. Conrad Keller of Zurich ("Fauna im Suez-Kanal u. Diffusion de Mediter. u. Eryth. Thierwelt," in *Neue Denkschriften d. allg. schweizer Ges. f. Naturwiss.*, Zurich, 1883). Deep-sea forms are, of course, prevented passing by the shallowness of the canal; and the sandy nature of the soil, the large lakes, the currents, the disturbing influence exerted by the continual movement of vessels, and the excessive saltness of the water all tend to limit and retard the progress of even those forms most adapted to make their way through such a channel. The salinity of the water is much greater than that of the Mediterranean or the Red Sea. This is due mainly to two causes,—the rapid evaporation to which the water in the canal is subjected and the gradual melting of the deposits of salt (the result of previous evaporation in distant ages) in some of the depressions through which the canal is carried. In the Bitter Lakes, for example, it was found in 1872 that on an average each cubic mètre of water contained 156.42 ℔ of salt, or about three times as much as ordinary sea water. A certain number of forms common to the Red Sea and the Mediterranean appear to have migrated from their original homes when in Quaternary times the isthmus was still a lagoon. These being discounted, the following remain as the result of the recent connection established between the seas: (1) from the Mediterranean *Pholas candida* (as far as Ismailia), *Solen vagina*, *Sphæroma serrata* (to the south of Timsah Lake), *Cardium edule*, *Gammarus* sp. (to the nearer end of the Great Bitter Lake), *Solea vulgaris*, *Umbrina cirrhosa*, *Ascidia intestinalis*, and *Labrax lupus* (to the Red Sea); (2) from the Red Sea seventeen forms were found journeying, but one only, *Mytilus variabilis*, had got out into the Mediterranean proper; *Ostracion cubicus* and *Caranx macrophthalmus* had just got *en route*, and *Pristipoma stridens* (the curious fish that utters a cry when caught), *Mactra olorina* and *Cerithium scabridum* were found in Lake Menzaleh. This lake seems to prove in the meantime an obstacle to the passage of eight other species.

The following figures are in continuation of the table in vol. iv. p. 699:

Year.	No. of Vessels entering.	Gross Tonnage.	Receipts.	Year.	No. of Vessels entering.	Gross Tonnage.	Receipts.
1875	1494	2,940,708	£1,204,387	1881	2727	5,794,401	£2,050,974
1876	1457	3,072,107	1,229,157	1882	3198	7,122,125	2,421,835
1877	1663	3,418,949	1,339,617	1883	3307	8,051,307	2,638,912
1878	1593	3,291,535	1,272,435	1884	3284	8,319,967	2,495,124
1879	1477	3,236,942	1,214,444	1885	3624	8,985,411	2,488,297
1880	2026	4,344,519	1,629,577	1886	3100	8,183,313	2,809,218

In 1883 10 francs 50 cents [$2.03] were charged per ton (net tonnage), and pilotage dues amounted to 70 cents [13 cents] per ton on an average; on 1st July, 1884, pilotage dues were abolished; and in 1885 the transit dues were reduced to 9 francs 50 cents [$1.84] per ton.

SUFFOLK, the most easterly county in England, is bounded E. by the North Sea, N. by Norfolk, W. by Cambridge, and S. by Essex, the boundaries being chiefly the sea and rivers; it has somewhat the shape of a half moon. Its greatest length north to south from Yarmouth to Landguard Point is about 50 miles, and its average length about 30; its greatest breadth from east to west is about 55 miles. The total area of the county is 944,060 acres, or 1475 square miles.

Plate VIII.

The principal geological formations are the Chalk and the Tertiaries, but they are frequently overlaid by drift. The surface is for the most part flat or slightly undulating. In the extreme northwest round Mildenhall it joins the fen country. The fen land is bordered by a low range of chalk hills extending from Haverhill by Newmarket and Bury St. Edmunds to Thetford. The Chalk extends eastwards, but towards the south passes under the London clay and crag, which adjoins the mouths of the principal rivers and extends from Sudbury by Ipswich to Aldeburgh. The easterly slopes of the Chalk are also overlaid by beds of clay, as well as by post-Glacial gravels, in which flint implements and other indications of the presence of pre-historic man have been found. The most interesting deposits are, however, those of the crag of the late Miocene and Pliocene periods, resting on the London clay, or, where it overlaps, on the Chalk. At the base of the crag resting on the London clay is the famous Suffolk bone bed. The coast-line has a length of about 52 miles, and is comparatively regular, with only slight convexities towards the sea, the bays being generally shallow and the headlands rounded and only slightly prominent. The estuaries of the Deben, Orwell, and Stour are, however, of some length. The shore is generally low and marshy, with occasional clay and sand cliffs. The rivers flowing northwards are the Lark in the northwest corner, which passes in a northwesterly direction to the Great Ouse in Norfolk; the Little Ouse or Brandon, also a tributary of the Great Ouse, flowing by Thetford and Brandon and forming part of the northern boundary of the county; and the Waveney, which rises in Norfolk and forms the boundary between that county and Suffolk, from Palgrave till it falls into the mouth of the Yare at Yarmouth. The Waveney is navigable from Bungay, and by means of Lake Lothing also communicates with Lowestoft. The rivers flowing in a southeasterly direction to the North Sea are the Blyth; the Alde or Ore, which has a course for a long distance parallel to the seashore, and has its port at Orford; the Deben, from Debenham, flowing past Woodbridge, up to which it is navigable; the Orwell or Gipping, which is navigable to Stowmarket, whence it flows past Needham Market and Ipswich; and the Stour, which forms nearly the whole southern boundary of the county, receiving the Brett, which flows past Lavenham and Hadleigh; it is navigable from Sudbury and has an important port at Harwich. The county has no valuable minerals. Cement is dug for Roman cement; and lime and whiting are obtained in various districts.

Agriculture.—Suffolk is one of the most fertile counties in England. In the 18th century it was famed for its dairy products. The high prices of corn during the wars of the French Revolution led to the extensive breaking up of its pastures, and it is now one of the principal corn-growing counties in England. There is considerable variety of soils, and consequently in modes of farming, in different parts of the county. Along the sea-coast a sandy loam or thin sandy soil prevails, covered in some places with heath, on which large quantities of sheep are fed, and interspersed with tracts, more or less marshy, on which cattle are grazed. The best land adjoins the rivers, and consists of a rich sandy loam, with patches of lighter and easier soil. In the southwest and the centre is much fine corn land, having mostly a clay subsoil, but not so tenacious as the clay in Essex. In climate Suffolk is one of the driest of the English counties, the rainfall being only half that of the counties in the west. Towards the northwest the soil is generally poor, consisting partly of sand on chalk and partly of peat and open heath.

According to the agricultural returns for 1886, 780,448 acres or nearly five-sixths of the total area were under cultivation, 363,641 being under corn crops, 120,256 under green crops, 94,893 clover and rotation grasses, 174,970 permanent pasture, 19 flax, 57 hops, and 26,612 fallow. Wheat and barley are the most important of the corn crops, having an area of 118,873 and 151,630 respectively. Of green crops only 2452 were under potatoes, while 55,434 were under turnips and swedes, 36,211 under mangold, 852 under carrots, 4100 under cabbage, and 21,207 under vetches,—figures which indicate that much attention is paid to the winter feeding of cattle. Horses in 1886 numbered 42,617, of which 32,262 were used solely for purposes of agriculture. The breed known as Suffolk punches is one of the most valued for agricultural purposes in England (see AGRICULTURE, vol. i. p. 341). Cattle numbered 70,695, of which 23,652 were cows and heifers in milk or in calf, and 17,322 other cattle two years old and above. The breed native to the county is a polled variety, on the improvement of which great pains have been bestowed in recent years. The old Suffolk cows, famous for their great milking qualities, were of various colors, yellow predominating. The improved are all red. Much milk is now sent to London, Yarmouth, etc. Many cattle, mostly imported from Ireland, are grazed in the winter. The sheep are nearly all of the black-faced improved Suffolk breed, a cross between the old Norfolk horned sheep and Southdowns. Sheep numbered 433,986, of which 230,954 were one year old and above. Suffolk is famous for pigs. The breed most common is small and very compact, and black in color. Pigs numbered 121,866 in 1886.

The following table gives classifications of holdings in 1875 and 1885:

Years.	50 acres and under		From 50 to 100 acres.		From 100 to 300 acres.		From 300 to 500 acres.		From 500 to 1000 acres.		Above 1000 acres.	
	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.
1875	5667	66,251	1436	101,644	2043	336,383	387	157,894	169	110,169	12	14,744
1885	5607	64,899	1278	94,994	1872	330,133	409	154,590	174	115,089	17	22,314

Thus in 1875 there were in all 9714 holdings with 767,085 acres, and in 1885 9357 with 782,019 acres. According to the latest landowners *Return* (1873) Suffolk was divided among 19,276 proprietors, holding 920,268 acres, at a valued rental of £1,784,827 [$8,674,259.22], or an average all over of about £1, 18s. 9½d. [$9.42] per acre. Of the owners 12,511 or nearly three-fourths possessed less than one acre each. The following possessed over 10,000 acres each: Lord Rendlesham, 19,869; George Tomline, 18,473; marquis of Bristol, 16,954; the maharajah Dhuleep H. H. Singh, 14,615; Lord Huntingfield, 11,713; earl of Stradbroke, 11,697; Sir Richard Wallace, 11,223; Lord Henniker, 10,910.

Communication.—The river navigation affords means of communication with different ports, and supplies facilities for a considerable amount of traffic. The county is intersected in all directions by branches of the Great Eastern Railway, which touch at almost every town of importance.

Manufactures and Trade.—The county is essentially agricultural, and the most important manufactures relate to this branch of industry. They include that of agricultural implements, especially at Ipswich, Bury St. Edmunds, and Stowmarket, and that of artificial manures at Ipswich and Stowmarket, for which coprolites are dug. Malting is extensively carried on throughout the county. There is a gun-cotton manufactory at Stowmarket, and gun flints are still made at Brandon. At different towns a variety of small miscellaneous manufactures are carried on, including silk, cotton, linen, woollen, and horsehair and cocoa-nut matting. The principal ports are Yarmouth (situated chiefly in Norfolk), Lowestoft, Southwold, Aldeburgh, Woodbridge, and Ipswich. Yarmouth is one of the most important fishing stations on the east coast of England; within the county Lowestoft is the chief fishing town. Herrings and mackerel are the fish most abundant on the coasts.

Administration and Population.—Suffolk comprises 21 hundreds; the boroughs of Beccles (pop. 5721), which has several large maltings; Bury St. Edmunds (16,111), the chief town in West Suffolk; Eye (2296), an ancient market town; Ipswich (50,546), the largest town and principal port of the county; Aldeburgh (2106), the birthplace of Crabbe; Southwold (2107), a fishing town and bathing resort; the largest part (5855) of Sudbury (6584) a market and manufacturing town; and small portions of the boroughs of Thetford and Great Yarmouth, which are situated chiefly in Norfolk. The other principal towns are Hadleigh (3237), with a considerable trade in corn and malt; Haverhill (3685) (partly in Essex), of great antiquity, and possessing important silk manufactures; Lowestoft (16,755), a port and fishing station; Stowmarket (4052); and Woodbridge (4544), with some coasting trade. Suffolk is divided into geldable portions, in which the sovereign has the chief rights, and liberties. The liberties are those of St. Etheldreda, St. Edmund, and the dukedom of Norfolk. The court of quarter sessions is at Ipswich for the eastern division and by adjournment at Bury St. Edmunds for the western. There are nineteen petty and sessional divisions. The hundreds of Hartismere and Stow and the borough of Eye are for petty sessional purposes included in the eastern division, and for other purposes in the western. The boroughs of Bury St. Edmunds, Ipswich, Great Yarmouth, and Sudbury have commissions of the peace and separate courts of quarter sessions; and Eye and Southwold have commissions of the peace. For parliamentary purposes the county was until 1885 divided into East and West Suffolk, but it now constitutes five divisions, each returning one member, viz., North or Lowestoft division, North-east or Eye, North-west or Stowmarket, South or Sudbury, and South-east or Woodbridge. Bury St. Edmunds returns one member and Ipswich two; Eye, which formerly returned one member, was merged in the North-east division of the county in 1885. The county contains 517 civil parishes with parts of 7 others. It is mostly in the diocese of Norwich. From 214,404 in 1801 the population had increased by 1821 to 271,541, by

1841 to 315,073, by 1861 to 337,070, and by 1881 to 356,893, of whom 174,606 were males and 182,287 females. The number of persons to an acre was 0.38 and of acres to a person 2.65.

History and Antiquities.—The district which now includes Norfolk, Suffolk, and a portion of Cambridge, and afterwards formed East Anglia, had in early times, on account of the marshes to the west, practically the character of a peninsula. It was inhabited by the Iceni, who had their capital at Icklingham, in the northwest of Suffolk. Of the numerous barrows and tumuli belonging to this period mention may be made of those at Fornham St. Geneveve and those between Aldeburgh and Snape. Many of the mediæval castles were built on ancient mounds. The district submitted to the Romans during the campaign of Aulus Plautius, and, although the Iceni joined the Trinobantes under Boadicea, the resistance made was ultimately fruitless. A Roman road from London crossed the centre of Suffolk northwards by Stratford St. Mary, Needham Market, and Billingford (Norfolk) to Norwich, another passing in a more westerly direction to Thetford. Walton, where important Roman relics have been found, Dunwich (possibly *Sitomagus*), and Burgh Castle (probably *Combretonium*), one of the most perfect specimens of a Roman fort in England, inclosing an area of five acres, are supposed to have been Roman fortified stations erected for the defence of the Saxon shore. Other Roman stations were at Stratford St. Mary, Thetford, and Icklingham. The capital of the kingdom of East Anglia was at Dunwich in Suffolk. Afterwards East Anglia was divided into Norfolk and Suffolk. Sigebert established an ecclesiastical diocese at Dunwich in 630, and erected a palace and a church partly out of the Roman remains. The earldom of Norfolk and Suffolk was bestowed by the Conqueror on Ralph le Guader. Though Suffolk suffered from incursions of the Danes, they did not effect a complete subjugation of it. The prevailing terminations of the place names are Anglian. The remains of old castles are comparatively unimportant, the principal being the entrenchments and part of the walls of Bungay, the ancient stronghold of the Bigods; the picturesque ruins of Mettingham, built by John de Norwich in the reign of Edward III.; Wingfield, surrounded by a deep moat, with the turret walls and the drawbridge still existing; the splendid ruin of Framlingham, with high and massive walls, originally founded in the 6th century, but restored in the 12th; the outlines of the extensive fortress of Clare Castle, anciently the baronial residence of the earls of Clare; and the fine Norman keep of Orford Castle, on an eminence overlooking the sea. Among the many fine residences within the county there are several interesting examples of domestic architecture of the reigns of Henry VIII. and Elizabeth. Throughout its whole history the annals of Suffolk have been comparatively uneventful. It adhered with Norfolk to the cause of the Parliament. James, duke of York, twice defeated the Dutch off the coast,—viz., Van Tromp off Lowestoft on 3d June, 1665, and De Ruyter in Southwold Bay on 28th May, 1672. Of monastic remains the most important are those of the great Benedictine abbey of Bury St. Edmunds, noticed under that town; the college of Clare, originally a cell to the abbey of Bec in Normandy and afterwards to St. Peter's, Westminster, converted into a college of secular canons in the reign of Henry VI., and still retaining much of its ancient architecture, and now used as a boarding-school; the decorated gateway of the Augustinian priory of Butley; and the remains of the Gray Friars monastery at Dunwich. A peculiarity of the church architecture is the use of flint for purposes of ornamentation, often of a very elaborate kind, especially on the porches and parapets of the towers. Another characteristic is the round towers, which are confined to East Anglia, but are considerably more numerous in Norfolk than in Suffolk, the principal being those of Little Saxham and Herringfleet, both good examples of Norman. It is questionable whether there are any remains of Saxon architecture in the county. The Decorated is well represented, but by far the greater proportion of the churches are Perpendicular, special features being the open roofs and woodwork and the fine fonts.

See Blome's *Description of Suffolk*, 1673: Kirby's *Description*, 1748, 2d ed. 1829; Suckling's *History of Suffolk*, 1846–48; Hervey's *Visitation of Suffolk in* 1561, ed., with additions, by Dr. J. J. Howard, 1866; and Browne's *History of Congregationalism and Memorial of Churches in Suffolk*, 1877. (T. F. H.)

SUFISM. See MOHAMMEDANISM, vol. xvi. p. 616; MYSTICISM, vol. xvii. p. 137; and SUNNITES, *infra.*

SUGAR. Formerly chemists called everything a "sugar" which had a sweet taste, and acetate of lead to this day is known as "sugar of lead" in commerce and familiar chemical parlance; but the term in its scientific sense soon came to be restricted to the sweet principles in vegetable and animal juices. Only one of these—cane sugar—was known as a pure substance until 1619, when Fabrizio Bartoletti isolated the sugar of milk and proved its individuality. In regard to all other "sugars" besides these two the knowledge of chemists was in the highest degree indefinite, and remained so until about the middle of the 18th century, when Marggraf made the important discovery that the sugars of the juices of beets, carrots, and certain other fleshy roots are identical with one another and with the sugar of the cane. Lowitz subsequently showed that the granular part of honey is something different from cane sugar; this was confirmed by Proust, who found also that Lowitz's honey sugar is identical with a crystallizable sugar present largely in the juice of the grape. Proust's investigations extended to other sweet vegetable juices also. All those investigated by him owed their sweetness to one or more of only three species,—(1) cane sugar, (2) grape sugar, (3) (amorphous) fruit sugar. Proust's results obtain substantially to this day; a number of new sugars strictly similar to these three have been discovered since, but none are at all widely diffused throughout the organic kingdom.

Species.

The quantitative elementary composition of cane sugar was determined early in the 19th century by Gay-Lussac and Thénard, who may be said to have virtually established our present formula, $C_{12}H_{22}O_{11}$. Under FERMENTATION (vol. ix. pp. 81–82) it has been explained how Gay-Lussac (in 1811) came to mis-correct his numbers so as to bring them into accordance with what we now express by $C_6H_{12}O_6 = \frac{1}{2}C_{12}H_{24}O_{12}$. Dumas and Boullay, some years later, found that cane sugar is what Gay-Lussac and Thénard's analysis makes it out to be, while the "corrected" numbers happen to be correct for grape sugar. Dumas and Boullay's research completed the foundations of our present science of the subject. "Sugar" is now a collective term for two chemical genera named *saccharoses* (all $C_{12}H_{22}O_{11}$) and *glucoses* (all $C_6H_{12}O_6$). All sugars are colorless non-volatile solids, soluble in water and also (though less largely) in aqueous alcohol; from either solvent they can in general be obtained in the form of crystals. The aqueous solution exhibits a sweet taste, which, however, is only very feebly developed in certain species.

Quantitative determination.

All sugars and their solutions have the power of turning the plane of polarization of light. In a given solution of a given kind of sugar the angle α through which the plane is turned is governed by the equation $\alpha = \pm [\alpha]\, lp$, where l stands for the length of solution traversed (the customary unit of length being the centimetre) and p for the number of grams of dry sugar present in a volume of solution equal to that of (say) 100 grams (3.52 oz.) of water, where, however, "gram" must be taken as merely a convenient word for "unit of weight"; $\pm[\alpha]$, *i.e.*, the special value of α for $l = 1$ and $p = 1$, is called the specific rotatory power of the sugar operated upon. The sign ± indicates that the plane of polarization is turned either to the right or to the left according to the nature of the species. For a given species and a given temperature $[\alpha]$ has a constant value. Supposing its value to have been determined by standard experiments and l to be known (or to be kept constant throughout and taken as unit of length), the determination of α for a given solution suffices for the calculation of p. This method is largely used industrially for the assaying of cane sugar.

Action on polarization of light.

Sugars, though neutral to litmus and inert towards such substances as carbonates on the one hand and aqueous acids (*qua* acids) on the other, combine with strong bases, such as caustic potash, baryta, and lime, into *saccharates*, and, when brought into contact with the strongest nitric acid (or a mixture of the same with oil of vitriol) or (at the proper temperature) with acetic anhydride, unite with these into nitrates and acetates respectively, with elimination of water. These nitrates, etc., are related to the respective sugar exactly as (to take an analogous case) nitrate of methyl, $CH_3(NO_3)$, is to methyl-alcohol, $CH_3(OH)$; only in the case of a sugar a plural of NO_3's is capable of entering into every one molecule and turning out so many HO's; hence sugars are said to be *polyvalent alcohols*. Of the several points of difference between saccharoses and glucoses the most important is that, while the latter remain unchanged when boiled with highly dilute sulphuric or hydrochloric (or certain other kinds of) acid, the former take up water and every molecule breaks up into two molecules of glucose, which in general are of different kinds. Cane sugar, for instance, yields *dextrose* and *lævulose* (so called from the direction in which they turn the plane of polarized light), thus—

$$\underset{\text{Cane Sugar}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{Dextrose}}{C_6H_{12}O_6} + \underset{\text{Lævulose.}}{C_6H_{12}O_6}$$

Cane sugar turns the plane of polarized light to the right; the mixed glucose produced is lævo-rotatory; hence the process is spoken of technically as involving the *inversion* of cane sugar, and the mixed product is called *invert sugar*. The term "inversion," however, has come somehow to be used for all decompositions which fall under the above equation; occasionally it is used even in a wider sense, to include any decomposition of a carbo-hydrate (*e.g.*, starch) into two less complex carbo-hydrates.

Fermentative changes.

All sugars are liable to fermentative changes; a special character of the three principal vegetable sugars is that, when brought into contact as solutions with yeast (living cells of saccharomyces), under suitable conditions, they suffer vinous fermentation, *i.e.*, break up substantially into carbonic acid and alcohol. Dextrose and lævulose break up directly,—$C_6H_{12}O_6 = 2C_2H_6O + 2CO_2$. Cane sugar first, under the influence of a soluble ferment in the yeast, gets inverted, and the invert sugar then ferments, the dextrose disappearing at a greater rate than the lævulose.

Artificial production.

It is remarkable that no sugar has ever been produced artificially even in the sense of being built up from other native organic substances of less chemical complexity. It is easy to produce dextrose from starch, or lævulose from inulin, or both from cane sugar, by inversion; but none of these processes is reversible by known methods. Yet the problem of producing cane sugar artificially may in a sense be said to have found a virtual solution at the hands of a German-American chemist, Fahlberg.[1] Fahlberg, by subjecting toluene, $C_6H_5CH_3$ (one of the components of coal-tar naphtha), to a series of operations has produced from it a body, $C_6H_4\genfrac{}{}{0pt}{}{CO}{SO}NH$, which he called *saccharine*, because he found it to be about 230 times as sweet as cane sugar. This saccharine is a white crystallized solid, only slightly soluble in cold water, but sufficiently so to admit of its incorporation with jellies, puddings, beverages, etc. A mixture of one part of it with 1000 parts of ordinary grape sugar (as produced industrially from starch) is as sweet as the best cane sugar. The substance, though an antiseptic, is said to be perfectly innocuous.

Glucoses.

Glucoses.

Of these a pretty large number are now known, but only lævulose and dextrose need be noticed here. Both are largely present in all kinds of sweet fruit juices and in honey. In most of these materials they are accompanied by a small proportion of cane sugar, which forcibly suggests that the glucose in fruit juices is really inverted cane sugar. But, in opposition to this surmise, the proportion of cane sugar in oranges increases during the process of ripening, and the sourest of all fruits—the lemon—contains four parts of cane for every ten of invert sugar; besides, the juices of grapes and sweet cherries contain no cane sugar whatever. According to Stammer, the young leaves of the sugar cane contain abundance of invert sugar, which gradually disappears and gives way to cane sugar as the leaves develop and ultimately dry up. In the living body of man dextrose is constantly being produced from the glycogen of the liver, to be taken up by the blood and oxidized into carbonic acid and water. In certain diseases, however (see NUTRITION, vol. xvii. pp. 700–1), the sugar survives and passes into the urine; as much as one pound avoirdupois may be discharged by a diabetic patient in twenty-four hours. A numerous class of vegetable substances, known as *glucosides*, contain glucose of some kind in the sense that, when decomposed by boiling dilute sulphuric acid or by the action of certain ferments, they split up into glucose and some product—not a sugar—which is characteristic of the respective species. For examples, see FERMENTATION, vol. ix. pp. 84–5.

Dextrose.

Dextrose is being produced industrially from starch by inversion (see below), and sold as grape sugar. Such grape sugar, however, is very impure. For the preparation of pure dextrose rich diabetic urine, honey, and cane sugar are convenient materials. The method recommended by Soxhlet is to dissolve 160 grams (5.64 oz.) of powdered cane sugar in a mixture of 500 c.c. of alcohol of 85 per cent. by weight, and 20 c.c. of fuming hydrochloric acid at 45° C. and to allow the solution to stand. After about a week dextrose begins to crystallize out, and, if the mixture is being frequently agitated, the deposit of crystals increases gradually. A small crop of crystals thus obtained suffices for inducing crystallization in a large supply of fresh liquor. Dextrose crystallizes from its highly concentrated aqueous solution—somewhat tardily—in minute soft crystals, united into warts or cauliflower-like masses, which contain $1H_2O$ of crystal water beside $C_6H_{12}O_6$. The crystals lose their water at 100° C. From absolute alcohol it crystallizes as $C_6H_{12}O_6$. It dissolves in 1.2 parts of cold and far less of boiling water. 100 parts of alcohol of 0.837 specific gravity dissolve 1.94 parts at 17.5° C. and 21.7 parts on boiling. In a given volume of aqueous solution 5 parts of dextrose produce the same degree of sweetness as 3 parts of cane sugar. Dextrose fuses at 146° C. and at 170° passes into glucosan, $C_6H_{10}O_5$, an almost tasteless solid, which when boiled with dilute sulphuric acid is reconverted into dextrose. If a solution of dextrose in absolute alcohol is saturated with hydrochloric acid gas at 0° C., di-glucose, $C_{12}H_{22}O_{11}$, is produced, which, however, is only isomeric with cane sugar (Gautier).

Lævulose.

Lævulose.—The liquid part of crystalline honey consists chiefly of lævulose; but its purification is difficult. From invert sugar it can be extracted, according to Dubrunfaut, by cautious addition of slaked lime at a low temperature. The lævulose separates out as a difficultly soluble lime compound, which is separated from the mother-liquor containing the dextrose by pressure and by judicious washing with cold water. The lævulosate of lime is decomposed by the exact equivalent of oxalic acid solution; then the oxalate of lime is filtered off, and the filtrate evaporated on a water-bath. The lævulose ultimately remains as a thick syrup, which formerly was supposed not to be susceptible of crystallization; but Jungfleisch and Lefranc have succeeded lately in obtaining crystals from it by means of alcohol. Lævulose is very largely soluble in water, and fully as sweet as cane sugar. It fuses at 95° C.; at 170° it passes into lævulosan, $C_6H_{10}O_5$, analogous to glucosan.

Reactions.

The following reactions, though studied chiefly with dextrose, apply also to lævulose, and, substantially at least, to glucoses generally. If a solution of glucose is mixed with excess of caustic potash or soda, a solution of alkaline glucosate is formed, which, however, has little stability. If the solution is heated, the glucosate is decomposed with formation of dark-colored (soluble) alkali salts of acid products, which, whatever they may be, are not reconvertible into glucose. Cane sugar, in these circumstances, remains substantially unchanged, and can be regenerated by elimination of the alkali. If a solution of glucose is mixed with (not too much) sulphate of copper, and an excess of caustic potash or soda be then added, no precipitate of cupric hydrate is formed, but an intensely blue solution, which, on standing in the cold gradually, and on heating promptly, deposits a red precipitate of cuprous oxide, Cu_2O, the glucose being oxidized at the expense of the dissolved CuO into soluble alkali salts of little known acids. By means of this (Trommer's) test the least trace of glucose in a solution can be discovered. Cane sugar, in the circumstances, yields cuprous oxide only on long-continued boiling. Fehling has brought this test into the following more convenient form, which, besides, admits of quantitative application: 34.65 grams (1.22 oz.) of sulphate of copper, $CuSO_4 + 5H_2O$, and 173 grams (6 oz.) of Rochelle salt (double tartrate of potash and soda) are dissolved in a solution of 70 grams (2.46 oz.) of solid caustic soda, and the intensely blue solution produced is diluted to 1000 c.c. Every c.c. of Fehling solution oxidizes about 5 milligrams (.077 grain) of dextrose (not of glucose generally). To determine an unknown weight of glucose, its solution is added to an excess of suitably diluted Fehling solution at a boiling heat, which is maintained for a sufficient time to oxidize the glucose as completely as possible,—the requisite time depending on the nature of the glucose. The cuprous oxide precipitate is allowed to settle, is then collected on a filter, and weighed directly or indirectly. From its weight the weight of the glucose is calculated,—a standard experiment with a known weight of the respective kind of pure glucose furnishing the factor. A less exact but more expeditious method is to dissolve the sugar to be analyzed in water, to dilute to a known volume (not less than 200 c.c. for every gram of glucose), and to drop this solution from a burette into a measured volume of dilute Fehling solution at a boiling heat until the blue color is just destroyed, *i.e.*, the copper just precipitated completely as Cu_2O. This method is largely used in sugar-houses in the assaying of crude cane or beetroot sugars.[1]

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[1] See *Amer. Chem. Jour.*, i. p. 170, ii. p. 181, and i. p. 425; short notices in *Jour. Soc. Chem. Ind.*, iv. p. 606, and February, 1886.

Saccharoses.

Cane sugar.

Of these only cane sugar, milk sugar, and maltose can be noticed here. The highest qualities of commercial cane sugar are chemically pure. Pure cane sugar crystallizes from its supersaturated syrup in colorless, transparent monoclinic prisms (exemplified in colorless candy sugar). The crystals are barely, if at all, hygroscopic; they are rather hard, and when broken up in the dark give off a peculiar kind of bluish light. Sp. gr. 1.593 at 4° C. The aqueous solution, saturated at *t*° C., contains *p* per cent. of dry sugar. For

t —	0°	10°	20°	30°	40°	50°
p —	65.0	65.6	67.0	69.8	75.8	82.7.

From 50° upwards the solubility increases at such a rate that a given quantum of water dissolves any quantity of sugar if the mixture is constantly kept boiling. Accordingly a sugar syrup when boiled down deposits nothing, but passes gradually into the condition of fused sugar when the boiling-point merges into the fusing-point of sugar, which lies at 160–161° C. Even a cold-saturated solution of sugar has the consistence of a syrup. Absolute alcohol hardly dissolves sugar at all; aqueous alcohol dissolves it the more largely the greater its proportion of water. Fused sugar freezes into a transparent glass, which is colorless if pure, but in practice generally exhibits a yellowish hue, and, if really anhydrous, remains glassy for an indefinite time. Barley-sugar and certain other confections are substantially fused sugar; but from their mode of manufacture they retain a trace of inclosed water, which constantly dissolves particles of the surrounding sugar glass to redeposit them in the less soluble form of crystals, so that barley-sugar in the course of time loses its transparency through conversion into an aggregate of minute crystals. If fused sugar is kept at a few degrees above its fusing-point for some time, it passes into an alloy, $C_6H_{12}O_6 + C_6H_{10}O_5$, of dextrose and lævulosan (see above). At higher temperatures it loses water and passes into anhydrides not reconvertible into cane sugar, which are known in the aggregate as "caramel,"—a most intensely brown viscous solid, easily soluble in water and in aqueous alcohol, with formation of intensely colored solutions. Caramel (often made of dextrose) is much used as an innocent coloring agent for sauces, liqueurs, etc. A pure solution of cane sugar is said to remain unchanged on boiling (it being understood, of course, that local overheating be carefully avoided); but continued contact with even so feeble an acid as carbonic induces at least partial inversion. The statement of the unchangeability of sugar solution on boiling seems hardly credible, because a syrup boiling at all considerably above 100° C. contains plenty of molecules at temperatures above 160° C., which are bound to suffer irreversible conversion into dextrose and lævulosan (or lævulose), and even, if hot enough, caramelization. In ordinary practice, at any rate, sugar solutions on boiling do behave as indicated by this theory. Cane sugar, as already stated, unites with alkalies, alkaline earths, and other of the more strongly basic metallic oxides into saccharates. A soluble saccharate of lime, which is readily decomposable by carbonic acid and even by filtration through bone charcoal, plays a great part in the manufacture of sugar. The following strontium salt must be named, because it at least promised some years ago to occupy a similar position industrially. According to Scheibler, if strontia hydrate, $SrOH_2O + 8H_2O$, is added to a boiling 15 per cent. solution of cane sugar, then as soon as 2SrO is added for every $C_{12}H_{22}O_{11}$ the salt $C_{12}H_{22}O_{11} + 2SrO$ separates out as a sandy powder, and after addition of 2.5 times SrO almost all the sugar is precipitated. The precipitate is easily washed and decomposed by water and carbonic acid, with formation of insoluble carbonate of strontia (from which the hydrate can be reproduced) and a solution of cane sugar. The ultimate molasses produced in sugar making or refining, though they refuse to deposit crystals under any conditions, contain some 30 to 40 per cent. of real cane sugar; Scheibler's process applies to them,—to put the industrial bearings of the discovery in the proper light,—and it has led to quite a series of patents for the production of strontia; but, as far as we know, it has failed to take root in the sugar industry.

Milk sugar.

Milk Sugar occurs in the milk of mammals, and it is doubtful whether it occurs anywhere else, although Bouchardat once proved its presence in a sample marked as sugar obtained from *Sapota Achras* (the sapodilla of the West Indies). It is made industrially in Switzerland as a bye-product in the making of cheese. It passes into the whey, from which it is extracted by evaporation to a small volume, decolorization with animal charcoal, and crystallization. From the commercial product the pure substance can be obtained by repeated recrystallization from water, and ultimately by precipitation from the aqueous solution by alcohol. Milk sugar as it crystallizes from water under the ordinary conditions forms hydrated crystals of the composition $C_{12}H_{22}O_{11} + H_2O$; under certain conditions anhydrous crystals separate out. The hydrated crystals have pretty much the aspect of candy sugar, but they are less transparent, far harder, quite free from every *soupçon* of hygroscopicity, and far less sweet. They dissolve in six parts of cold and in 2.5 parts of boiling water; the solutions are not syrupy. Milk sugar is hardly soluble in alcohol. The ordinary crystals, as the formula shows, have the composition of a glucose; indeed milk sugar solution behaves to caustic alkalies and to Fehling solution as if it were a glucose. But the hydrated crystals lose their water at 130°, with formation of a residue reconvertible into the original substance by the mere action of water; besides, milk sugar is susceptible of inversion into dextrose and a specific galactose. The optical behavior of a milk sugar solution varies according as it is derived from the ordinary crystals or the anhydride produced at 130°, and according to the time which has elapsed since its preparation; but if it stands sufficiently long the specific rotatory power assumes ultimately the same (constant) value. Milk sugar solution when brought in contact with yeast does not suffer vinous fermentation; but certain *Spaltpilze* induce a fermentation involving the formation of alcohol and of lactic acid. This process is utilized by the Kirghiz in the production of their native drink, "koumiss," made from mare's milk (see MILK, vol. xvi. p. 318). Milk sugar is used in medicine as a diluent for dry medicines. Homœopathists use it by preference. A solution of milk sugar in certain proportions of water and cow's milk is used occasionally as a substitute for mother's milk.

Maltose.

Maltose does not occur in nature; it is largely produced along with dextrin when starch paste is acted upon by dilute sulphuric acid or the ferment called "diastase," which is supposed to be the active agent in malt. For its preparation 2 kilograms (4.40 lb) of potato starch are made into a paste with 9 litres (15.84 pints) of water over a water-bath; after allowing it to cool down to 60° or 65° C., an infusion of from 120 to 140 grams (4.23 to 5 oz.) of malt made at 40° C. is added. The mixture is kept at from 60° to 65° for an hour; it is then boiled and filtered. The filtrate is evaporated to a syrup, which is exhausted twice with alcohol of 85 per cent. by weight and then once with absolute alcohol. The dextrin (mostly) remains; the maltose passes into solution. The alcoholic extracts are evaporated to a syrupy consistence and allowed to stand. The absolute alcohol extract soon yields a crop of impure crystals of maltose, which are used to induce crystallization in the other two syrups. In regard to the somewhat tedious methods of purification we refer to the handbooks of chemistry. Maltose crystallizes (from alcohol on spontaneous evaporation) in fine needles of the composition $C_{12}H_{22}O_{11} + H_2O$. The H_2O goes off at 100° C. Maltose is less soluble in alcohol than dextrose, to which it is otherwise very similar. To caustic alkalies and Fehling solution it behaves exactly as dextrose does. Like it, it suffers vinous fermentation under the influence of yeast. When boiled with dilute sulphuric acid it breaks up into (so to say) dextrose and dextrose. Maltose plays an important part in the brewing of alcoholic malt liquors.

(W. D.)

History.

History.

The original habitat of the sugar-cane is not known, but it seems to have been first cultivated in the country extending from Cochin China to Bengal (De Candolle). Sugar reached the West from India, and at a comparatively late date. Strabo (xv. i. 20) has an inaccurate notice from Nearchus of the Indian honey-bearing reed, and various classical writers of the first century of our era notice the sweet sap of the Indian reed, or even the granulated salt-like product which was imported from India, or from Arabia and Opone (these being entrepôts of Indian trade),[1] under the name of saccharum, or σάκχαρι (from Sanskr., *sarkara*, "gravel," "sugar") and used in medicine. The art of boiling sugar was known in Gangetic India, from which it was carried to China in the first half of the 7th century; but sugar-refining cannot have then been known, for the Chinese learned the use of ashes for this purpose only in the Mongol period, from Egyptian visitors.[2] The cultivation of the cane in the West spread from Khúzistán in Persia. At Gundé-Shápúr in this region "sugar was prepared with art" about the time of the Arab conquest,[3] and manufacture on a large scale was carried on at Shuster, Sús, and Askar-Mokram throughout the Middle Ages.[4] It has been plausibly conjectured that the art of sugar-refining, which the farther East learned from the Arabs, was developed by the famous physicians of this region, in whose pharmacopœia sugar had an important place. Under the Arabs the growth and manufacture of the cane spread far and wide, from India to Sús in Morocco (Edrísí, ed. Dozy, p. 62), and were also introduced into Sicily and Andulasia.

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[1] [Dr. G. Oliver's indigo-carmine test for glucose is very delicate. Two test papers, one of indigo-carmine and the other of carbonate of soda, introduced into a test-tube and covered with water, give on being heated a fine blue solution. If sugar now be added in any quantity the blue color is discharged and the solution becomes yellow. If the mixture now be shaken or boiled the original blue will return.—AM. ED.]

In the age of discovery the Spaniards became in their turn the great disseminators of the sugar cultivation: the cane was planted by them in Madeira in 1420; it was carried to San Domingo in 1494; and it spread over the occupied portions of the West Indies and South America early in the 16th century. Within the first twenty years of the 16th century the sugar trade of San Domingo expanded with great rapidity, and it was from the dues levied on the imports brought thence to Spain that Charles V. obtained funds for his palace-building at Madrid and Toledo. In the Middle Ages Venice was the great European centre of the sugar trade, and towards the end of the 15th century a Venetian citizen received a reward of 100,000 crowns [$111,940] for the invention of the art of making loaf-sugar. One of the earliest references to sugar in Great Britain is that of 100,000 ℔ of sugar being shipped to London in 1319 by Tomasso Loredano, merchant of Venice, to be exchanged for wool. In the same year there appears in the accounts of the chamberlain of Scotland a payment at the rate of 1s. 9½d. [43 cts.] per pound for sugar. Throughout Europe it continued to be a costly luxury and article of medicine only, till the increasing use of tea and coffee in the 18th century brought it into the list of principal food staples. The increase in the consumption is exemplified by the fact that, while in 1700 the amount used in Great Britain was 10,000 tons, in 1800 it had risen to 150,000 tons, and in 1885 the total quantity used was almost 1,100,000 tons.

In 1747 Andreas Sigismund Marggraf, director of the physical classes in the Academy of Sciences, Berlin, discovered the existence of common sugar in beetroot and in numerous other fleshy roots which grow in temperate regions. But no practical use was made of the discovery during his lifetime. The first to establish a beet-sugar factory was his pupil and successor, Franz Carl Achard, at Cunern (near Breslau) in Silesia in 1801. The processes used were at first very imperfect, but the extraordinary increase in the price of sugar on the Continent caused by the Napoleonic policy gave an impetus to the industry, and beetroot factories were established at many centres both in Germany and in France. In Germany the enterprise came to an end almost entirely with the downfall of Napoleon I.; but in France, where at first more scientific and economical methods of working were introduced, the manufacturers were able to keep the industry alive. It was not, however, till after 1830 that it secured a firm footing; but from 1840 onwards it advanced with giant strides. Now it is an industry of national importance, especially in Germany, controlling in the meantime the market against the cane-sugar trade. While cane sugar was practically without a rival, the cultivation was in general highly profitable, but it was conducted under tropical skies, largely by slave labor and entirely removed from scientific supervision. The staple produced at the plantations was raw sugar, which was sent to Europe to be refined. It was not till the pressure of the competition with beet sugar began to make itself felt that planters realized the necessity for improving their methods of working. It has now been found possible to apply many of the processes and appliances devised in connection with the production of beet sugar to the extraction of its older rival.

Manufacture.

Manufacture.

Cane Sugar Manufacture.—The sugar-cane (*Saccharum officinarum*) is a species of grass, the stalks or canes of which reach a height of from 8 to 15 feet, and attain a diameter of 1½ to 2 inches. The stalks are divided into prominent joints or internodes, the long sheathing alternate leaves springing from each joint. As the canes approach maturity they throw up a long smooth hollow joint termed the *arrow*, whence springs the flower head, consisting of beautiful feather-like loose panicles. The points are filled with a loose spongy fibrous mass, saturated with a juice which is at first watery but afterwards becomes sweet and glutinous. As the joints ripen, the leaves wither and fall away and the stem becomes externally smooth, shining, and hard, containing much silica. The varieties of sugar-cane in cultivation are very numerous, and are distinguished from each other by external color, length of internodes (3½ to 10 inches), height to which they grow, richness in juice, and many other characters. The four principal classes cultivated in the West Indies are the Creole or country cane, the Tahiti cane, the Batavian cane, and the Chinese cane. An average sample of Tahiti cane at maturity contains—water, 71.04 per cent.; sugar, 18.00; ligneous tissue and pectin, 9.56; albumen, coloring matter, and insoluble salts, 1.20; silica, 0.20. The sugar-cane requires a rich, well-drained, but moist soil. It is propagated by slips taken from the upper part of the canes, which are planted at intervals about 5 feet apart or in close-set rows 6 feet apart. In the West Indies the planting takes place between June and October, and in the case of the Creole variety the canes are ready for cutting down by the beginning of January in the second following year. When mature the canes are cut down close to the ground, the remaining leaves and upper shoot removed, and the stalks immediately taken to the mill for crushing. The stocks left are liberally manured with crushed remains and ashes of former crops, combined with nitrogenous manures, and are covered over; they then send up a crop of new stems, termed *rattoons*. The system of rattooning can be continued for several years, but the canes so treated go on declining in size and in yield of sugar. The yield of canes, of course, varies within wide limits; but 20 tons per acre may be regarded as a good average crop.

Cane-Crushing.—The juice is extracted by pressing the canes in a sugar-mill between three, or sometimes five, heavy close-set rollers of iron, placed horizontally in a powerful framework or cheeks. In a three-roller mill they consist of a *cane*, *top*, and *megass* roller respectively. The top roller is set above and between the other two, and under its periphery is a fixed metal plate called the *trash turner*, which guides the cane coming from between the cane and top rollers into the bite between top and megass rollers. Generally the cane roller is screwed up to within half an inch of the top roller, while the free space between top and megass rollers is considerably less. The mill is set in motion by steam power, and the canes are fed by hand on a travelling band or carrier into the rollers. If a thick feed is placed at one side and little at the other, one portion passes through imperfectly crushed, while the other severely strains the mill and may either stop the machinery or cause a breakdown by some portion giving way. The yield of juice obtained with an ordinary mill varies from 60 to 65 per cent. One of the most useful devices for improving the machinery is the substitution of an hydraulic attachment, which can be applied to the headstocks of any of the rollers, in place of the rigid and immovable screws and wedges of the ordinary mill. This secures a uniform pressure with the most irregular feed and much greater pressure than is possible with rigid rollers, resulting in a greatly increased yield of juice (67 to 70 per cent.) and a megass or refuse proportionately drier and therefore more available for fuel for steam-raising. The juice from the mill is led into a trough, whence it is carried by pipes to the clarifiers. But even the most perfect system of mechanical pressure leaves a large percentage of sugar in the refuse cane, and to remedy this the diffusion method (see below), which has been attended with remarkable success in the beet industry, has been also applied to the extraction of cane juice. At Aska (Madras) in India it has been found possible by that process to obtain as much as 87½ of the 90 per cent. of juice present in canes. Considerable difficulty was at first found in slicing the silicious stalks for diffusion; but this process seems to promise a much more exhaustive extraction of the juice than can be secured by mechanical means. The juice is a turbid frothy liquid of a yellowish green color, with a specific gravity of from 1.070 to about 1.100. The variety of cane cultivated, its age, and especially the nature of the season in which it has grown as regards rain, all have an important influence on the yield of sugar. The expressed juice contains from 15 to 18 per cent. of solids, showing on a good average—sugar, 14.55 per cent.; glucose, 1.65; non-saccharine solids, .917; ash, .283. The juice got from sugar-cane is much richer in sugar and less contaminated with non-saccharine solids than that yielded by beet; and its pleasant taste and aromatic odor contrast markedly with the acrid taste and unpleasant smell of beet juice.

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[1] Lucan, iii. 237; Seneca, *Epist.*, 84; Pliny, *H.N.*, xii. 8 (who supposes that sugar was produced in Arabia as well as in India); *Peripl. Mar. Eryth.*, § 14; Dioscorides, ii. 104. The view, often repeated, that the saccharum of the ancients is the hydrate of silica, sometimes found in bamboos and known in Arabian medicine as *ṭabáshír*, is refuted by Yule, *Anglo-Indian Glossary*, p. 654; see also *Not. et Extr. des MSS. de la Bibl. Nat.*, xxv. 267 *sq.*

[2] Marco Polo, ed. Yule, ii. 208, 212. In the Middle Ages the best sugar came from Egypt (Kazwíní, i. 262), and in India coarse sugar is still called Chinese and fine sugar Cairene or Egyptian.

[3] So the Armenian *Geography* ascribed to Moses of Chorene (*q.v.* for the date of the work); St. Martin, *Mém. sur l'Arménie*, ii. 372.

[4] Iṣṭakhrí, p. 91; Yákút, ii. 497. Tha'álibí, a writer of the 11th century, says that Askar-Mokram had no equal for the quality and quantity of its sugar, "notwithstanding the great production of 'Irák, Jorján, and India." It used to pay 50,000 pounds of sugar to the sultan in annual tribute (*Laṭáïf*, p. 107). The names of sugar in modern European languages are derived through the Arabic from the Persian *shakar*.

Purification of cane juice.

Purification of the Juice.—In the hot climates where sugar-canes grow a process of fermentation is almost immediately set up in the impure juices from the canes, causing the formation of invert sugar and later products of fermentation, and thereby a serious loss of sugar. It is therefore essential that with the least possible delay the manufacturing processes should be proceeded with. The juice is first filtered through a set of sieves to remove the mechanical impurities it carries from the mill. Then it is run into the clarifiers, a series of iron vessels capable of holding six or eight hundred gallons of juice, and in these it is heated up to about 130° Fahr., and milk of lime is added in quantity sufficient to neutralize the acid constituents it contains. The heat is then raised to just under the boiling-point, when gradually a thick scum rises and forms on the surface, and when the defecation thereby effected is complete the clear liquid below is drawn off. Various other substances besides lime are employed for the defecation of juice, one of which, the bisulphide of lime in the so-called Icery process, has attained considerable favor. The bisulphide is added in excess; the acids of the juice decompose a certain proportion of it, liberating sulphurous acid, which by its influence promotes the coagulation of the albuminous principles and at the same time promotes the bleaching of the liquid. In another process the green juice is first treated with sulphurous acid, which (with the natural acid constituents) is subsequently neutralized by lime. Recently also phosphoric acid has come into favor as a defecating agent.

Boiling down.

Boiling Down.—From the clarifier the juice passes on to the battery, a range of three to five pans or "coppers," heated by direct fire, in which it is concentrated down to the crystallizing point. The juice, gradually increasing in density, is passed from the one to the other till it reaches the last of the series, the *striking teach*, in which it is concentrated to the granulating point. The skimmings from these pans are collected and used for making rum. From the striking teach the concentrated juice is removed to shallow coolers, in which the crystals form. A few days later it is transferred to hogsheads in the curing-house, and the molasses is drained away from the crystallized raw sugar into tanks. The sugar so obtained is the *muscovado* of the sugar-refiners, and both that and the molasses form their principal raw materials. Clayed sugar consists of raw sugar from which a portion of the adherent molasses has been dissolved by the action of moisture percolating through it from moist clay laid over its surface. Labor difficulties and scarcity of water operate against the general introduction of improved systems of working cane-juice, but in many plantations central usines or sugar-factories have been established with great success. In these the canes of many growers are worked up with the aid of the *triple effect apparatus*, the vacuum pan, and the centrifugal separator employed by beet manufacturers. Wetzel's pan, Fryer's concreter, and similar devices for the efficient evaporation of juice by exposing it to the action of heat in thin films over an extended surface are also in use.

Sugar beet.

BEET SUGAR MANUFACTURE.—The sugar beet is a cultivated variety of *Beta maritima* (natural order *Chenopodiaceæ*), other varieties of which, under the name of mangold or mangel wurzel, are grown as feeding-roots for cattle. The plants are cultivated like turnips, and the roots attain their maturity in about five months after sowing, being gathered during September and October. The efforts of growers have been largely directed to the development of roots yielding juice rich in sugar; and especially in Germany these efforts have been stimulated by the circumstance that excise duty on inland sugar is there calculated on the roots. The duty is based on the assumption that from 12½ parts of beet 1 part of grain sugar is obtained; but in actual practice 1 part of raw sugar is now yielded by 9.27 parts of root. Moreover, when the sugar is exported a drawback is paid for that on which no duty was actually levied, and hence indirectly comes the so-called bounty on German sugar. In 1836 for 1 part of sugar 18 parts of beet were used, in 1850 13.8 parts, in 1860 12.7 parts, and now (1887) about 9.25 parts only are required. In France till recently the inland duty was calculated on the raw sugar; hence the French grower devoted himself to the production of roots of a large size yielding great weight per acre, and had no motive to aim at rich juice and economical production. Many processes, therefore, have come into use in German factories which are not available under the French methods of working. But since 1884 the French manufacturers have had the power to elect whether duty shall be levied on the roots they use or on the raw sugar they make, and a large proportion have already chosen the former. The nature of the seasons exercises much influence on the composition of sugar beet, especially on its richness in sugar, which may range from 10 to 20 per cent. The following represents the limits of average composition:

Water,	juice	84.5 to	79.0
Sugar and other soluble bodies	juice; solids	11.5 to	17.0
Cellulose and other solids	solids	4.0	4.0

The non-saccharine solids in the juice are very complex, embracing albumen, amido-acids, and other nitrogenous bodies, beetroot gum, soluble pectose compounds, fat, coloring matter, with the phosphates, sulphates, oxalates, and citrates of potash, soda, lime, and iron, and silica. The relation and relative proportion of these to the sugar present are of the utmost importance.

Extraction of juice.

Method of pressure.

Two distinct ways of obtaining the juice from beet are now principally employed,—pressure and diffusion. The mechanical methods of pressure are principally used in France; the process of diffusion is all but universal in Germany. Formerly a modified diffusion process—maceration—was in use; but it has now been generally abandoned, as has also a means of separating the juice by centrifugal action. For the mechanical processes the roots have first to be reduced to a condition of fine pulp. For this purpose the roots, thoroughly trimmed and washed, are fed into a pulping machine, in which a large drum or cylinder, armed with close-set rows of saw-toothed blades, is revolved with great rapidity, so that the fleshy roots on coming against them are rasped down to a fine uniform pulp. The operation is assisted by pouring small quantities of water or of watery juice on the revolving drum, which thins the pulp somewhat, and aids the free flow of the juice in the subsequent operation. The expression of the juice is effected either by the hydraulic press or by continuous roller presses. From the hydraulic press the juice flows freely at first; but in order to obtain the largest possible yield it is necessary to moisten the first press-cake and submit it to a second pressure, whereby a thin, watery juice is expressed. After having been pressed twice, the cake that is left should amount to not more than 17 per cent. of the original roots; hence, allowing 4 per cent. for ligneous tissue, etc., only about 13 per cent. of water, sugar, and soluble salts, etc., remain in the refuse. For the system of continuous pressure presses analogous to the mills employed for cane-crushing are used. Many modifications of the roller press have been introduced, and, although the best express from 3 to 5 per cent. less juice than the hydraulic press, they have several advantages under the system formerly common in France, which bound the maker to return press-cake containing a certain proportion of sugar for use as a feeding-stuff on the farm. In certain forms of press the lower rollers are perforated to allow the escape of the expressed juice; in some the rollers are covered with india-rubber, so that they give an elastic squeeze on an extended surface; and in others the pulp is carried in an endless cloth through a series of rollers, being all the while subjected to gradually increasing pressure.

Diffusion process.

The diffusion process for obtaining beet juice depends on the action of dialysis, in which two liquids of different degrees of concentration separated by a membrane tend to transfuse through the membrane till equilibrium of solution is attained. In the beet the cell-walls are membranes inclosing a solution of sugar. Supposing these cells to be brought into contact with pure water, then by theory, if the cells contain 12 per cent. of juice, transfusion will go on till an equal weight of water contains 6 per cent. of sugar, while by the passage of water into the cell the juice there is reduced to the same density. Taking the 6 per cent. watery solution and with it treating fresh roots containing again 12 per cent., a 9 per cent. solution will be attained which on being brought a third time in contact with fresh roots would be raised to a density of 10.5. Thus theoretically seven-eighths of the whole sugar would be obtained at the third operation, and it is on this theory that the diffusion process is based. In working the process a range of ten or twelve diffusers are employed, eight being in operation while the others are being emptied, cleaned, and refilled. These diffusers consist of large close upright cylinders capable of holding each two or three tons of sliced roots. They are provided with manholes above, perforated false bottoms, and pipes communicating with each other, so that the fluid contents of any one can be forced by pressure into any other. In working, pure water from an elevated tank is run into No. 1 cylinder, which contains the slices almost exhausted of their soluble contents; it percolates the mass, and by pressure passes into No. 2, where it acts on slices somewhat richer in juice. So it goes through the series, acquiring density in its progress and meeting in each successive cylinder slices increasingly rich in juice. Before entering the last cylinder the watery juice is heated, and under the combined influence of heat and pressure the juice within the cylinder becomes richly charged with sugar. No. 1 cylinder when exhausted is disconnected; No. 2 then becomes No. 1, and a newly charged cylinder is joined on at the other extremity; and so the operation goes on continuously. The juice ultimately obtained is diluted with about 50 per cent. of water; but it is of a comparatively pure saccharine quality, with less gummy, nitrogenous, and fibrous impurities than accompany the juice yielded by mechanical means.

Purification of beet juice.

If the juice obtained by any process were a pure solution of sugar the manufacturing operations would be few and simple. But beet juice is at best a very mixed solution, containing much gum, acid bodies, nitrogenous matter, and various salts. These adhere to the saccharine solution with the utmost obstinacy; they attack the sugar itself and change crystalline into invert sugar, communicating to it a dirty brown color and a disagreeable acrid taste and smell. To separate as far as possible the non-saccharine constituents and to remove the color from the juice are troublesome tasks. The preliminary purification embraces two sets of operations,—first the treatment of the juice with lime and carbonic acid; secondly, filtration through animal charcoal. Under the old method of working the juice is first boiled in a copper pan with milk of lime to the extent of from ½ to 1 per cent. of lime to the weight of juice operated on. The boiling serves to coagulate the albuminoids, while the lime forms with certain of the other impurities an insoluble precipitate, and in part combines with the sugar to form a soluble saccharate of lime. The insoluble lime combination and the coagulum rise as a scum over the surface of the juice, and the latter, now comparatively clear, is drawn off by a siphon pipe, to be treated in another vessel with carbonic acid. The acid breaks up the saccharate of lime and forms insoluble carbonate of lime, which in precipitating carries down further impurities with it. After settlement the clear juice is drawn off and the precipitated slime pressed in a filter press, whereby it gives up the juice it contains. As now commonly conducted these operations—treating with lime and carbonic acid—are combined, according to the method devised by Jelinek. The juice to be purified is heated and treated with as much as 5 per cent. of lime, while carbonic acid is simultaneously injected into the mass. The juice meantime is raised to a temperature just under boiling-point. The addition of such a large amount of lime affects the precipitation of a great proportion of the non-saccharine constituents of the juice. The whole mass of turbid liquid formed by this treatment is forced into a filter press, and there the lime compounds and impurities are separated with great rapidity from the saccharine juice. Numerous other methods of purification have been proposed, and to some extent have met with favorable reception; but of these we can only mention that of Dubrunfaut and De Massy, in which baryta is substituted for lime, thereby producing an insoluble barium saccharate, and the analogous process of Scheibler, in which strontia is employed in the same sense, producing likewise insoluble strontia saccharate. The juice, which still contains much saline and other non-saccharine matter, is next filtered through animal charcoal; this largely removes coloring matter and carries away a further proportion of the salts. Charcoal filtering is an expensive process; being, moreover, a feature of the subsequent refining, many attempts have been made to dispense with it, and the success of the Jelinek method in producing a comparatively pure and colorless juice has given rise to hopes that it may at this stage be yet dispensed with.

Crystallization.

The next operation consists in concentrating the comparatively pure but thin and watery juice,—a work formerly done in open pans by direct firing, but now carried out in closed vessels, in which the vacuum pan principle of boiling is brought into play. The apparatus consists of a series of three closed vessels, hence called a "triple effect," although in some cases a two-vessel apparatus or double effect is employed. These pans are provided internally with a series of closed pipes for steam-heating, the steam from the boiler of the first passing by a pipe into the worm of the second, and similarly the steam from the second into the worm of the third when a third pan is employed. The steam which rises in the third pan is drawn off by a condenser and vacuum pump, and, as the vacuum so created acts through the whole series, the juice is evaporated and concentrated at a comparatively low temperature by the agency of the steam supplied to the first pan. The juice increases in gravity as it is drawn from the one pan to the other, till by the time it is run off from the third cylinder it has attained a concentration representing a gravity of about 25 Baumé. This concentrated juice is while in a heated condition filtered through fresh charcoal, from which it comes ready for boiling down to crystallization. To bring the dense juice to the crystallizing point it is necessary to conduct the evaporation at the lowest possible temperature. High temperature increases the uncrystallizable at the expense of the crystallizable portion, and burns some proportion into caramel, which darkens the liquid and the resulting sugar crystals. Boiling down at low temperature is effected by the use of the vacuum pan, a closed globular vessel in which by the aid of a condenser and air-pump a vacuum is maintained over the boiling juice and the boiling-point is lowered in proportion to the decrease of air pressure. In vacuum pan boiling the thick juice may simply be concentrated to that degree of density from which, on cooling, the crystals will form, or the crystals may be allowed to separate from the mother-liquor in the pan while the boiling proceeds; these crystals, forming nuclei, increase in size from the concentration of fresh charges of juice added from time to time. By this method the boiled-down juice as it leaves the pan consists of a grainy mass of crystals floating in a fluid syrup.

Separation of crystals from molasses.

After being allowed to cool, the mass is fed into the drum or basket of a centrifugal machine, which by its rapid rotation separates the fluid molasses from the crystals, driving the liquid portion through the meshed wall of the basket. For further cleaning of the crystals from adherent syrup a small quantity of either water or pure syrup is added to the drum, and is likewise forced through the sugar crystals by centrifugal action. Steam also is employed for cleaning the crystals whilst in the centrifugal machine. The syrup from the first supply of sugar is returned to the vacuum pan, again boiled, and treated as above for a second supply of less pure sugar; similarly a third supply is yielded by the drainings of the second. The molasses from the third supply is a highly impure mixture of crystallizable and invert sugar, potash, and other salts, smelling and tasting powerfully of its beet origin. Many methods have been tried to recover the large amount of sugar contained in this molasses. That most extensively employed is the osmose process originated by Dubrunfaut, in which, by the application of a dialyser, it is found that the salts pass through the membrane more rapidly than does sugar. The elution process of Scheibler, which depends on the formation of a saccharate of lime, and the more recent strontia process of the same chemist, in which a strontiate of lime is formed, are also much employed. Another means of utilizing the molasses consists in fermenting and distilling from it an impure spirit for industrial purposes.

Refining.

Sugar-Refining—Sugar-refiners deal indifferently with raw cane and beetroot sugars which come into the market, and by precisely the same series of operations. The sugar is first melted in charges of 5 or 6 tons in *blow-ups*,—cast-iron tanks fitted with mechanical stirrers and steam-pipes for heating the water. The solution called *liquor* is brought to a certain degree of gravity, from 25 to 33 Baumé, and formerly it was the practice to treat it, especially when low qualities of sugar were operated on, with blood albumen. The hot liquor is next passed through twilled cotton bags encased in a meshing of hemp, through which the solution is mechanically strained. From 50 to 200 of these filters are suspended in close chambers, in which they are kept hot, from the bottom of a perforated iron tank, each perforation having under it a bag. These bags have from time to time to be taken off for cleaning out and washing. From the bag filter the liquor is passed for decolorizing through beds of animal charcoal enclosed in cisterns to a depth of from 30 to 50 feet, the sugar being received into tanks for concentration in the vacuum pan. In that apparatus it is "boiled to grain," and the treatment is varied according to the nature of the finished sugar to be made. To make loaves small crystals only are formed in the pan, and the granular magma is run into steam-jacketed open pans and raised to a temperature of about 180° to 190° Fahr., which liquefies the grains. The hot solution is then cast into conical moulds, the form of the loaf, in which the sugar as it cools crystallizes into a solid mass, still surrounded and mixed with a syrup containing colored and other impurities. After thorough settling and crystallization, a plug at the bottom of the mould is opened and the syrup allowed to drain away. To whiten the loaves they are treated with successive doses of saturated syrup, ending with a syrup of pure colorless sugar. These doses are poured on the upper side of the cone, and, percolating down through the porous mass, carry with them the impure green syrup which still may adhere to the crystals. The liquor which obstinately remains in the interstices is driven out by suction or centrifugal action; the loaf is rounded off, papered, and placed in a stove for drying. The syrup which drains from the loaves is sold as golden syrup. When refined crystals are to be made the contents of the vacuum pan are passed into the centrifugal machine; the syrup is then driven off by rotation, and the crystals purified either by adding pure syrup to the revolving basket or by blowing steam through it. There are numerous modified and subsidiary processes connected with refining, as well as with all branches of the sugar industry, regarding which it is not possible here to enter into detail. The industry is essentially progressive and subject to many changes.

Sorghum sugar.

SORGHUM SUGAR.—The stem of the Guinea corn or sorghum (*Sorghum saccharatum*) has long been known in China as a source of sugar, and the possibility of cultivating it as a rival to the sugar-cane and beetroot has attracted much attention in America. The sorghum is hardier than the sugar-cane; it comes to maturity in a season; and it retains its maximum sugar content a considerable time, giving opportunity for leisurely harvesting. The sugar is obtained by the same method as cane sugar. The cultivation of sorghum sugar has not found much favor in the United States; the total yield from that source in 1885 did not exceed 600,000 ℔.

Maple sugar.

MAPLE SUGAR.—The sap of the rock or sugar maple, *Acer saccharinum*, a large tree growing in the United States and Canada, yields a local supply of sugar, which also occasionally finds its way into commerce. The sap is collected in spring, just before the foliage develops, and is procured by making a notch or boring a hole in the stem of the tree about 3 feet from the ground. A tree may yield 3 gallons of juice a day and continue flowing for six weeks; but on an average only about 4 ℔ of sugar are obtained from each tree, 4 to 6 gallons of sap giving 1 ℔ of sugar. The sap is purified and concentrated in a simple manner, the whole work being carried on by farmers, who themselves use much of the product for domestic and culinary purposes. The total production of the United States ranges from 30,000,000 to 50,000,000 ℔, principally obtained in Vermont, New York, Ohio, and Pennsylvania. In Canada also a considerable quantity of maple sugar is collected for domestic use.

Palm sugar.

PALM SUGAR.—That which comes into the European market as *jaggery* or *khaur* is obtained from the sap of several palms, the wild date (*Phœnix sylvestris*), the Palmyra (*Borassus flabelliformis*), the cocoanut (*Cocos nucifera*), the gomuti (*Arenga saccharifera*), and others. The principal source is *Phœnix sylvestris*, which is cultivated in a portion of the Ganges valley to the north of Calcutta. The trees are ready to yield sap when five years old; at eight years they are mature, and continue to give an annual supply till they reach thirty years. The collection of the sap (toddy) begins about the end of October and continues, during the cool season, till the middle of February. The sap is drawn off from the upper growing portion of the stem, and altogether an average tree will run in a season 350 ℔ of toddy, from which about 35 ℔ of raw sugar—jaggery—is made by simple and rude processes. Jaggery production is entirely in native hands, and the greater part of the amount made is consumed locally; it only occasionally reaches the European market.

Starch sugar.

STARCH SUGAR.—This, known in commerce as glucose or grape sugar, an abundant constituent of sweet fruits, etc. (see p. 656 above), is artificially elaborated on an extensive scale from starch. The industry is most largely developed in Germany, where potato starch is the raw material, and in the United States, Indian corn starch being there employed. The starch is acted on by a weak solution of sulphuric acid, whereby soluble starch is formed, which ultimately results in a mixture of glucose and dextrose in varying proportions, constituting the starch sugar of commerce. The operations embrace the boiling of the starch with water containing the requisite proportion of acid, the neutralization of the acid with lime, and the formation of a precipitate of sulphate of lime, which is separated by filtration in a filter press. The filtered liquid is, when necessary, deprived of color by passing it through a bed of animal charcoal, and then it is concentrated to a density of from 40 to 45 Baumé in a vacuum pan. If the resulting syrup contains little dextrin it will on cooling slowly solidify into a granular concretionary mass; but if much dextrin is present it remains in the condition of a syrup. Starch sugar is very largely used by brewers and distillers, and by liqueur makers, confectioners, and others for making fruit and other syrups. Burnt to caramel, it is also employed to color beverages and food substances. As an adulterant it is largely employed in the honey trade and for mixing with the more valuable cane sugar. In 1885 there were about fifty factories in Germany engaged in starch sugar making, in which 10,000 tons of hard sugar, 20,000 tons of syrup, and 1250 tons of "color" were made.

Commerce.

Commerce.

At the present time, judging by the amount sent to the market cane and beet sugars are produced in about equal amount; but, since vast quantities of cane sugar are grown and consumed in India, China, and other Eastern countries of which we get no account, there cannot be a doubt that the annual production of cane far exceeds that of beet sugar. Still, as a growth of not more than forty years, the dimensions to which the beet sugar trade has attained are certainly remarkable. But these dimensions would not have been so suddenly attained had it not been for the system of protection established in the producing countries and of bounties paid to the beet manufacturers on exporting their produce. The United Kingdom is the only open market for sugar, which is consequently sold there at an unprecedentedly low price. The following table shows the relative proportions of the beet and the cane sugar trade and the principal sources of the supply for 1880–85:

	1880-81.	1881-82.	1882-83.	1883-84.	1884-85.
1. BEET SUGAR.	Tons.	Tons.	Tons.	Tons.	Tons.
German empire	594,223	644,775	848,124	986,000	1,155,000
Austria-Hungary	498,082	411,015	473,002	446,000	558,000
France	333,614	393,269	423,194	474,000	308,000
Russia and Poland	250,000	308,779	284,991	308,000	387,000
Belgium	68,626	73,136	82,720	107,000	88,000
Holland and other countries	30,000	30,000	35,000	40,000	50,000
Total	1,774,545	1,860,974	2,147,031	2,361,000	2,546,000
2. CANE SUGAR.					
Cuba	484,000	500,300	485,000	560,900	627,800
Porto Rico	57,100	80,000	70,000	65,000	60,000
Trinidad	43,600	53,400	54,000	59,800	65,700
Barbados	45,000	53,000	52,000	56,000	60,700
Jamaica	17,000	27,000	25,000	20,000	18,000
Antigua and St. Kitt's	16,800	23,000	16,000	23,000	20,000
Martinique	42,000	47,800	46,800	49,400	38,800
Guadeloupe	43,000	57,000	52,000	55,300	41,200
Demerara	92,300	124,200	117,000	126,000	96,000
Réunion	27,100	25,000	34,000	37,800	37,000
Mauritius	119,000	118,000	116,700	120,400	128,000
Java	210,500	273,000	283,600	311,400	380,000
British India	45,000	66,000	87,000	60,000	45,000
Brazils	344,600	304,400	218,000	359,000	269,000
Manila, Cebu, Iloilo	199,000	151,500	211,600	123,000	203,400
Louisiana	121,900	71,400	135,300	128,400	94,500
Peru	40,000	40,000	31,000	25,000	35,000
Egypt	32,000	29,000	21,000	30,000	40,000
Total	1,979,900	2,044,000	2,056,000	2,210,400	2,260,100
Beet and Cane	3,754,445	3,904,974	4,203,031	4,571,400	4,806,100

The relative values of beet and of a low quality of raw cane sugar for 1879–86 are shown in the following table:

Average Price each Year.																
	1879.		1880.		1881.		1882.		1883		1884.		1885.		1886.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Unclayed Manila (taal) on spot	14	8	15	3	15	0	13	11¼	12	9	10	0	10	0¼	9	10¼
German beet; basis 88 per cent. f.o.b.	21	3	22	8	22	9	22	0	20	2	14	0	14	0¼	13	1

Av. Price of the Fourteen Years 1872 to 1885.	Price, Aug. 1886.
Unclayed Manila (taal).........14s. 11¾d. per cwt.	8s. 3d. per cwt.
Germ. beet; basis 88 per ct. f.o.b. 21s. 6¾d. "	11s. "

(J. PA.)

SUGAR-BIRD, the English name commonly given in the West India Islands to the various members of the genus *Certhiola* (generally regarded as belonging to the Family *Cœrebidæ*[1]) from their habit of frequenting the curing-houses where sugar is kept, apparently attracted thither by the swarms of flies. These little birds on account of their pretty plumage and their familiarity are usually favorites. They often come into dwelling-houses, where they preserve great coolness, hopping gravely from one piece of furniture to another and carefully exploring the surrounding objects with intent to find a spider or insect. In their figure and motions they remind a northern naturalist of a Nuthatch, while their coloration—black, yellow, olive, gray and white—recalls to him a Titmouse. They generally keep in pairs and build a domed but untidy nest, laying therein three eggs, white blotched with rusty-red. Apart from all this the genus presents some points of great interest. Mr. Sclater (*Cat. B. Br. Museum*, xi. pp. 36–47) recognizes 18 "species," therein following Mr. Ridgway (*Proc. U. S. Nat. Museum*, 1885, pp. 25–30), of which 3 are continental with a joint range extending from southern Mexico to Peru, Bolivia, and southeastern Brazil, while the remaining 15 are peculiar to certain of the Antilles, and several of them to one island only. Thus *C. caboti* is limited, so far as is known, to Cozumel (off Yucatan),[2] *C. tricolor* to Old Providence, *C. flaveola* (the type of the genus) to Jamaica, and so on, while islands that are in sight of one another are often inhabited by different "species." Further research is required; but even now the genus furnishes an excellent example of the effects of isolation in breaking up an original form, while there is comparatively little differentiation among the individuals which inhabit a large and continuous area. The non-appearance of this genus in Cuba is very remarkable. (A. N.)

SUGDEN, EDWARD BURTENSHAW. See ST. LEONARDS, LORD.

SUHL, a manufacturing town in an isolated portion of Prussian Saxony, is picturesquely situated on the Lauter, on the southern slope of the Thuringian Forest, 6½ miles to the northeast of Meiningen and 29 miles to the southwest of Erfurt. The armorers of Suhl are mentioned as early as the 9th century, but they enjoyed their highest vogue from 1550 to 1634. The knights of south Germany especially prized the swords and armor of this town, and many of the weapons used in the mediæval campaigns against the Turks and in the Seven Years' War are said to have been manufactured at Suhl. Its old popular name of the "armory of Germany" is more appropriate, however, to its past than to its present position, for, already seriously crippled by the ravages of the Thirty Years' War and by frequent conflagrations, it has suffered considerably in more modern times from the competition of other towns, especially since the introduction of the needle-gun. It still contains, however, large factories for firearms (military and sporting) and side arms, besides iron-works, machine-works, potteries, and tanneries. The once considerable manufacture of fustian has declined. A brine spring (Soolquelle) at the foot of the neighboring Domberg is said to have given name to the town. The population in 1880 was 9937 and 10,605 in 1885. Suhl, made a town in 1527, belonged to the early principality of Henneberg, and formed part of the possessions of the kingdom of Saxony assigned to Prussia by the congress of Vienna.

SUICIDE. The phenomenon of suicide has at all times attracted a large amount of attention from moralists and social investigators. Though of very small dimensions, even in the countries where it is most prevalent, its existence is rightly looked upon as a sign of the presence of maladies in the body politic which, whether remediable or not, deserve careful examination. To those who look at human affairs from a theological standpoint, suicide necessarily assumes a graver aspect, being regarded, not as a minute and rather obscure disease of the social organism, but as an appalling sign of the tendency of man to resist the will of God. Compare FELO DE SE. As a great number of persons are, either directly or indirectly, under the influence of the theological bias, and as the act of suicide is in itself of a striking character to the imagination, the importance of the phenomenon from a sociological point of view has been to some extent exaggerated, especially in those countries of the Continent where suicides are most numerous. Moreover, the matter has during the last twenty years become of direct interest to the Governments of those countries where the whole able-bodied male population are more or less under the control of a military organization; for, rightly or wrongly, a portion of the recent considerable increase in the suicide rate of Prussia, Saxony, Austria, and France is attributed to dislike of the military service. It may be observed in passing that the suicide rate among soldiers is high in all countries, Great Britain not excepted, as was shown by Mr. W. H. Millar in the *Journal of the Statistical Society*, vol. xxxvii., 1874, and more recently by Dr. Ogle in the same *Journal*, vol. xlix. (March), 1886. As enlistment is voluntary in the United Kingdom, the alleged dislike to conscription cannot be the sole cause of the high rates prevailing in some of the Continental states. Before referring to the more general characteristics of suicide, it will be well to furnish some idea of its magnitude in relation to the category of social phenomena to which it belongs, namely, death. The following tables are constructed for this purpose. The first (I.)

I. *Statement of the Number of Cases of Suicide in the Principal Countries of Europe during the undermentioned Periods and Years.*

Periods.	Sweden.	Norway.	Denmark	England and Wales.	Prussia.	Belgium.	France.	Baden.	Würtemberg.	Bavaria.	Saxony.	Austria (proper).	Italy.
1836-40	214	113	272	967	1471	183	2574	...	...	...	264	523	...
1841-45	212	138	306	...	1642	[3]235	2951	[3]89	...	247	340	595	...
1846-50	229	150	341	...	1696	[3]263	3446	...	185	218	373	[3]774	...
1851-55	253	154	402	1025	2075	166	3639	150	196	275	496	666	...
1856-60	211	145	446	1310	2152	213	4002	170	144	332	509	[3]799	...
1861-65	301	141	[3]431	1343	2247	221	[3]4700	189	[3]175	[3]384	601	1051	[3]718
1866	309	121	443	1329	2485	215	5119	189	244	410	704	1265	588
1867	371	131	469	1316	3625	365	5011	198	270	471	752	1407	758
1868	366	130	498	1508	3658	376	5547	212	283	441	800	1566	784
1869	356	131	462	1588	3544	257	5114	221	251	430	710	1375	683
1870	369	148	486	1554	3270	338	4157	195	247	459	657	1510	786
1866-70	354	133	472	1459	3316	310	4989	208	259	442	725	...	[illegible]
1871	321	128	505	1495	3135	367	4490	244	238	419	653	2040	836
1872	309	132	464	1514	3457	356	5275	219	258	405	687	2194	890
1873	337	126	489	1518	3345	377	5525	216	304	447	723	2463	975
1874	394	99	439	1592	3490	374	5617	244	282	450	723	2617	1015
1875	376	144	394	1601	3432	336	5472	226	334	459	745	2741	922
1871-75	347	126	448	1544	3368	362	5256	231	294	436	706	2411	923
1876	409	142	507	1770	4448	439	5804	269	348	522	981	3376	1024
1877	430	130	530	1699	4568	470	5878	291	324	650	1114	3598	1139
1878	411	132	544	1764	4992	490	6434	317	425	674	1126	3488	1158
1879	438	141	505	2085	4881	553	6496	309	380	750	1121	3469	1225
1880	384	124	496	1979	5034	591	6638	338	371	682	1171	3649	1261
1876-80	414	134	516	1849	4784	509	6250	305	369	656	1103	3516	1161
1881	384	128	495	1955	5159	550	6741	306	348	695	1248	3504	1313
1882	482	136	505	1965	5812	595	7213	283	...	724	1128	3530	1389
1883	470	134	513	1962	5837	599	7267	341	...	...	1206	3595	1456
1884	431	...	...	2043	6013	...	...	...	...	...	...	3783	...
1881-84	442	...	...	1981	5205	...	...	...	...	...	...	3608	...

[3] Uncertain data.

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[1] Known in French as *Guit-guits*, a name used for them also by some English writers. The *Guitguit* of Hernandez (*Rer. Medic. N. Hisp. Thesaurus*, p. 56), a name said by him to be of native origin, can hardly be determined, though thought by Montbeillard (*Hist. Nat. Oiseaux*, v. p. 529) to be what is now known as *Cœreba cærulea*, but that of later writers is *C. cyanea*. The name is probably onomatopoetic, and very likely analogous to the "Quit" applied in Jamaica to several small birds.

[2] In the article BIRDS (iii. p. 651) attention was drawn to what was then believed to be a fact—namely, that the form found in this island was identical with that which inhabits the Bahamas; but now the two forms are regarded as distinct.

gives the absolute number of cases of suicide as officially stated in a number of countries for a series of years. Table II. (A, B, C) refers to three separate years and shows the number of cases of suicide relatively to all the deaths and to the population for certain countries. The totals for the countries in question are also given. Table I. is obtained from Morselli (Table I.) with the addition of figures that have been published since his work appeared.[1] Table III. gives the figures relating to three States of the American Union which have published statistics on the subject.

II. *Statement of the Estimated Population of the undermentioned Countries in the Years* 1868, 1876, *and* 1882; *the Number of Deaths from Suicide and other Causes in the same Years in the same Countries; and the Proportions borne by the Deaths to the Population in each case.*[2]

A.—1868.

Countries.	Estim'ted Population in the Middle of the Year.	Deaths.			Number of Deaths per 1,000,000 Inhabitants.		
		Suicide.	Other Causes.	Total.	Suicide.	Other Causes.	Total.
Austria	20,026,554	1986	569,566	571,552	99	28,401	28,500
Baden	1,453,939[3]	212	39,677	39,889	146	27,284	27,430
Bavaria	4,750,000[4]	441	158,559	159,000[5]	93	33,377	33,470
Belgium	4,961,644	376	107,180	107,556	75	21,625	21,700
Denmark	1,748,000	498	33,318	33,816	285	19,015	19,300
France	38,329,617	5547	916,491	922,038	145	23,955	24,100
Italy	25,484,376	784	776,440	777,224	31	30,569	30,600
Prussia	24,069,379	3658	655,070	658,728	152	27,248	27,400
Saxony	2,453,555	800	71,918	72,718	325	29,315	29,640
Sweden	4,173,080	366	87,441	87,807	88	20,912	21,000
Un. King'm—England and Wales	21,948,713	1508	479,114	480,622	69	21,731	21,800
Ireland	5,465,914	87	86,098	86,185	16	15,784	15,800
Scotland	3,275,350	123	69,293	69,416	37	21,163	21,200
	158,090,121	16,386	4,050,165	4,066,551	104	25,636	25,740

II. B.—1876.

Countries.	Estim'ted Population in the Middle of the Year.	Deaths.			Number of Deaths per 1,000,000 Inhabitants.		
		Suicide.	Other Causes.	Total.	Suicide.	Other Causes.	Total.
Austria	21,319,544	2438	631,925	634,363	114	29,686	29,800
Baden	1,507,179[6]	269	40,054	40,323	178	26,582	26,760
Bavaria	5,022,390	522	153,674	154,196	104	30,596	30,700
Belgium	5,336,185	439	116,348	116,787	82	21,818	21,900
Denmark	1,893,100	506	86,859	87,365	267	19,433	19,700
France	36,905,788	5804	828,270	834,074	157	22,443	22,600
Italy	27,626,825	1024	795,396	796,420	37	28,763	28,800
Prussia	25,921,687	3917	656,469	660,386	151	25,349	25,500
Saxony	2,800,000[7]	981	77,140	78,121	350	27,550	27,900
Sweden	4,429,718	409	85,925	86,334	92	19,508	19,600
Un. King'm—England and Wales	24,370,267	1770	508,545	510,315	73	20,827	20,900
Ireland	5,277,544	111	92,213	92,324	20	17,279	17,300
Scotland	3,552,183	131	73,998	74,129	37	20,863	20,900
	165,961,405	18,321	4,096,816	4,115,137	110	24,690	24,800

The first feature which appears prominently in connection with these tables is, as already observed, the small absolute amount of suicide officially reported. There is, however, a general consensus of opinion among those who have made a special study of this branch of vital statistics, to the effect that the number of suicides which actually occur is rather greater than is shown by the official returns. This opinion is based on the known natural repugnance on the part of those concerned to make a declaration that any person found dead committed suicide if his death can be accounted for in any other way. Continental statisticians think that this tendency to "give the benefit of the doubt" in cases of apparent suicide in the manner least likely to give pain to the relatives and friends of the deceased is more strongly operative in England than in other countries,—an opinion which may be fairly considered doubtful when we bear in mind the remarkable difference between the two sets of official figures for Austria. It is not, however, maintained that the number of suicides is much understated, even in England, at any rate of late years. It may be observed that the information on the subject in any country cannot be much relied upon for years previous to 1850, at the earliest, and previous to 1860 for the United Kingdom. Perhaps an exception may be made in favor of the figures for Norway and Sweden. Differences in the mode of determining cases of supposed suicide in different countries make it necessary to be very careful in preparing "international" statistics of suicide. The remarks made by Dr. Ogle in the paper already referred to are worth careful attention. He says: "I have been tempted to compare the English figures with those of foreign countries. I have, however, rigidly abstained from doing so. Those who have read the laborious treatise of Morselli on suicide, and have

II. C.—1882.

Countries.	Estim'ted Population in the Middle of the Year.	Deaths.			Number of Deaths per 1,000,000 Inhabitants.		
		Suicide.	Other Causes.	Total.	Suicide.	Other Causes.	Total.
Austria	22,316,567	3530	683,421	686,951	158	30,642	30,800
Baden	1,596,206	283	38,654	38,937	177	24,223	24,400
Bavaria	5,389,732	724	152,428	153,152	134	28,276	28,410
Belgium	5,655,197	595	113,703	114,298	105	20,095	20,200
Denmark	2,008,100	513	38,225	38,738	255	19,045	19,300
France	37,769,000	7213	831,326	838,539	191	22,009	22,200
Italy	28,596,512	1889	785,937	787,826	49	27,451	27,500
Prussia	27,796,189	5312	694,979	700,291	191	25,009	25,200
Saxony	3,040,000	1128	85,106	86,234	371	27,999	28,370
Sweden	4,579,115	482	78,924	79,406	105	17,295	17,400
Un. King'm—England and Wales	26,413,861	1965	514,689	516,654	74	19,526	19,600
Ireland	5,097,853	105	88,395	88,500	21	17,379	17,400
Scotland	3,785,400	167	72,822	72,989	44	19,256	19,300
	174,048,782	23,406	4,178,609	4,202,015	134	21,986	24,120

III. *Statement of the Number of Deaths by Suicide in the undermentioned States of the American Union in the Years named, with their Proportion to the Population.*

Years.	Massachusetts.		Rhode Island.		Connecticut.	
	Total.	Per 1,000,000 Inhabitants.[8]	Total.	Per 1,000,000 Inhabitants.[8]	Total.	Per 1,000,000 Inhabitants[8].
1870	91	62	27	124	...	...
1871	122	82	19	84	...	...
1872	117	76	18	77	...	...
1873	117	74	8	33	...	...
1874	115	71	18	72	...	...
1875	159	96	26	101	...	...
1876	119	72	18	69	49	83
1877	163	98	22	83	52	84
1878	126	76	21	78	55	83
1879	161	94	18	48	58	95
1880	133	75	10	36	48	77
1881	165	88	23	82	69	109
1882	162	88	31	109	65	101
1883	167	89	25	...	...	...
1884	184	96	35	...	...	...

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[1] The figures for Austria up to 1871, although collected by the official registrar, are far from trustworthy. Since 1873 more reliable data have been obtained by the sanitary service. The registrar's figures for 1871 and 1872 have been corrected by Dr. Neumann-Spallart; those for the succeeding years are the figures of the sanitary service. A comparison of the returns from the two official sources shows that the figures of the latter authority are (except in two cases) 30 per cent. greater than the corresponding figures furnished by the former.

[2] Still-births are excluded.

[3] Adding natural increase of 1868 to population of 1867 (Kolb).

[4] Estimate, deducting natural increase of 1869–70 from figure in census of 1871.

[5] 159,186 including still-births.

[6] 1st December, 1875.

[7] 2,760,586 in 1875.

[8] Population calculated from average annual increase since 1880.

noted how heterogeneous in form and how unequal in numerical efficiency were the materials from different countries with which he was forced to be content, will, I think, agree with me that it is at present more essential that statisticians should look to the accuracy and sufficiency of the returns of their own several countries than that they should indulge in premature comparison.'' The tables given above are not conceived in a spirit contrary to these judicious observations, but are merely intended to supply indications of the general nature of the phenomenon as met with in different countries. Those who wish to inquire more fully into the matter will find all the available information in the works of Morselli and Legoyt.

It is quite admissible, subject to the above reservations, to point out briefly, and if possible to explain, the leading features brought into relief by the tables. It will be seen that from 1868 to 1876 suicide increased in all countries for which returns were available in both years, not merely in number, but relatively (except Denmark, Prussia, and Scotland) to the population, and the figures for the years subsequent to 1876 do not show any improvement in this respect. It will also be observed that the figures for the United Kingdom and Italy are low, those for Austria, Bavaria, Belgium, and Sweden moderate, those for Prussia, Baden, and France high, and those for Saxony and Denmark very high. Attempts have been made to account for these differences by considerations derived from (1) race, (2) climate, (3) density of population, and other circumstances; but it cannot be said that any satisfactory result has been obtained from these investigations, owing, no doubt, to the fact that the phenomenon is too minute to furnish numbers large enough for the proper application of the statistical method. Investigations into certain other points have been more successful, such as the relative proportions of the two sexes as regards number of suicides, the relation of the number of suicides to the age scale (see POPULATION) of the population, and also the distribution of the cases of suicide over the months of the year. Most valuable inquiries have also been made into the distribution of suicides with regard to occupation, with results which appear to show that suicide is more prevalent among the educated than among the illiterate classes. For the suicidal tendency in insanity, see vol. xiii. p. 112.

Sex.—It will have been observed that, apart from fluctuations in particular years, the various countries maintain fairly constant relations to one another as regards number of suicides. The series of numbers in Table I. is fairly regular, in each country usually increasing as the population increases, but in several cases faster. The proportion of female to male suicides is also fairly constant, so far as experience has hitherto gone. Broadly speaking, female suicides are never less than 15 per cent. and never more than 30 of the average annual number of suicides in any country. In England the proportion is high, having during the period 1863–76 averaged 26 per cent. In France the rate is nearly as high, though it appears to have been decreasing of late. In Prussia and most German states the rate is under 20 per cent. For further details reference may be made to Morselli, and for England and Wales to Dr. Ogle's paper already mentioned.

Age.—The influence of age on suicide shows considerable regularity in each country from year to year, and a certain degree of similarity in its effects is perceptible in all countries. Morselli gives a number of tables and diagrams, a study of which indicates a variety of interesting features. The observations already made as to the minuteness of the whole phenomenon in relation to the social organism must be particularly borne in mind in drawing conclusions from investigations which involve the breaking up of numbers already small into parts. It is true that, by adding together the corresponding figures for a series of years, fairly large numbers may be obtained, even for those parts of the age scale which, in any single year, yield only one or two cases of suicide, or even occasionally none. But this mode of obtaining an enlarged image of the age scale of suicide must be employed with caution, since there may have been changes in the tendency to suicide, in the age scale, and in the occupations of the people during the period. Dr. Ogle has prepared a table (IV.) which gives as correct a representation of the effect of age on suicide in England and Wales as it is possible to furnish. The age scale of suicide in question is also fairly representative of the corresponding age scales of other countries, though in each country slight variations from the typical scale are apparent at different parts of it.

IV. *Average Annual Suicides in England and Wales at successive Age Periods per million Lives*, 1858–83 (Ogle).

Age.	Rates per Million.			Age.	Rates per Million.		
	Persons	Males.	Females		Persons	Males.	Females
10	4	4	3	55	251	396	119
15	28	26	30	65	243	394	112
20	47	62	34	75	183	306	85
25	69	99	42	85	116	226	46
35	116	175	62				
45	184	271	108	All ages.	72	104	41

It will be seen that, taking both sexes together, the suicide rate rises steadily and rapidly after the tenth year has been passed, attaining its maximum in the period fifty-five to sixty-five years, after which it remains almost stationary for another ten years, when it sinks rapidly. Although no figures are given for any period previous to the tenth year, Dr. Ogle mentions that there were actually four cases of suicide of children between the ages of five and ten during the twenty-six years observed. Child suicide is apparently of more frequent occurrence on the Continent than in the British Isles. It is important to notice that the age scale of suicide for women is materially different from that for men. If represented by a diagram its curve makes a smaller angle with the base line than the corresponding curve of male suicide. As might be expected from the fact that females become fully developed, both in mind and body, at an earlier period of life than males, the suicide rate for women is relatively very high during the years fifteen to twenty, being in England and several other countries actually higher than that for men. Comparison between different countries in this respect is difficult, but the figures given by Morselli (Table xxvi. in his work) show that during the period in question the number of female suicides increases with great rapidity in all countries. Regarding the suicide of young persons of both sexes, Dr. Ogle observes that it is higher than is generally supposed. "Few," he says, "would imagine that one out of every 119 young men who reach the age of 20 dies ultimately by his own hand; yet such is the case." According to Dr. Ogle's figures, 1 out of every 312 girls who reach the age of 15 ultimately dies by her own hand.

Influence of Occupation.—The difficulty of investigating the mode in which the suicide rate is affected by differences of occupation is considerable. Dr. Ogle has with great labor worked out the figures for males for the six years 1878–83 in England and Wales. He obtained about 9000 cases of the suicides of persons with known occupations; these he compared with the statement of occupations obtained from the census of 1881, taking account of the very considerable variety in the average age of the persons in each occupation. This precaution was necessary in an attempt to ascertain whether the persons engaged in any particular occupation were more liable to suicide than those in other occupations, for the effect due to the occupation would in some cases be entirely obliterated by the effect due to age. The general result of his labors[1] was that the rate for soldiers is enormously in excess of that for any other occupation. It is followed at a considerable distance by innkeepers and other persons having constant access to alcohol, —a fact which certainly suggests that an excessive use of spirits is one of the principal causes of suicide. But another reason for the high rate among soldiers is certainly the fact that they have a ready and effective means of destruction constantly at hand. In like manner the high rate of suicide among medical men, chemists, and druggists may be attributed in part to their familiarity with poisons. Hardly any other general inferences can be drawn without entering on matters of conjecture, except that, excluding the case of clergymen, the rate of those occupations which involve no serious bodily labor is higher than that observed in persons who work chiefly with their hands. It is impossible to make any satisfactory comparison in this respect between England and Wales and other countries, as the divisions of occupations in different countries are not on the same plan. It would be very advantageous if some approach to a common list of occupations could be adopted by all states; but there is little prospect of that being realised for some time to come. It is, however, satisfactorily established that in all countries the suicide rate is higher for the educated than for the uneducated classes.

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[1] See *Stat. Jour.*, March, 1886, p. 112.

Season.—May and June are in most countries the months in which most suicides occur; but in some countries, such as Bavaria and Saxony, the maximum is in July. The difference between the warm and cold portions of the year is more marked in female suicides than in male suicides, especially in Italy. This is probably due to the fact that women show a tendency to adopt drowning as a mode of killing themselves, and that there is more shrinking from a plunge into water in cold than in warm weather. The fact that the maximum number of suicides occurs in the hot season, during which, according to Morselli and other Continental statisticians, insanity is more frequent than in the cool portions of the year, has been alleged as a reason for the high suicide rate in May, June and July.

Modes of Suicide.—The favorite mode of suicide in England is among men hanging and among women drowning,—about one-third of the suicides of each sex being effected in these modes respectively (Morselli, Table xlv.). In Italy, however, the most common mode is by gunshot, among men and after that by drowning, hanging being less usual. A very large number of Italian women drown themselves, the proportion being in some years over 50 per cent. of the total. In Prussia considerably over one-half the male suicides hang themselves, and women also make use of the rope more than in England. The use of poison is more common among English women than among those of Italy and Prussia. Dr. Ogle observes that women take less care than men to select painless poisons, nearly 50 per cent. of female suicides by poison in England during the years 1863–82 being effected by means of strychnia, vermin killer, carbolic acid, and oxalic acid, while 60 per cent. of the men employed prussic acid, laudanum, and other comparatively painless poisons. Dr. Ogle, Morselli, and other writers have investigated the connection between the choice of means and the age of suicide. Dr. Ogle has also compiled a valuable table relating to method of male suicide in relation to occupation.

The whole subject has been treated exhaustively by Morselli in his *Il Suicidio, Saggio di Statistica Morale Comparata*, Milan, 1879 (Eng. trans., *Suicide: Essay on Comparative Moral Statistics*, London, 1881). Reference may also be made to A. Legoyt's *Le Suicide Ancien et Moderne*, Paris, 1881. This volume contains much interesting historical matter, but is inferior as a statistical work to that of Morselli. It contains, however, a useful bibliography of works on suicide.

Official Information.—Accurate information regarding suicide has for many years been given for all the countries of which mention has been made above in the publications of their respective Governments. For other countries the available statistics are meagre, accurate figures having in many cases only recently been obtained from Finland, Switzerland, Holland, Hungary, Croatia, Spain, and three or four of the States of the American Union. There are no figures for the whole United States, and none of value for any other countries. Such statistics as are in existence for these countries will be found in *Confronti Internationali per gli Anni* 1865–83 (Rome, 1884), published by the Italian General Statistical Department. (W. HO.)

SUIDAS, the author of a Greek lexicon. His personal life is totally unknown and even his date is uncertain. He must have lived before Eustathius (12th century), who quotes him repeatedly. Under the heading "Adam" the author of the lexicon gives a brief chronology of the world, ending with the death of the emperor John Zimisces. Under "Constantinople" are mentioned the emperors Basil and Constantine, who succeeded John Zimisces in 975. It would thus appear that Suidas lived in the latter part of the 10th century. The passages in which Michael Psellus (who lived at the end of the 11th century) are referred to are thought by Küster to be later interpolations; one of them is wanting in the Paris MSS. The lexicon of Suidas is arranged alphabetically, with some slight deviations from the strict alphabetical order. It partakes of the nature of a dictionary and encyclopædia, containing not only definitions of words but also short articles on historical, biographical, geographical, and antiquarian subjects. It includes numerous quotations from ancient writers; the scholiast on Aristophanes in particular is much used. Although the work is uncritical and the value of the articles very unequal, it contains a great deal of important information on ancient history and life. It deals with Scriptural as well as pagan subjects, from which we infer that the writer was a Christian. Prefixed to the work is a notice stating "the present book is by Suidas, but its arrangement is the work of twelve learned men," and then follow their names.

The first edition of Suidas was that by Demetrius Chalcondylas (Milan, 1499), the next by Aldus (Venice, 1514). The chief later editions are those by L. Küster (Cambridge, 1705), by T. Gaisford (Oxford, 1834), and by G. Bernhardy (Halle, 1834–1853). There is a cheap and convenient edition by Im. Bekker (Berlin, 1854).

SULLA (138–78 B.C.). The life of Lucius Cornelius Sulla makes one of the most important chapters in Roman history. Both as a general and as a politician he stands in the foremost rank of the remarkable figures of all time. It was by his ability and his force of character that Sulla, who had neither great wealth nor noble ancestry[1] to back him up, pushed himself to the front in early manhood, distinguishing himself in the Jugurthine War in 107 and 106, and being able with a good show of reason to claim the credit of having terminated that troublesome war by capturing Jugurtha himself. In these African campaigns Sulla showed that he knew how to win the hearts and confidence of his soldiers, and through his whole subsequent career the secret of his brilliant successes seems to have been the enthusiastic devotion of his troops, whom he continued to hold well in hand, while he let them indulge themselves in plundering and in all manner of license. "Rome's soldiers from Sulla's time," says Sallust (*Cat.*, 11), "began to drink, to make love, to have a taste for works of art, to rob temples, and to confound things sacred and profane." From the year 104 to 101 he served again under Marius in the war with the Cimbri and Teutones and fought in the last great battle near Verona, which annihilated the barbarian host. Marius, it is said, was jealous of him, and any friendly feeling there may have hitherto been between the two now finally ceased. Sulla on his return to Rome lived quietly for some years and took no part in politics. What with his genuine love of letters and his love of gay company he was never at a loss for amusement, and he must always have been a particular favorite with fashionable society at Rome. In 93 he was elected prætor after a lavish squandering of money, and he delighted the populace with an exhibition of a hundred lions from Africa, from the realm of King Bocchus. Next year (92) he went to the East with special authority from the senate to put pressure on the famous Mithradates of Pontus, and make him give back Cappadocia to its petty prince Ariobarzanes, one of Rome's dependents in Asia, whom he had driven out. Sulla with a small army soon won a victory over the general of Mithradates, and Rome's client-king was restored. An embassy from the Parthians now came to solicit the honor of alliance with Rome, and Sulla was the first Roman who held diplomatic intercourse with that remote people. In the year 91, which brought with it the imminent prospect of revolution and of sweeping political change, with the enfranchisement of the Italian peoples, Sulla returned to Rome, and it was generally felt that he was the man to head the conservative and aristocratic party. Who was to have the command in the Mithradatic War and be intrusted with the settlement of the East was the question of the day, and the choice lay plainly between Marius and Sulla. The rivalry between the two men and their partisans was as bitter as it could possibly be. Marius was old, but he had by no means lost his prestige with the popular party.

Meanwhile Mithradates and the East were forgotten in the crisis of the Social or Italic War, which broke out in 91 and threatened Rome's very existence. The services of both Marius and Sulla were needed, and were given; but Sulla was the more successful, or, at any rate, the more fortunate. Of the Italian peoples Rome's old foes the Samnites were the most formidable; these Sulla thoroughly vanquished, and took their chief town, Bovianum. But his victories were, after all, followed by the concession of the franchise to the Italian towns and communities generally, though an arrangement which made them vote in separate tribes greatly diminished their political power and became a further source of irritation. It was clear that Rome was on the eve of yet further troubles and revolutionary changes. Her armies, now recruited from the very scum of the population, had not the loyal and honorable spirit of former days, and cared only for license and plunder. On every side it seemed that public life was demoralized and politics degraded. In 88 Sulla was consul; the revolt of Italy was at an end; and again the question came to the front—who was to go to the East and encounter the warlike king of Pontus, against whom war had been declared. The tribune Publius Sulpicius Rufus moved that Marius should have the command; there was fearful rioting and bloodshed at Rome at the prompting of the popular leaders, Sulla narrowly escaping to his legions in Campania, whence he marched on Rome, being the first Roman who entered the city at the head of a Roman army. Marius now had to fly; and he and his party were crushed for the time.

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[1] He belonged to quite a minor branch of the Cornelian gens.

Sulla, leaving things quiet at Rome, quitted Italy in 87 for the East, taking Greece on his way, and for the next four years he was winning victory after victory against the armies of Mithradates and accumulating boundless plunder. Athens, the headquarters of the Mithradatic cause, was taken and sacked in 86, and Sulla possessed himself of a library which contained Aristotle's works. In the same year at Chæroneia, the scene of Philip of Macedon's memorable victory more than two and a half centuries before, and in the year following, at the neighboring Orchomenus, he scattered like chaff, with hardly any loss to himself, immense hosts of the enemy. Crossing the Hellespont in 84 into Asia, he was joined by the troops of Fimbria, who soon deserted their general, a man sent out by the Marian party, now again in the ascendant at Rome. The same year peace was concluded with Mithradates on condition that he should resign all his recent conquests, give up all claim to meddle with Rome's Asiatic dependencies, and pay a considerable indemnity. In fact the king was to be put back to the position he held before the war; but, as he raised cavils and Sulla's soldiers wanted better terms and more spoil, he had in the end to content himself with being on the same footing as the other princes of Asia,—simply a vassal of Rome.

Sulla returned to Italy in 83, landing at Brundusium, having previously informed the Senate in an official despatch of the result of his campaigns in Greece and Asia, and announced his presence on Italian ground. He complained, too, of the ill-treatment to which his friends and partisans had been subjected during his absence. The revolutionary party, specially represented by Cinna, Carbo, and the younger Marius, had massacred them wholesale, confiscated his property, and declared him a public enemy. They felt they must resist him to the death, and with numerous bodies of troops scattered throughout Italy, and the support of the newly enfranchised Italians, to whom it was understood that Sulla was bitterly hostile, they counted confidently on success, but on Sulla's advance at the head of his 40,000 veterans many of them lost heart and deserted their leaders, while for the most part the Italians themselves, whom he confirmed in the possession of their new privileges, were won over to his side. Only the Samnites, who were as yet without the Roman franchise, remained his enemies, and it seemed as if the old war between Rome and Samnium had to be fought once again. Several Roman nobles, among them Cneius Pompeius (Pompey the Great), Metellus Pius, Marcus Crassus, Marcus Lucullus, joined Sulla, and in the following year (82) he won a decisive victory over the younger Marius near Præneste (Palestrina) and then marched straight upon Rome, where again, just before his defeat of Marius, there had been a great massacre of his adherents, in which the famous and learned jurist Mucius Scævola perished. Rome was at the same time in extreme peril from the advance of a Samnite army, and was barely saved by Sulla, who, after a bloody and very hard-fought battle routed the enemy before the walls of Rome. With the death of the younger Marius, who killed himself after the surrender of Præneste to one of Sulla's officers, the civil war was at an end and Sulla was master of Rome and of the Roman world. Then came, with the object of breaking the neck of the Marian or popular party, the memorable "proscription," when, for the first time in Roman history, a list of men declared to be outlaws and public enemies was exhibited in the forum, and a reign of terror—a succession of wholesale murders and confiscations throughout Rome and Italy—made the name of Sulla forever infamous. The title of "dictator" was revived after a long period and conferred upon him: Sulla was in fact emperor of Rome, with absolute power over the life and fortunes of every Roman citizen. There were of course among them some really honest well-meaning men, who looked up to him as the "saviour of society." After celebrating a splendid triumph for the Mithradatic War, and assuming the surname of "Felix" ("Epaphroditus," "Venus's favorite," he styled himself in addressing Greeks), he carried in 80 and 79 his great political reforms (see ROME, vol. xx. pp. 779–81). Of these, the main object was to invest the senate, the thinned ranks of which he had recruited with a number of his own creatures, with full control over the state, over every magistrate and every province, and the mainstay of his political system was to be the military colonies which he had established with grants of land throughout every part of Italy, to the injury and ruin of the old Italian freeholders and farmers, who from this time dwindled away, leaving whole districts waste and desolate. Sulla's work had none of the elements of permanence; it was a mere stop-gap purchased at the cost of infinite misery and demoralization.

In 79 Sulla resigned his dictatorship and retired to Puteoli, where he died in the following year, probably from the bursting of a bloodvessel, though there is a story that he fell a victim to a particularly loathsome disease similar to that which cut off one of the Herods (Acts xii. 23). The half lion, half fox, as his enemies called him, the "Don Juan of politics," to quote Mommsen's happy phrase, the man who carried out a policy of "blood and iron" with a grim humor, amused himself in his last days with actors and actresses, with dabbling in poetry, and completing the *Memoirs* of his strange and eventful life.

For Sulla and his times, there is his *Life*, by Plutarch, who had his *Memoirs* for one of his authorities, and there are very numerous references to him in Cicero's writings. The best and fullest modern account of him is that of Mommsen (vol. iii. bk. iv. ch. 8, 9). (W. J. B.)

SULLY, MAXIMILIAN DE BÉTHUNE, DUKE OF (1560–1641), French statesman, was born at the château of Rosny near Mantes on 13th December, 1560. He derived his early appellation and the title of baron from the place of his birth, and was known as Rosny during the greater part of his life. Some one of his numerous enemies pretended that he did not really belong to the illustrious family represented four centuries earlier by the trouvère and warrior Quenes de Béthune, but that his race was derived from Scottish Bethunes of no mark. There is, however, no reason for giving any credit to this story. Sully was a second son; his elder brother died when but just of age, and even before this his father (if his own account may be trusted), treated Maximilian (so he himself spelt his name, and not Maximilien) as an eldest son. He was only eleven years old when his father, who was a Protestant, was presented to Henry of Navarre, and from that time he was more or less inseparably attached to the future king of France. He had a narrow escape on St. Bartholomew's Day, but he did escape, and when little more than sixteen began to take an active part in the Civil Wars. He distinguished himself not a little, especially in the character of engineer. In 1583 he married Anne de Courtenay, who, however, died in 1589, and in the intervals of war he lived the life of a country gentleman at Rosny. At the battle of Ivry, 1590, he had the good luck, though seriously wounded, to capture Mayenne's standard. As soon as Henry's power was established, Sully, who, though by no means always a complaisant or obliging servant, had been uniformly faithful, received his reward in the shape of numerous places, estates, and dignities. In 1601 he was made grand-master of the ordnance, and in 1606 duke of Sully. He was also, practically, the king's minister of finance during the greater part of his reign. After the assassination of his master he makes no further figure in history, though he survived for many years, saw the rise of a far greater minister than himself, and did not die till (less than a year before Richelieu himself died) the 22d of December, 1641, at Villebon, near Chartres.

He had married a second time, and anecdote is not complimentary to his second wife, while his daughter, who married the great duke of Rohan, also had a not unblemished reputation. Sully, however, who, though deprived of (and indeed resigning) all control of public affairs after Henry's death, retained great wealth, lived in what was almost a caricature of the stately fashions of the time, and busied himself in the composition of memoirs which are among the most curious in form, and not the least interesting in contents, of the kind. He instructed his secretaries to draw the book up in the form of an elaborate address to himself: "you then did this"; "you said as follows"; "as you have been good enough to inform us, the affair went on this wise"; and so forth. And he not only had the book executed in this extraordinary fashion, but had it read out to him. Its title is as odd as other things about it, and runs thus: *Mémoires des Sages et Royales Œconomies d'Estat, domestiques, politiques, et militaires de Henry le Grand, l'Exemplaire des Roys, le Prince des Vertus, des Armes, et des Loix, et le Père en effet de ses Peuples François. Et des servitudes utiles, obéissances convenables, et administrations loyales de Maximilian de Béthune, l'un des plus confidans, familiers, et utiles soldats et serviteurs du grand Mars des François. Dediés à la France, à tous les bons soldats, et tous peuples François.* Two folio volumes were splendidly printed, nominally at Amsterdam, but really under Sully's own eye at his château, in 1634; the other two did not appear till twenty years after his death. As his wealth, his imperious and grumbling temper, the favor which he had enjoyed and his subsequent loss of it, joined to attract odium, his character and his book were rather roughly handled in his lifetime. Marbault, secretary to Du Plessis-Mornay, Sully's chief rival, wrote a very caustic criticism of the *Memoirs*, from which, though it remained in MS. till the 19th century, Tallemant des Réaux, the insatiable scandal-monger, compiled a not unamusing but distinctly calumnious article on Sully. Most of the stories it contains may be unhesitatingly disbelieved. At the same time, Sully was by no means the ideally wise and good minister that he has not unfrequently been represented as being. He was as faithful as a dog, and as surly. He grasped wealth and place to an extent not quite compatible with the idea of pure devotion to his king or his country, and his jealousy of all other ministers and all other favorites was extravagant and unceasing. Still, there is no doubt that he was an excellent man of business; that, if not exactly what would be now called an incorruptible minister, he made no gains not sanctioned by the customs of the time, that he was inexorable in interfering with peculation and malversation on the part of others, that he opposed the ruinous personal expenditure which was the bane of almost all European monarchies in his day, and that he did much, both as a man of war and as a man of peace, to make France strong, united, and happy. His literary power, moreover, was far from small. Although the fantastic form of his *Memoirs*, after being diverting for a time, grows not a little wearisome, they have phrases and passages of great vivacity, which it is reasonable to attribute to Sully himself rather than to his spokesmen, and they show much grasp of administrative business.

The arrangement of the *Memoirs* so shocked the 18th century that in 1745 the abbé de l'Ecluse re-edited or rather rewrote them in the ordinary form of narrative. This text has of course no interest; the proper version with the commentary of Marbault may be found in the collection of Michaud and Poujoulat (vols. xvi. and xvii.).

SULMONA, or **SOLMONA**, a city of Italy, in the province of Aquila (Abruzzo Ulteriore), now reached by a branch line from the railway between Pescara and Aquila, lies, at a height of 1575 feet above the sea, at the junction of the Vella with the Gizio (a tributary of the Pescara), which supplies water-power to its paper-mills, fulling-mills, copper-works, etc. Besides its cathedral (S. Panfilo), rebuilt by Bishop Walther of Ocre (Frederick's II.'s grand chancellor) in 1119, and several times remodelled in the 15th and 16th centuries, Sulmona has in Santa Maria della Tomba a good example of pure Gothic, and in Corpus Domini a striking instance of the vagaries of Gothic in its decay. The communal buildings are half Gothic, half Renaissance. A statue of Ovid, the most celebrated native of the city (which also gave birth to Innocent VII.), stands in front of the cancellaria. In the vicinity of the town is Monte Morrone, where Celestine V. lived as a hermit and founded a monastery of "Celestines," which remained till 1870, when it was transformed into a penitentiary. The population of Sulmona was 12,594 in 1861 and 14,171 in 1881 (commune, 17,601).

Sulmo, a city of the Peligni, is first mentioned during the Second Punic War (211 B.C.). It became a Roman colony probably in the reign of Augustus, and as a municipium it continued to flourish throughout the empire. Charles V. erected it into a principality, which he bestowed on Charles Lannoy of "Pavia" celebrity. It ultimately passed to the Corno and Borghese families. The bishopric is known as that of Valva and Sulmona.

SULPHUR.[1] The sulphur minerals, which are very numerous and varied, arrange themselves under three heads,—(1) *metallic sulphates*, of which hydrated sulphate of lime, $CaSO_4 . 2H_2O$, gypsum, is the most abundant; (2) *metallic sulphides*, a numerous family, including the majority of metallic ores, of which, however, only iron pyrites serves as a source for sulphur; (3) *elementary sulphur*. In the organic world we meet with sulphur everywhere, this element forming an essential (though quantitatively subordinate) component of the albuminoids, a class of compounds contained in all vegetable and animal structures. Of organic materials rich in sulphur we may name animal hair (containing about 4 per cent.) and the essential oils of the onion, garlic, and mustard.

Elementary Sulphur.

This occurs as a mineral chiefly in the Upper Miocene deposits and in the Flötz, associated in general with gypsum, massive limestone, and marl. Commercially important deposits are found in Sicily (provinces of Caltanissetta, Girgenti, Catania), Italy (Latera and Scrofano, province of Rome), Spain (Teruel and Arcos), France (dept. Vaucluse), Transylvania, Poland (Swoszowice near Cracow), and Germany (Lüneburg, in Hanover).[2] The exhalations of volcanoes include, as a rule, sulphurous acid, SO_2, and sulphuretted hydrogen, H_2S, which two gases, if moist, readily decompose each other into water and sulphur,—a circumstance which accounts for the constant occurrence of sulphur in all volcanic districts. Mt. Purace in Colombia wears a cap of sulphur (derived from its own crater) which accumulates at the rate of about 2 feet per annum,—its superficial area amounting to 1435 square yards. The solfatara at Bahara Saphinque on the Red Sea is said to yield 600 tons of sulphur annually. The molten sulphur discharged from the crater of the Alaghez in the Armenian highlands forms solid excrescences, which the natives dislodge from their inaccessible positions by means of rifle-shots. A sulphur deposit near the Borax Lake in California is estimated to contain 20,000 tons. Most of the sulphur or brimstone of commerce comes from the rich fields of Sicily, where in 1884 the annual production had almost reached 400,000 tons. The mode of mining there adopted is by a network of horizontal galleries (tunnels) driven through the deposit; the solid squares thus marked off are hewn out, a central pillar being left to support the roof. The total excavation is generally 100 feet high and from 25 to 50 wide; not unfrequently the whole collapses. Down to a comparatively recent date all the work used to be done by hand, boys of eight to ten years of age being employed to carry the ore to the shaft and thence to the surface; only where a mine has reached a depth of 325 feet or more is water-power, if available, resorted to. Since 1868, however, the ore at Grotta Calda at least has been raised by properly constructed shafts with the help of steam-power, and this system is spreading.

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[1] This chemical element has already been treated in its scientific aspects under CHEMISTRY (vol. v. p. 431 *sq.*). The present article is intended to supplement what is there given, in the direction chiefly of practical applications.

[2] [For the sulphur mines of Iceland see vol. xii. p. 652, and of Popocatepetl see vol. xix. p. 527. Large deposits exist in S. W. Louisiana and in the Dutch West India island of Saba.—AM. ED.]

Sicilian sulphur.

The Sicilian ores are customarily classified as follows:

	Per 100 parts of ore Sulphur present.	Per 100 parts of ore Sulphur recovered.
Richest ores......	30-40	20-25
Rich ores..........	25-30	15-20
Ordinary...........	20-25	10-15

The poor yield of actual sulphur is explained by the rather primitive method used for its extraction. A semicircular or semi-elliptical pit (*calcarone*) about 33 feet in diameter and 8 deep is dug into the slope of a hill, and the sides are coated with a wall of stone. The sole consists of two halves slanting against each other, the line of intersection forming a descending gutter which runs to the outlet. This outlet having been closed by small stones and sulphate of lime cement, the pit is filled with sulphur ore, which is heaped up considerably beyond the edge of the pit and covered with a layer of burnt-out ore. In building up the heap a number of narrow vertical passages are left to afford a draught for the fire. The ore is kindled from above and the fire is so regulated (by making or unmaking air-holes in the covering) that, by the heat produced by the combustion of the least sufficient quantity of sulphur, the rest is liquefied. The molten sulphur accumulates on the sole, whence it is from time to time run out into a square stone receptacle, from which it is ladled into damp poplar-wood moulds and so brought into the shape of truncated cones weighing 110 to 130 ℔ each. These cakes are sent out into commerce. A calcarone with a capacity of 28,256 cubic feet burns for about two months, and yields about 200 tons of sulphur. The immense volumes of sulphurous acid evolved give rise to many complaints; all the minor pits suspend work during the summer to avoid destruction of the crops. A calcarone that is to be used all the year round must be at least 220 yards from any inhabited place and 110 from any field under cultivation.

The yield of sulphur, as seen from the table given above, is miserably small, but the scarcity of fuel in Sicily almost prohibits the introduction of any more rational method. As sulphur fuses at 114° C., high-pressure steam at once suggests itself as a suitable medium of heating. In the sulphur-works of Latera, in the province of Rome, the following apparatus (constructed by Gritti) is being used with success. A vertical truncated perforated cone of thick sheet-iron serves for the reception of the ore. This cone is inclosed in a similar cone of iron, which terminates in a detachable deep iron basin below, and is provided with a tightly fitting lid. All the joints in this outer shell are steam-tight. The inner cone having been charged and the lid secured, steam of sufficient pressure to insure a temperature of from 125° to 135° C. is blown into the apparatus, which soon causes the sulphur to melt and collect in the basin below. After from 30 to 50 minutes, reckoning from the time when the above temperature is reached, the operation is completed. The steam is then turned off and the sulphur made to run from the basin into a receptacle beside the apparatus, to be cast into sticks or cakes. The iron basin is then detached, and by turning aside an iron damper which held the ore in its place the exhausted ore is made to drop into a pit. Each charge of ore amounts to about from 25½ to 26½ cwts., containing about 385 ℔ of sulphur. Of this some 360 ℔ are recovered as salable sulphur, at the expense of about 286 ℔ of oak-wood as fuel.

Extraction.

R. E. Bollmann in 1867 proposed to extract the sulphur by means of bisulphide of carbon. The process, after having been tried at Bagnoli near Naples and given up as hopeless, was introduced in 1873 in Swoszowice near Cracow under the guidance of Winkler and has proved a success. The apparatus is constructed so that the bisulphide used in the process of extraction is recovered by distillation; the loss of bisulphide amounts only to one-half per cent., sometimes to less, and the sulphur produced is very pure. But by far the greater part of the purer qualities of commercial sulphur is produced from Sicilian calcarone sulphur by distillation, which removes the 3 per cent. or so of earthy impurities contained in it. The following apparatus (invented originally by Michel of Marseilles and improved subsequently by others) enables the manufacturer to produce either of two forms of "refined" sulphur which commerce demands. It consists of a stone-built chamber of about 2825 cubic feet capacity, which communicates directly with two slightly slanting tubular retorts of iron, each of which holds about 660 ℔ of sulphur. The retorts are charged with molten sulphur from an upper reservoir, which is kept at the requisite temperature by means of the lost heat of the retort fires. The chamber has a safety valve at the top of its vault, which is so balanced that the least surplus pressure from within sends it up. The first puff of sulphur vapor which enters the chamber takes fire and converts the air of the chamber into a mixture of nitrogen and sulphurous acid. The next following instalments of vapor, getting diffused throughout a large mass of relatively cold gas, condense into a kind of "snow," known in commerce and valued as "flowers of sulphur" (*flores sulphuris*). By conducting the distillation slowly, so that the temperature within the chamber remains at a sufficiently low degree, it is possible to obtain the whole of the product in the form of "flowers." If compact ("roll") sulphur is wanted the distillation is made to go on at the quickest admissible rate. The temperature of the interior of the chamber soon rises to more than the fusing-point of sulphur (114° C.), and the distillate accumulates at the bottom as a liquid, which is tapped off from time to time to be cast into the customary form of rods of about 1½ inches diameter.

In some places sulphur is extracted from iron pyrites by one of two methods. The pyrites is subjected to dry distillation from out of iron or fire-clay tubular retorts at a bright red heat. One-third of the sulphur is volatilized—$3FeS_2 = Fe_3S_4 + S_2$—and obtained as a distillate. The second method is analogous to the calcarone method of liquation; the ore is placed in a limekiln-like furnace over a mass of kindled fuel to start a partial combustion of the mineral, and the process is so regulated that, by the heat generated, the unburnt part is decomposed with elimination of sulphur, which collects in the molten state on an inverted roof-shaped sole below the furnace and is thence conducted into a cistern. Such pyrites sulphur is usually contaminated with arsenic, and consequently is of less value than Sicilian sulphur, which is characteristically free from this impurity.

Milk of sulphur.

The substance known as "milk of sulphur" (*lac sulphuris*) is very finely divided sulphur produced by the following, or some analogous, chemical process. One part of quicklime is slaked by means of 6 parts of water, and the paste produced diluted with 24 parts of water; 2.3 parts of flowers of sulphur are added; and the whole is boiled for about an hour or longer when the sulphur dissolves,—

$$3CaO + 12S = 2CaS_5 + CaS_2O_3.$$

The mixed solution of pentasulphide and thiosulphate of calcium thus produced is clarified, diluted more largely in a tub, and then mixed with enough of pure dilute hydrochloric acid to produce a feebly alkaline mixture; this shows that only the bulk of the pentasulphhide is decomposed.—$CaS_5 + 2HCl = CaCl_2 + H_2S +$ (4S of precipitated sulphur. The addition of more acid would produce an additional supply of sulphur (by the action of the $H_2S_2O_3$ on the dissolved H_2S); but this thiosulphate sulphur is yellow and compact, while the CaS_5 part has the desired qualities, forming an extremely fine, almost white, powder. The precipitate is washed, collected, and dried at a very moderate heat. It is used as a medicine. If sulphuric acid is used instead of hydrochloric acid the preparation is apt to be contaminated with hydrated sulphate of lime. In the United Kingdom, indeed, precipitated sulphate of lime used to be added intentionally to produce what the public had got accustomed to; but this practice has been rightly stopped by the authorities.

Production and uses.

During the year 1875 the production of sulphur in Europe is stated to have been as follows:

	Tons.
Italy	360,000
Spain	4,000
Austria-Hungary	3,730
German empire (including 5000 tons of regenerated[1] sulphur)	14,520
Belgium	450
Total	382,700

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[1] See SODIUM, "Le Blanc process for making soda-ash," p. [illegible] above.

By far the greater part of all the sulphur produced in Sicily and elsewhere is used for the manufacture of sulphuric acid. Subjoined is an enumeration of some other applications. (1) The manufacture of gunpowder (see vol. xi. p. 286). (2) The taking of casts. (3) The making of cements: (*a*) a mixture of molten sulphur and ferric oxide is used to cement the isolating bells to telegraph posts; (*b*) a mixture of iron filings (100), flowers of sulphur (3 to 20), and sal-ammoniac (3 to 5) made into paste with water is used to cement iron bars (fences, etc.) into stone sockets; (*c*) a mixture of molten sulphur with powdered quartz or glass has been recommended as an acid-proof material for sulphuric acid chambers; (*d*) a mixture produced by the incorporation of powdered quartz and coloring matters, such as vermilion, etc., with molten sulphur is employed for ornamental articles. (4) The vulcanization of india-rubber (see vol. xii. p. 882 *sq.*). (5) Dusting vine-plants with flowers of sulphur is said to keep off the fungus *Oidium Tuckeri*, which has caused such devastation in the vineyards in France and elsewhere.

Sulphur Compounds.

Sulphuretted hydrogen.

Sulphuretted hydrogen, H_2S (see CHEMISTRY, vol. v. p. 433 *sq.*), is used largely as such, or as sulphide of ammonium, $(NH_4)_2S = 2NH_3 + H_2S$, for the detection, discrimination, and separation of metals. To give an example: the least quantity of lead dissolved in water as (say) nitrate can be detected by the addition of sulphuretted hydrogen, which brings down the lead as a black precipitate of sulphide of lead,—$Pb(NO_3)_2 + H_2S = PbS + 2HNO_3$. The presence of a moderate quantity of mineral acid in the original solution does not interfere with the test. What we said of solution of salts of lead holds substantially of those of the following groups of metals. The formulæ and the colors of the sulphides are given in brackets. A. Lead (black, PbS), silver (black, Ag_2S), mercury as mercurous or mercuric salt (black, $HgS + Hg$ or HgS respectively), copper (greenish black, CuS), bismuth (brown, Bi_2S_3), cadmium (yellow, CdS). B. Arsenic (yellow, As_2S_3), antimony (orange-red, Sb_2S_3), tin as stannic salt (yellow, SnS_2). The sulphides A are insoluble; the sulphides B are soluble in sulphide of ammonium solution, and the latter, from this solution, can be reprecipitated by acidification with dilute sulphuric or hydrochloric acid. The brown SnS precipitated from stannous salts is insoluble in the (colorless) solution of $(NH_4)_2S$, but soluble in the yellow solution of the polysulphide $(NH_4)_2S_2$, as SnS_2. C. The following metals are not precipitated from their salt solutions if these are acidified sufficiently by added mineral acid; but they are precipitated from their neutral or alkaline solutions by sulphide of ammonium: iron (black, FeS), nickel (black, NiS), cobalt (black, CoS), manganese (flesh-colored, MnS), zinc (white, ZnS). Aluminium and chromium, given as salts of their oxides, R_2O_3, are precipitated by sulphide of ammonium as hydrated oxides ($Al_2O_3 . xH_2O$, colorless; $Cr_2O_3,. xH_2O$, green or violet). The reagent acts on these as ammonia, NH_3, the H_2S being liberated, and behaves in a similar way to acid solutions of certain salts, *e.g.*, the phosphates, of the following group D, these salts, *e.g.*, $Ca_3P_2O_8$, being precipitated as such. The ordinary salts of group D (barium, strontium, calcium, magnesium), and the salts of the alkali metals E (potassium, sodium, etc.) generally, give no precipitate with either sulphuretted hydrogen or sulphide of ammonium. It is easy to translate what we have stated into a method for the separation of groups A, B, C (D and E), from one another.

Chlorides.

Of the three chlorides treated of in CHEMISTRY (vol. v. p. 434) only the lowest, S_2Cl_2, is of industrial importance. It is prepared by passing perfectly dry chlorine gas over heated sulphur contained in a retort, the retort being connected with a condenser constructed so that the uncondensed vapors are led away into the chimney. The two elements unite readily, and chloride of sulphur, S_2Cl_2, distils over, contaminated, however, by more or less of surplus chlorine present as higher chlorides. To remove (or decompose) these the crude product is subjected to fractional distillation; the thermometer rises rapidly and soon becomes constant (at about 136° under 758 mm. pressure). What afterwards distils over, at the constant boiling-point, is collected as pure S_2Cl_2,—a yellowish red liquid of 1.68 sp. gr. at 16.7° C. and 1.7055 at 0° (Kopp), which emits fumes of hydrochloric acid in moist air. Its smell is characteristic and unpleasant. Chloride of sulphur is decomposed by water, alcohol, ether (see CHEMISTRY); and benzol and bisulphide of carbon mix with it in all proportions without decomposition. A mixture of 100 parts of bisulphide of carbon and some 2.5 of chloride of sulphur is used for the vulcanization of (chiefly sheet) india-rubber. The mixture is readily imbibed by the rubber, which when allowed to dry (at from 22° to 25° C.) gives up the bisulphide of carbon and the chlorine of the reagent, the latter as HCl, but retains its sulphur in a state of chemical combination.

Sulphurous acid.

The gas SO_2 (see CHEMISTRY, vol. v. p. 435), produced extempore by the combustion of sulphur, is used for the bleaching of silk, wool, straw, and wickerwork, also for the disinfection of rooms and of wine-casks (to prevent acetous fermentation). A solution of the gas in water is manufactured industrially, for use chiefly in the manufacture of sugar. It is added to the beetroot or cane juice to prevent its fermentation while awaiting concentration. A solution of "bisulphite of lime" (produced by saturating milk of lime with sulphurous acid gas) is much used as an antiseptic generally. Liquefied sulphur dioxide has found an application as a frigorific for the manufacture of ice. The apparatus used is so constructed that the volatilized sulphur dioxide is all caught and recondensed. Sulphurous acid when required as such or for the making of sulphites is always produced, even industrially, from oil of vitriol, by reduction with either sulphur or charcoal. In the heat the reactions are $2SO_3 + S = 3SO_2$ and $2SO_3 + C = CO_2 + 2SO_2$ respectively, and either can be (and is) executed practically in cast-iron vessels. The presence of carbonic acid in the gas produced by the charcoal process does not interfere with the preparation of sulphites.

Thiosulphates.

The soda salt $Na_2S_2O_3 + 5H_2O$, known commercially as hyposulphite of soda, is used industrially for chiefly two purposes, namely, (1) as a solvent for chloride of silver in photography (see PHOTOGRAPHY),—$AgCl + Na_2S_2O_3 = NaCl + AgNaS_2O_3$,—and (2) as an "antichlor" in paper-making, to destroy the remnants of chlorine in bleached paper pulp. To understand its action we need only know that chlorine and water in such cases act like oxygen,—$Cl_2 + H_2O = 2HCl + O$; every 4 × O thus produced converts one S_2O_2 of $Na_2OS_2O_2$ into $2SO_3$ of sulphuric acid. For the preparation of this salt a great many methods have been invented. The simplest to explain is the treatment of a solution of normal sulphite of sodium with sulphur,—$SO_3Na_2 + S = S_2O_3Na_2$. Instead of adding free sulphur, Liebig prepares a solution of polysulphide of sodium (by dissolving sulphur in caustic-soda ley) and adds it to the sulphite. The surplus sulphur combines with the sulphite; besides, the polysulphide contains thiosulphate from the first. Another method is to pass sulphurous acid through a solution of sulphide of sodium. Here, by first intention, if we may say so, sulphite of sodium and H_2S are produced; but the H_2S and the excess of SO_2 give water and sulphur, and two-thirds of this sulphur unite with the sulphite first formed into thiosulphate. The crude sulphide of calcium, which is produced so largely in the Le Blanc process (see SODIUM, *supra*, p. 256), when exposed to the air gets oxidized, with formation of calcium thiosulphate, which can be extracted by means of water and converted into sodium salt by double decomposition with carbonate or sulphate of soda. Pure thiosulphate of soda forms large transparent monoclinic prisms, which lose no water on exposure to ordinary air in the cold. At about 48° C. they fuse into a liquid, which may remain liquid on cooling, but solidifies suddenly when a fragment of the solid salt is dropped in. 100 parts of water dissolve

at 16°	25°	35°	45° C.
65	75	89	109 parts of the salt (Mulder).

The solution is not subject to oxidation in the air.

Sulphuric acid.

The anhydride SO_3 is used largely in the manufacture of tar colors. Oil of vitriol is decomposed by dropping it on a mass of platinum scrap kept at a bright red heat within a fireclay retort,—$SO_4H_2 = H_2O + SO_2 + \frac{1}{2}O_2$; and after removing the water —the bulk by partial condensation and the rest by means of vitriol—the sulphur dioxide and the oxygen are made to recombine by passing them over platinized asbestos at a dull red heat. The fumes of SO_3 formed are condensed in a dry receiver by application of cold from without (Winkler's process).

The fact that finely divided platinum, in virtue of its power of condensing oxygen, induces the union of SO_2 and $\frac{1}{2}O_2$ into SO_3 has been known for a long time; but all attempts to utilize the reaction for the production of sulphuric acid from a mixture of sulphur dioxide, air, and nitrogen produced by the combustion of sulphur or pyrites in air have failed. The platinum acts too feebly in the presence of the unavoidably large mass of nitrogen, and soon loses its efficacy altogether owing to the accumulation on it of particles of incombustible matter from the kiln gases. Oxide of chromium, Cr_2O_3, and oxide of iron, Fe_2O_3, act like platinum, through transitory formation of the respective sulphates—the gases produced in pyrites kilns include a considerable quantity of ready-made SO_3—but they also are not available practically for the making of sulphuric acid. In short, all attempts to produce this reagent otherwise than by means of the old Nordhausen or the chamber process have so far been unqualified failures industrially.

Chamber process of production.

In regard to the chamber process we may add a few notes to what has been said under CHEMISTRY (vol. v. p. 436 *sq.*). As stated in that article, nitrous acid, N_2O_3, when brought into contact with sufficiently strong vitriol unites with it, giving rise to bodies similar to chamber crystals,—

$$N_2O_3 + H_2O + 2SO_3 = 2SO_2{}^{OH}_{NO_2}$$

or, what comes practically to the same,

$$N_2O_3 + SO_3(\text{out of the vitriol}) = SO_2{}^{NO_2}_{NO_3}.$$

In the presence of sufficient water this union does not take place, because the water causes the product to break up as shown by the equation if read from right to left. These facts explain why a stronger acid than one containing some 60 per cent. or so of real H_2SO_4 cannot be produced directly in the chamber. This inconvenience has led, in the hands of Gay-Lussac, to an important improvement on the original process. He inserts between the chamber outlet and the chimney a tower made of acid-proof stone and filled with pieces of coke, over which concentrated oil of vitriol is made to trickle down while the chamber gases ascend through the tower on their way to the chimney. The vitriol absorbs all or most of the N_2O_3, which would otherwise be lost. But the practical reliberation of the N_2O_3 was beset with very great difficulties, which have been fully overcome only by a more recent invention of Glover's. He places between the kiln and the entrance side of the chamber a tower similar in construction to Gay-Lussac's, which the kiln gases have to traverse before they get into the latter. Through the tower he runs at the same time a stream of nitrated (Gay-Lussac) acid and one of ordinary chamber acid. The latter acts on the nitrated acid as water; at least it virtually sets free the combined nitrous acid, so that it is reduced by the sulphurous acid coming from the kiln to nitric oxide, which travels into the chamber with the rest of the gases to do duty there in the well-known manner. As the kiln gases are very hot, a considerable quantity of the water which goes through a Glover tower (as chamber acid) is volatilized and thus made to supply part of the steam necessary for the process. The Glover tower, besides fulfilling its primary object, serves to concentrate part of the chamber acid and to supply part of the necessary steam without expense for fuel. The expenditure of nitrate of soda, which before the introduction of the two towers used to amount to from 8 to 13 parts per 100 of sulphur burned, has been reduced to from 3.5 to 6.5. The actual loss of nitrous acid of course is the less, *cæteris paribus*, the larger the chamber, and (for a given chamber) the greater the care with which the process is conducted. But even under the most skilful management more nitrous acid is lost than can be accounted for by the unavoidable imperfections in the apparatus and in the mode of working them. From the investigations of Weber and of Frémy it appears that, in the presence of relatively much water more especially, part of the nitrous acid suffers reduction, not to nitric, but to nitrous oxide, N_2O, which, being unsusceptible of direct oxidation, is lost for the process.

Production of strong acid.

For a great many purposes (*e.g.*, the manufacture of "superphosphate" from bones or mineral phosphate of lime) the 60 to 64 per cent. acid which comes out of the chamber can be used as it is; but it is not strong enough for all purposes. In the production of stronger (from chamber) acid the first step always is to run the acid into long, very shallow lead pans and to simply boil it down in these, either by the application of heat from below, in which case the bottoms of the pans must be protected by making them rest on plates of iron, or by inclosing the pans in a vault and causing the hot gases of a furnace fire to strike along the surface of the acid. The result in either case is that, while more and more water goes away as steam, the residual acid of course gets stronger and stronger. But with the strength the boiling-point rises, and, as necessary consequences, the extent to which the acid attacks the lead (with formation of sulphate and sulphurous acid) and the danger of melting down the pans by local overheating become greater and greater. When the acid has come up to about from 78 to 80 per cent. (corresponding to a specific gravity of 1.7 after cooling), it is not safe to push the concentration any further, quite apart from the fact that an acid of 80 per cent. when boiled down emits a very appreciable proportion of acid along with the volatilized water. An acid of 1.7 indeed is amply strong enough for a variety of applications, such as, for instance, the conversion of salt into sulphate. If a stronger acid is wanted the concentration must be continued in glass or platinum retorts.

Vitriol maker's glass retort.

The vitriol maker's glass retort, as a rule, consists of two detachable parts, namely, a pear-shaped body about 3½ feet high and nearly 2 feet in diameter and a glass alembic whose wider end fits the mouth of the pear, while its narrower outlet end points downwards and terminates within a slightly slanting lead-pipe, which conveys the distillate to a leaden tank. The retort rests on a layer of sand contained in a closely fitting iron basin, and the lateral space between the two is filled completely with sand. The iron basin is suspended within a furnace in such a way that only it, and not any part of the retort, is touched directly by the flame. As a rule, some twelve retorts stand side by side, each in its own sandbath, and are heated by the same fire. As the temperature of the boiling liquid and of the vapor rises at the end to beyond 300° C., a sudden draught of cold air might cause a rupture of a retort; the apparatus is, therefore, placed in a special room accessible only through double doors, and the inner door is not permitted to be opened before the outer has been shut. The acid, as it is boiling down, gets stronger and stronger, because, although the vapor is very strongly acid from the first, its percentage p' of real H_2SO_4 at any given stage is less than the value p, which obtains in the boiling liquid as it is at the time. p' at a given barometric pressure is a fixed function of p only, and increases as p increases; the difference $p - p'$ accordingly gets less and less. It becomes nil, not when the acid has become pure H_2SO_4, but when it has come up to the composition $12SO_3 + 13H_2O$ (Marignac). This particular hydrate only boils without change of composition; even pure H_2SO_4 when distilled, by giving up more than $1SO_3$ for $1H_2O$, becomes reduced to that hydrate $12SO_3 + 13H_2O$, which then boils without further change of composition. A stronger acid than "Marignac," as we may call it, cannot be produced by the concentration of weaker acid, and even its production (from 1.7 acid) involves a very considerable loss of acid as distillate. Hence practically the process is stopped when the acid in the retorts has come up to some 96 per cent. of H_2SO_4, which is ascertained by the specific gravity of the last runnings being at a certain value. As soon as this point is reached the retorts are allowed to cool till the contents can be withdrawn with safety by means of lead siphons into glass carboys. This, however, means a considerable loss of time and fuel; besides, the process of distilling from out of glass vessels is not free from danger, and for these reasons it is preferred in many establishments to concentrate the pan acid in large platinum stills, although these are extremely expensive. The great advantage of the platinum still is that it admits of continuous working; while pan acid (containing say 1 ℔ of water per N ℔ of full strength—96 per cent. or so—acid) runs in, and a far weaker acid (containing for the same period of time 1 ℔ of water and n ℔ of full strength acid) is distilling over, the balance $N - n$ ℔ of finished acid is being withdrawn by means of a platinum siphon. The outer limb of the siphon in its middle portion divides into a system of four narrower tubes and is cooled down by means of a cold-water jacket surrounding it, so that the acid can be run directly into carboys.

Platinum retort.

The platinum retort in its latest form has a large undulating bottom made of strong metal, on which a rapidly converging low body joins, made of thinner metal because it is not so directly exposed to the flame. Along with this still a flat platinum pan is used with an undulating bottom similar to that of the still for the preliminary concentration of the acid. As platinum is not liable to fuse or be attacked by any strength of boiling acid, a relatively small platinum pan does as much work as a far larger one made of lead.

Sulphates.

Several of these are treated of under the heads of the respective bases. Thus, for the sulphates of ammonia, see NITROGEN, vol. xvii. p. 530 *sq.*; for POTASSIUM and SODIUM, see these articles; for calcium, see LIME (vol. xiv. p. 654) and GYPSUM (vol. xi. p. 313); for barium, see BARYTES (vol. iii. p. 350); for magnesium, see EPSOM SALTS (vol. viii. p. 440) and MAGNESIUM (vol. xv. p. 219); and for iron, see COPPERAS (vol. vi. p. 312).

Sulphate of aluminium.

Sulphate of aluminium, $Al_2(SO_4)_3 + 18H_2O$, the active ingredient of ALUM (vol. i. p. 566), is now being produced industrially in a state of perfect freedom from iron, and is more and more taking the place of alum. Paper-makers, at least, no longer use anything else for the production of alumina soap, which in machine-made paper serves as the principal ingredient of the size. The crude salt is easily produced by treatment of relatively pure bauxite (native hydrated alumina) or china clay with chamber acid at a suitable temperature. The resulting mass is dissolved in water, the undissolved matter (silica, etc.) allowed to settle, the clear liquor drawn off, and from it an apology for what is wanted is obtained by evaporation to a small volume and allowing to crystallize. But the salt thus obtained is always contaminated with a variety of foreign sulphates, including sulphate of iron, and this last-named impurity, for the majority of applications, cannot be suffered to remain. One of the best methods for its removal, if not the best, is that discovered by Semper and Fahlberg: the solution, which must contain all its iron as ferric salt and contain somewhat less than the normal proportion of sulphuric acid, is digested with hydrated binoxide of lead. In the course of about a week all the iron is completely precipitated. The better qualities of sulphate of alumina nowadays have at most only a few thousandths per cent. of iron.

Sulphate of copper.

Sulphate of copper (blue vitriol) is made technically in chiefly two ways. One method is to heat metallic copper to redness in air until it is almost completely oxidized, and to dissolve the oxide by means of dilute sulphuric acid. The Cu_2O present behaves like a mixture of metal and CuO. Another process starts from the sub-sulphide Cu_2S (produced metallurgically as "mat," or perhaps expressly from its elements), and converts this into sulphate and oxide by careful roasting. The product is dissolved in dilute sulphuric acid. Large quantities of blue vitriol are produced incidentally in the "parting" of auriferous silver (see GOLD, vol. x. p. 666) by means of oil of vitriol. Sulphate of copper crystallizes from its aqueous solution in large transparent blue crystals of the triclinic system; their composition is $CuSO_4 5H_2O$. The crystals are stable in the air. At 100° C. they lose $4H_2O$, the last H_2O requiring a temperature of 200° C. for its expulsion. The anhydrous salt is dirty white; it readily reunites with water, and consequently is available as a dehydrating agent, for instance, for the preparation of absolute alcohol from spirit of wine. 100 parts of water dissolve

at 0°	10°	20°	50°	100° C.
31.6	37.0	42.3	65.8	203.3 parts of crystallized salt (Poggiale).

The salt is insoluble in alcohol. Blue vitriol is used largely in electrotyping and for many other purposes.

Analysis.

Subjoined are two general tests for sulphur. (1) All sulphur compounds when brought in contact at a red heat with a mixture of nitre and carbonate of soda (or some other equivalent alkaline oxidizing mixture) are changed so that the sulphur assumes the form of alkaline sulphate, which can be extracted by means of water. From the (filtered) solution the SO_4 is precipitated by addition of chloride of barium as $BaSO_4$—a white powdery precipitate characteristically insoluble in water and in dilute acids. (2) Any non-volatile sulphur compound, when heated on charcoal in a reducing flame with carbonate of soda, yields sulphide of sodium ("hepar") which, when moistened with water on a silver coin, produces a black stain of metallic sulphide. (Compare SELENIUM, vol. xxi. pp. 663–4.) (W. D.)

SULPICIUS SEVERUS. See SEVERUS.

SULTÁNPUR, or SULTANPOOR, a district of British India, in the Rái Bareli (Roy Bareilly) division of Oudh, under the jurisdiction of the lieutenant-governor of the Northwestern Provinces, lying between 26° 39′ and 27° 58′ N. lat. and 81° 36′ and 82° 44′ E. long. With an area of 1707 square miles, it is bounded on the N. by Faizábád, on the E. by Jaunpur, on the S. by Partábgarh, and on the W. by Rái Bareli. The surface of the district is generally level, being broken only by ravines in the neighborhood of the rivers by which its drainage is effected. The central portion of the district is highly cultivated, while in the south are widespread arid plains and swampy jhils and marshes. The principal river is the Gumti, which passes through the centre of Sultánpur and affords a valuable highway for commerce. Minor streams are the Kándu, Píli, Tengha, and Nandhia, the last two being of some importance, as their channels are deep, though narrow, and form the outlet for the superfluous water of the extensive series of jhils. There are no forests in the district, the only tree-covered tracts being stunted *dhák* jungles used for fuel. Wild animals are very few, chiefly wolves, nylghau, and wild hog. There are some good roads in the district, chief of which is the imperial high road from Faizábád to Allahábád, which intersects it from north to south. The Oudh and Rohilkhand Railway traverses the district for a few miles in the extreme east. The climate is considered mild, temperate, and healthy; the average annual rainfall is about 46 inches.

The population, according to the census of 1881, was 957,912 (males 475,125, females 482,787), of whom 856,329 were Hindus and 101,524 Mohammedans. The only town with a population exceeding 5000 is Sultánpur, the administrative headquarters of the district, which is situated on the right bank of the Gumti, and in 1881 contained 9374 inhabitants. Of the total area 571,795 acres were returned as cultivated in 1884-85 and 368,911 as cultivable; the total area under crops in the same year was 672,058 acres, wheat and rice being the principal products. The trade of the district deals principally with grain, cotton, molasses, and native cloth, and its manufactures—which, however, are unimportant—comprise coarse cotton cloth, brass vessels and other metal work, sugar, and indigo. The only incident worthy of note in the history of the district since the British annexation of Oudh is the revolt of the native troops stationed at Sultánpur during the mutiny. The troops rose in rebellion on 9th June, 1857, and, after firing on and murdering two of their officers, sacked the station. Upon the restoration of order Sultánpur cantonment was strengthened by a detachment of British troops; but in 1861 it was entirely abandoned as a military station.

SULU ISLANDS. See PHILIPPINES, vol. xviii. p. 766.

SUMACH. See LEATHER, vol. xiv. p. 382.

Plate IX.

SUMATRA, in Malay called *Pulu Partcha* or *Indalas*, is one of the largest and most important islands of the East Indian Archipelago. It stretches from northwest to southeast to a distance of 1047 miles,—Tandjong Batu, the northmost point, being situated in 5° 40′ N. lat. and the southmost in 5° 59′ S. lat. The greatest breadth is about 230 miles. In area it is estimated that Sumatra, with its 170,744 square miles,[1] is thirteen times the size of Holland, of which country the island is in large measure a dependency. The northern half runs obliquely parallel to the Malay Peninsula, from which it is separated by the Strait of Malacca, and the southern end is separated by the narrow Sunda Strait from Java. Unlike Java, Sumatra has a series of considerable islands (Nias Islands, Mentawei Islands, etc.) arranged like outworks in front of the coast that faces the open Indian Ocean. The general physical features of the island are simple and striking: a range of lofty mountains extends throughout its whole length, their western slopes descending rapidly towards the ocean and their eastern looking out over a vast alluvial tract of unusual uniformity. This mountain range is known as Bukit Barisan or Chain Mountain. It varies in average height from 1500 to 6000 feet, and consists of three or four ridges separated by plateau-like valleys. Among its more remarkable summits are Ya Mura or Gold Mountain, near the north end (6879 feet); Seret Berapi or Merapi (5857 feet), in 0° 44′ N. lat.; Pasaman or Mount Ophir (10,866); Merapi (9563); Indrapura, in 1° 36′ S. lat. (11,800), which has the reputation of being the culminating point of the whole island; Dempo (10,000); and Abong Abong (10,000). The summit of Indrapura was reached by the Central Sumatran Expedition of 1877–79. Towards the north end of the island the spurs of the main chain sometimes extend towards the neighborhood of the east coast. Owing to this configuration of the island, the water-courses of the western side are comparatively short; only very few of them are large enough to be navigable. Those of the eastern slope, on the other hand—such as the Tamiang, the Simpang, the Asahan, the Kubu, the Siak, the Indragiri, the Jambi, the Kampas, the Palembang—are longer, and can not unfrequently carry vessels of considerable burden. In their lower courses they form enormous inosculating deltas. The mountainous regions contain numerous lakes, many of them evidently the craters of extinct volcanoes. When, as sometimes happens, two or three of these craters have merged into one, the lake attains a great size. Amongst the larger lakes may be mentioned the Tao Silalahi, with its offshoots Tao Muara and Tao Balige; Manindji, to the west of Fort de Kock; Sinkarah, southeast of Fort de Kock; Korintji, inland from Indrapura; Ranau, inland from Tampah; and the lake of the X. Kotas, in the Padang Highlands.

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[1] The triangulation of Sumatra was commenced in June, 1883, by the measurement of a base line 4857 metres (nearly 3¼ miles) long in the neighborhood of Padang.

Volcanoes.—Sumatra still possesses several centres of volcanic eruption, and in 1883 its southern extremity shared with Java in the disasters of the Krakatoa outbreak. Indrapura sends up from time to time heavy columns of smoke. Merapi,[1] the most active of the volcanoes in the island, was in full eruption in the years 1807, 1822, 1834, 1845, 1863–64, and 1872. Mt. Talang in the Padang Highlands, also has three craters one of which is filled with molten sulphur. Junghuhn registered sixteen Sumatran volcanoes, and others have since been discovered.

Geology.—A large part of The Sumatran highlands consists of very old (probably Silurian or Devonian) slates and clay schists, combined with hornblende talc and other schists, and traversed by veins of quartz. Granite also plays a considerable part, though it does not come so much to the surface. Carboniferous rocks (marls, sandstones, limestones, etc.) are in some places well developed. Between the Carboniferous period and the Tertiary there is a great blank all through the island. Augite-andesite of late Eocene origin has greatly modified the surface of the country, and constitutes, *inter alia*, the main part of the Barisan range.[2] The Tertiary formation is strongly developed in four different divisions. They are usually considered to be Eocene; but this determination rests on badly preserved fossils. The oldest or breccia division consists of débris of carboniferous limestone, syenites, and granites, sometimes in the form of breccia proper, sometimes in that of sandstones or marl clays. The fish remains found in the marls have led some palæontologists to assign a greater antiquity than that of Eocene to these strata, while others, again, consider them to be Miocene. Above this division (apparently absent in south Sumatra) comes the second of sandstones, clay rocks, coal beds, and coal. The coal appears to be the result of a vegetation which grew *in situ*. Above the coal is sandstone, sometimes 1000 feet thick. The third division consists of marly sandstones of evidently marine origin; it is well developed in west Sumatra, but is absent from the south of the island. The fourth division is a limestone, rich in remains of corals, molluscs, echinids, and especially in *Orbitoides*; it is well developed both in the west and in the south. Miocene deposits are more abundant in the south than in the west. At Lubu Lintang in the Benkulen residency the Ebuma fossils are characteristic.[3]

Minerals.—Sumatra possesses various kinds of mineral wealth. Gold occurs in the central regions; gold mines have long been worked in Menangkabau and the interior of Padang, and gold-washing is carried on in several of the streams. Tin, which forms the staple of the neighboring island of Bangka or BANCA (*q.v.*), is found more especially in Siak and the "division" of the L. Kotas. Copper mines are worked in the Padang Highlands (most largely in the district of Lake Sinkarah) and at Muki in Achin. Iron is not unfrequent, and magnetic iron is obtained at the "Iron Mountain" near Fort van der Capellen (Tanah Datar). Coal seams exist in the Malabuh valley (Achin),[4] in the Sinamu valley, and on both sides of the Ombilin (Umbilin) river; the Ombilin field was brought into notice more especially by Mr. D. D. Veth of the 1877–79 expedition. Lignite of good quality is found in several localities. Oil wells are worked at Langkat and other places; and arsenic, saltpetre, alum, naphtha, and sulphur may be collected in the volcanic districts.

Administrative Divisions.—The process by which the Dutch have advanced to their present position in Sumatra has been a very gradual one, and even yet, though their supremacy is effective all round the coast, much of the interior remains practically unpossessed. The following are the more important political subdivisions of the country.

A. The Dutch government of the West Coast (area 46,212 square miles), extending along the shore of the Indian Ocean from Trumon, 2° 53′ N. lat. to the Mandjuta, 2° 25′ S. lat., comprises the residencies Padang, Tapanuli, and the Padang Highlands (*Padangsche Bovenlanden*). The governor of the whole government has his residence at Padang. The residency of Padang is bounded south by Benkulen and north by Tapanuli. It contains a large number of separate districts, mostly corresponding to natural divisions formed by mountain-spurs or river valleys. Among the rest are Indrapura, Tapan, Lunang, and Silaut, which form the regency of Indrapura, and are the remains of the ancient kingdom of that name. Administratively Padang is divided into Ayer Bangis and Rau, Priaman, Padang, Painan. The headquarters of Ayer Bangis and Rau is Talu, to the north of Mt. Ophir. Ayer Bangis itself is on the coast, and has a good roadstead on one of the islands that protect its bay. At Rau is the Dutch fort of Amerongen, and to the northwest the old fort of Balong or Sevenhoven. Padang is a town of some 2000 houses and 15,000 inhabitants, with a Chinese settlement and a European quarter. It is the chief market in Sumatra for gold. Indrapura lies about 8 miles up the river of its own name, and is now only an unimportant village of bamboo huts. The residency of Tapanuli is divided into Siboga (which includes the Nias Islands), Natal, Mandeling and Angkola, Padang Lawas. The town of Siboga has considerable commercial importance, the bay on which it stands being one of the finest in all Sumatra. Tapanuli, the ancient capital, and Sinkil, a commercial town, also deserve to be mentioned. In Natal (properly Natar) the leading places are Jambur, Sinkuang, and Natar. Padang Sidempuan, the chief town of Mandeling and Angkola, lies to the south of Mt. Lubu Raya. Fort Elout was formerly the military centre in Great Mandeling. The residency of the Padang Highlands lies east of Padang proper. The whole surface is mountainous, and the natural districts are very numerous. Agam, Batipu and the X. Kotas,[5] the L. Kotas, Tanah Datar, and the XIII. and IX. Kotas form the five administrative divisions. Bukit Tinggi, or, as it is usually called Fort de Kock, is the capital of the residency; other places of note are Bondjol, Padang Pandjang Payakombo, Fort van der Capellen, Pagar Rujung (the residence of the last prince of Menangkabau), Priyangan (the remains of another capital of Menangkabau), Sinkarah, and Sōlok. To the government of the West Coast belong the following islands: Banyak Islands, a small limestone group, well wooded and sparsely peopled; Nias Islands, with an area of 2523 square miles; Batu Islands (Pulu Pingi, Pulu Baai, Tanah Masa, Tanah Balla, etc.; area 630 square miles); Mentawei and Pageh or Nassau Islands (area 4200 square miles); Engano (area 360 square miles), annexed by Holland in 1863 and seldom visited. The Nias Islands are a very interesting group (see Dr. Schreiber in *Petermann's Mittheil.*, 1881). There are no volcanoes, but earthquakes are very frequent. In

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[1] For an account of changes in the principal crater see Verbeek's paper in *Natuurk. Tidschr. van Ned. Indië*, 1885.

[2] For the geology see R. D. M. Verbeek, *Die Tertiärformation von Sumatra und ihren Thierresten*; "Topographische en Geologische Beschrijving van Zuid-Sumatra" in *Jaarboek van het Mijnwezen in Ned. Indië*, 1881, pl. 1.; and short papers in *Geol. Mag.*, 1877, 1878, etc. See also the 2d part of *Midden-Sumatra*, by D. D. Veth, 1882.

[3] Full details and a geological bibliography will be found in H. van Cappelle, *Het Karakter van de Nederlandsch-Indische Tertiaire Fauna*, Sneek, 1885.

[4] See *Indische Gids*, 1880, paper and map.

[5] "Kota" means settlement or township, and a great many of the districts are named from the number of kotas they contain: thus in Agam we have the VII. Kotas, the VIII. Kotas, etc.

the north the villages are merely perched on steep hills reached by ladders; in the south they are larger and occupy low-lying sites.

B. The residency of Benkulen or Bencoolen (*i.e.*, Bang Kulon, "west coast") lies along the west coast from the Mandjuta to the south end of Sumatra. It is divided into eight districts: Mokko-Mokko, Lais or Sungei Lama; the district (*ommelanden*) of Benkulen; the capital Benkulen; Seluma; Mana and Pasumah Ulu Mana; Kauer; and lastly Kru. Among the noteworthy places are Mokko-Mokko, with the old English fort Anna; Bantal; Lais (Laye), the former seat of the English resident; and Benkulen, the capital, with 12,000 inhabitants, Fort Marlborough, and a Chinese kampong (see Bencoolen).

C. The residency of the Lampong districts, separated from Palembang by the Masudji river, is partly mountainous (Lampong Peak 6800 feet), partly so flat as to be under water in the rainy season. It is divided into the districts of Telok Betong, Tulang Bawang, Seputih, Sekampong, Katimbang, and Semangka. The more important places are Telok Betong, chief town of the residency, Menggala (with a good trade), Gunung Sugi, Sukadana, Tandjong Karang, Beniawang.

D. The residency of Palembang consists of the former kingdom of this name, various districts more or less dependent on that monarchy, and (since 1839) the kingdom of Jambi. With the exclusion of this last it is divided into the administrative districts of Palembang; Tebing Tinggi; Lematang Ulu, Lematang Ilir, and the Pasumah country; Komering Ulu, Ogan Ulu, Inim, and the Ranau districts; Musi Ilir; Ogan Ilir, Komering Ilir, and Blidah; and Iliran and Banyu Asin. In the kingdom of Jambi the government is left in the hands of the native chief. The town of Palembang is a large place of 50,000 inhabitants (2500 Chinese), with extensive barracks, hospitals, etc., a mosque (1740), considered the finest in the Dutch Indies, and a traditional tomb of Alexander the Great. A good description of the town and its river approaches is given by Mr. Forbes.

E. The kingdom of Indragiri (along with Kwanten and the districts of Reteh and Mandah) is administratively subject to the residency of Riouw.

F. The residency of the East Coast was formed in 1873 of the territory of Siak and its dependencies and the state of Kampar. It consists of five divisions,—the island Bengkalis, Siak proper, Labuan Batu, Asahan, Deli. The island has an area of 529 square miles and a population of 5000. Deli is the most important part of the residency,—having been since 1870 the seat of the Amsterdam Deli Company, engaged in growing tobacco, coffee, etc.

G. In 1878 the Achin (Atjeh) kingdom was turned into a Dutch government, but the greater part of the territory is still but little known. Compare Achin, vol. i. p. 90 *sq.*

Flora.—Though Sumatra is separated from Java by so narrow a strait, the botanist at once finds that he has broken new ground when he crosses to the northern island, and the farther he advances inward the more striking becomes the originality of the flora. The alang fields, which play a great part in Java, have even a wider range in Sumatra, descending to within 700 or 800 feet of sea-level; wherever a space in the forest is cleared this aggressive grass begins to take possession of the soil, and if once it be fully rooted the woodland has great difficulty in re-establishing itself. Among the orders more strongly represented in Sumatra than in Java are the *Dipterocarpaceæ*, *Chrysobalanceæ*, sclerocarp *Myrtaceæ*, *Melastomaceæ*, Begonias, *Nepenthes*, *Oxalidaceæ*, *Myristicaceæ*, *Ternströmiaceæ*, *Connaraceæ*, *Amyridaceæ*, *Cyrtandracéæ*, *Epacridaceæ*, and *Eriocaulaceæ*. Many of the Sumatran forms which do not occur in Java are found in the Malay Peninsula. In the north the pine tree (*Pinus Merkusii*) has advanced almost to the equator, and in the south are a variety of species characteristic of the Australian region. The distribution of species does not depend on elevation to the same extent as in Java, where the horizontal zones are clearly marked; and there appears to be a tendency of all forms to grow at lower altitudes than in that island. A remarkable feature of the Sumatran flora is the great variety of trees that vie with each other in stature and beauty, and as a timber-producing country the island ranks high even among the richly wooded lands of the archipelago.[1] The process of reckless deforestation, is, however, beginning to tell on certain districts,—the natives often destroying a whole tree for a plank or rafter. The principal cultivated plants, apart from sugar cane and coffee, are rice (in great variety of kinds), the cocoa-nut palm, the areng palm, the areca and the sago palms, maize (jagung), yams, and sweet potatoes; and among the fruit trees are the Indian tamarind, the blimbing, pomegranate, jambosa, guava, papaw, orange, and lemon. Even before the arrival of Europeans Sumatra was known for its pepper plantations; and these still form the most conspicuous feature of the south of the island. For the foreign market coffee is the most important of all the crops,—the Padang districts being the chief seat of its cultivation. The average value of the coffee brought to market in Padang in the three years 1880–82 was £521,000 [$2,532,060]. Benzoin was formerly obtained almost exclusively from Sumatra from the *Styrax Benzoin.*[2]

Fauna.—Snellemann confirms the statement of Wallace that no trace has been found of the orang-outan (*Simia satyrus*). The siamang (*Hylobates syndactylus*), an ape peculiar to the island, fills the woods with the cry "*uwa uwa*" The ungko (*Hylobates agilis*) is not so common. A fairly familiar form is the simpei (*Semnopithecus melalophus*). No apes are found on the plateau of Alahan Pandjang and the slopes of the mountains above 1500 metres. The tjigah (*Cercocebus cynomolgus*) is the only ape found in central Sumatra in a tame state. The pig-tail ape (*Macacus nemestrinus*)—as Raffles described it in his "Descriptive Catalogue of a Zoological Collection made in Sumatra," *Trans. Linn. Soc.*, 1820, vol. xiii. p. 243—is employed by the natives of Benkulen to ascend the cocoa-nut trees for the purpose of gathering the nuts. The *Galeopithecus volans* ("kubin," "flying cat," or "flying lemur") is fairly common. Bats of from twenty to twenty-five species have been registered; in central Sumatra they dwell in thousands in the limestone caves. The *Pteropus edulis* ("kalong," "flying fox") is to be met with almost everywhere, especially in the durian trees. The tiger frequently makes his presence felt, but is seldom seen, and less frequently hunted; he prefers to prowl in what the Malays call tiger weather, that is, dark, starless misty nights. The "clouded tiger" or rimau bulu (*Felis macrocelis*) is also known, as well as the Malay bear and wild dog. *Paradoxurus musanga* ("coffee-rat" of the Europeans) is only too abundant; *Arctictis binturong* appears to be rare. The Sumatran hare (*Lepus netscheri*), discovered in 1880, adds a second species to the *Lepus nigricollis*, the only hare previously known in the East Indian Archipelago. The *Manis javanicus* is the only representative of the *Edentata*. The *Pachydermata* are strongly characteristic of the Sumatran fauna; not only are the rhinoceros (*Rh. sumatranus*), the *Sus vittatus*, and the *Tapirus indicus* common, but the elephant (altogether absent from Java) is represented by a peculiar variety.[3] The Sumatran rhinoceros differs from the Javanese in having two horns, like the African species. Its range does not extend more than 8500 feet above sea-level, and that of the elephant not above 4900 feet. The wild *Bos sundaicus* does not appear to exist in the island. The *Antilope sumatrensis* (kambing-utan) has been driven to the loneliest parts of the uplands. *Cervus equinus* is widely distributed, *Cervus muntjac* less so.[4]

Inhabitants.—The bulk of the Sumatran population is Malayan; but to what extent the Malay has absorbed pre-Malayan blood is still open to investigation. The Kubus, a race or tribe still found in an emphatically savage state in the interior, have been by some regarded as the remains of an aboriginal stock; but Mr. J. G. Garson, reporting on Kubu skulls and skeletons submitted to him by Mr. Forbes, comes to the conclusion that they are decidedly Malay, though the frizzle in the hair might indicate a certain mixture of Negrito blood (*Journ. Anthrop. Inst.*, 1884). They speak the Malay dialect of the district to which they belong.

One of the most interesting of all the savage or semi-savage peoples is the Battaks or Batahs. About these a great deal has been written since Junghuhn published his *Die Battaländer* in 1847. It is not known whether they were settled in Sumatra before the Hindu period. Their language contains words of Sanskrit origin and others most

[1] The Central Sumatra Expedition alone collected specimens of about 400 kinds of timber.

[2] See Miquel, *Flora Ind. Batavæ;* Suppl. 1, "Prodr. Floræ Sumatranæ," 1860.

[3] [Found also in Ceylon. See vol. v. p. 315.—Am. Ed.]

[4] For the birds see Forbes's *Naturalist's Wanderings.* On this, as on other branches of natural history elaborate treatises appear in *Midden-Sumatra.*

readily referred to Javanese, Malay, Menangkabau, Macassar, Sundanese, Niasese, and Tagal influence. At the present time they occupy the country to the southeast of Achin, in the centre of which lies the great Toba Lake; but it is evident that they formerly possessed, or at least were present in, various other districts both north and south. The process of absorption into the Achin and Malay population which is now rapidly going on seems to have been long at work. In many points the Battaks are quite different from the Malay type. The average stature of the men is about 5 feet 4 inches, of the women 4 feet 8 inches. In general build they are rather thickset, with broad shoulders and fairly muscular limbs. The color of the skin ranges from dark brown to a yellowish tint, the darkness apparently quite independent of climatic influences or distinction of race. The skull is rather oval than round. In marked contrast to the Malay type are the large black long-shaped eyes, beneath heavy black or dark brown eyebrows. The cheek bones are somewhat prominent, but less so than among the Malays. J. B. Neumann[1] reckons the inhabitants of the whole river basin of which he treats at 50,000. The Battak language,[2] especially the Toba dialect, has been studied by Van der Tuuk (*Bataksch Woordenboek*. On the borders of Palembang and Benkulen live the Redjangers, a peculiar tribe who still employ a distinctive written character, which they cut with a kris on bamboo or lontar. The same character is employed by the Pasumahs, who bear traces of Javanese elements or influence. Full details as to the various forms are given by Van Hasselt, *Volksbeschr. en Taal van Mid.-Sumatra* (1877–79 expedition). The original stock of the Achinese appears, according to K. H. F. van Langen (*Tijdschr. voor Ind. Taal-, Land-, en Volken-Kunde*, Batavia, xxviii.), to have consisted of the Mantirs, who seem to have been driven inland by the Battaks and the Cheties (Tjeties) or Hindus. The Achinese language is at present spoken in four main dialects, of which the purest or most cultured is that of the XXV. and XXVI. Mukims. It shows, besides the Mantir element, Malay, Battak, Hindu, and Arabic influence. The inhabitants of the Nias Islands have a special tongue, which has been studied by Herr Sundermann.

The physical conditions of large tracts render it certain that as a whole the island cannot be thickly peopled. In 1881 the Government *Almanac* gave the population of the Dutch possessions as 2,142,873 (2894 Europeans, 2,098,984 natives, 11,289 Chinese, 1929 "Arabs," and 27,777 Orientals of other stock). To this considerable additions must be made, as the kingdom of Achin (356,000 at least), as well as Indragiri and Kwanten (about 30,000). Perhaps a fair estimate for the whole is somewhat under 3,500,000. The Nias Islands would add 230,000 to the total. The most populous region is the government of the West Coast.

History.—As far as is known, Sumatran civilization and culture are of Hindu origin; and it is not improbable that the island was the first of all the archipelago to receive the Indian immigrants who played so important a part in the history of the region. Certain inscriptions discovered in the Padang Highlands seem to certify the existence in the 7th century of a powerful Hindu kingdom in Tanah Datar, not far from the site of the later capital of Menangkabau. In these inscriptions Sumatra is called the "first Java." The traces of Hindu influence still to be found in the island are extremely numerous, though far from being so important as those of Java. There are ruins of Hindu temples at Butar in Deli, near Pertibi, on the Panbi river at Jambi, in the interior of Palembang above Lahat, and in numerous other localities. One of the principal Hindu ruins is at Muara Takus on the Kampar river.[3] The buildings (including a stupa 40 feet high) may possibly date from the 11th century. At Pagar Rujung are several stones with inscriptions in Sanskrit and Menangkabau Malay. Sanskrit words occur in the various languages spoken in the island; and the *Ficus religiosa*, the sacred tree of the Hindu, is also the sacred tree of the Battaks. At a later period the Hindu influence in Sumatra was strengthened by an influx of Hindus from Java, who settled in Palembang, Jambi, and Indragiri, but their attachment to Sivaism prevented them from coalescing with their Buddhist brethren in the north. In the 13th century Mohammedanism began to make itself felt, and in course of time took a firm hold upon some of the most important states. In Menangkabau, for instance, the Arabic alphabet displaced the Kawi (ancient Javanese) character previously employed. Native chronicles derive the Menangkabau princes from Alexander the Great; and the Achinese dynasty boasts its origin from a missionary of Islam. The town of Samudera was at that period the seat of an important principality in the north of the island, whose current name is probably a corruption of this word.[4] Mr. Wenniker in 1881 found a village called Samudra near Pasei (Passir), which possibly indicates the site.

Subjoined are a few leading events in the recent history of Sumatra. The island, or rather the portions possessed by the Dutch, were British from 1811 to 1816. 1821. Second expedition against Palembang; Palembang captured 23d June. 1822. Menangkabau recognized Dutch authority. 1825. Benkulen taken over from the English in May. 1837. Cultivation of coffee extended in West Coast region by Governor A. v. Michiels. 1840. Extension of the West Coast government to Sinkil. 1851. Revolt suppressed in Palembang; expedition to the Lampong districts. 1853. Cholera rages in the island; Raja Tiang Alam, ringleader of the revolt in Palembang, surrenders. 1858. Expedition against Jambi; sultan dethroned and treaty made with his successor. 1860. Redjang added to Palembang residency. 1863. Expedition against Nias. 1865. Expedition against Asahan and Serdang (East Coast). 1872. Agreement with the British Government in regard to Sumatra. 1873. War in Achin commenced. 1874. Capture of the kraton of Achin. 1876. Capture of the VI., IV., and IX. Mukims (Achin); expedition against Kota Jutan (East Coast); emancipation of slaves on West Coast. 1878. Benkulen made a residency; civil administration of Achin and dependencies intrusted to a governor.

The literature dealing with Sumatra is very extensive. Of the older works the best known is Marsden's *History of Sumatra*, 1811. A full list of other authorities will be found in Veth's *Aardrijkskundig Woordenboek van Nederl. Indië*, 1869. Among recent works by far the most important is *Midden-Sumatra; Reizen en Onderzoekingen der Sumatra Expeditie*, 1877-1879 (1882), edited by Prof. P. J. Veth. See also Brau de Saint-Pol Lias, *Île de Sumatra*, 1884; Bastian *Indonesien*; Buijs, *Twee Jaren op Sumatra's Westkust*; M. Fauque, "Rapport sur un Voyage à Sumatra," in *Archives des Missions Scient.* 3d ser. vol. xii.; Kielstra, *Beschrijving van der Atjeh Oorlog*, 1885-86, and "Sumatras West-Kust van 1819-1825," in *Bijd. tot Land-*, etc., *-Kunde*, 1887. (H. A. W.)

SUMBAL, or **Sumbul**, also called **Musk Root**, a drug recently introduced into European medical practice. It consists of the root of *Ferula Sumbul*, Hook., a tall Umbelliferous plant found in the north of Bokhara, its range apparently extending beyond the Amur. It was first brought to Russia in 1835 as a substitute for musk; it was subsequently recommended as a remedy for cholera, and in 1867 was introduced into the British pharmacopœia. The root as found in commerce consists of transverse sections an inch or more in thickness and from 1 to 3 or more inches in diameter. It has a dark thin papery bark, a spongy texture, and the cut surface is marbled with white and blackish or pale brown; it has a musky odor and a bitter aromatic taste. Sumbal is used in medicine as an antispasmodic and stimulating tonic, especially in nervous diseases. It owes its medicinal properties to a balsamic resin and an essential oil. Of the former it contains about 9 per cent. and of the latter one-third per cent. The resin is soluble in ether and has a musky smell, which is not fully developed until after contact with water; by dry distillation it yields umbelliferone, $C_9H_6O_3$, a crystalline substance soluble in water, ether, and chloroform, and producing in an alkaline solution a brilliant blue fluorescence, which is destroyed by the addition of an acid in excess.

Under the name of East Indian sumbal, the root of *Dorema ammoniacum*, Don., has occasionally been offered in English commerce. It is of a browner hue, has the taste of ammoniacum, and gives a much darker tincture than the genuine drug; it is thus easily detected. The name "sumbal" (a word of Arabic origin, signifying a spike or ear) is applied to several fragrant roots in the East, the principal being *Nardostachys Jatamansi*, D.C. (see Spikenard). West African sumbal is the root of a species of *Cyperus*.

SUMBAWA (properly **Sambawa** or **Samawa**), an island of the East Indian Archipelago, one of the Sunda group, lies between 8° 6′ and 9° 3′ S. lat. and 116° 47′ and 119° 12′ E. long., to the east of Lombok, from which it is separated by the narrow Allas strait. Its area is estimated at 5186 square miles. The population was computed to number about 150,000 in 1887. The deep Bay of Salee or Sumbawa on the north divides the island into two peninsulas, and the isthmus is further reduced by the narrower Bay of Tjempi (Chempi) entering from the south. The eastern peninsula is deeply indented by the Bay of Bima. The whole surface of Sumbawa is mountainous; G. Nyenges, in the western peninsula, is 5560 feet high, and G. Tambora, in the eastern, which is said to have lost a third of its elevation in the eruption of 1815, is still 8697 feet high. There are no navigable streams. The climate and productions are not unlike those of Java, though the rains are heavier, the drought more severe, and the fertility less. Sulphur, arsenic, asphalt, and petroleum are the mineral products. Mohammedanism prevails throughout the island, except among certain mountain tribes.

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[1] "Het Pane en Bila Stroomgebied," in *Tijdsch. Ned. Aardrijksk. Gen.* 1886.

[2] Mr. C. A. van Ophuijsen has published (in *Bijd. tot Land-, Taal-, en Volken-Kunde*, 1886) an interesting collection of Battak poetry. He describes a curious leaf language used by Battak lovers, in which the name of some leaf or plant is substituted for the word with which it has greatest phonetic similarity.

[3] See descriptions of it in *Tijdschr. van Ind. Taal-, Land-, en Volken-Kunde*, 1860 and 1879, and *Verhandel. Batav. Gen. van Kunst en Wetensch.*, 1881.

[4] All the facts relating to this derivation are given in Yule and Burnell, *Glossary of Anglo-Indian Words*, s. v. "Sumatra."

Sumbawa is divided into four independent states,—Sumbawa proper, Dompo, Sangar, and Bima. Two other states on the northern extremity of the island were so devastated by the Tambora eruption of 1815 that their territory, after lying for long uninhabited, was in 1866 divided between Dompo and Sangar. Sumbawa proper occupies the western peninsula. The residence of the sultan is Sumbawa, 2 miles from the coast of the great bay, in 8° 32′ S. lat. and 117° 20′ 33″ E. long. It is surrounded with palisade and ditches. The inhabitants of this state employ sometimes the Malay and sometimes the Macassar character in writing. A considerable trade is carried on in the export of horses, buffaloes, goats, dinding (dried flesh), skins, birds' nests, wax, rice, katjang, sappanwood, etc. Sumbawa entered into treaty relations with the Dutch East India Company in 1674. Dompo is the western half of the eastern peninsula. The capital of the state, Dompo, lies in the heart of the country, on a stream that falls into Tjempi Bay. Bada, the sultan's residence, is farther west. Sangar occupies the northwestern promontory of the island, and Bima the extreme east. Bima or Bodjo, the chief town of the latter state, lies on the east side of the Bay of Bima; it has a stone-walled palace and a mosque, as well as a Dutch fort. The population of Bima is curiously divided into twelve guilds or castes (*dari*). In the town is a Government Christian school dating from 1874.

SUMMARY JURISDICTION. By a court of summary jurisdiction is meant a court in which cases are heard and determined by a justice or justices of the peace, without the intervention of a jury. Such a court has duties to perform of two different kinds. It either hears and determines a case in a judicial capacity, or it acts rather in a ministerial capacity where a *prima facie* case has been established, as by issuing a warrant of distress for non-payment of poor rate, or by committing an accused person for the decision of a higher court, generally assizes or quarter sessions. It is to the court acting in the former capacity that the term "court of summary jurisdiction" more strictly applies. Ever since the first institution of justices of the peace (see Justice of the Peace), the tendency of English legislation has been to enlarge their jurisdiction and to enable offences of a less heinous nature to be tried in their courts without a jury. This inroad upon the functions of the jury can only be made by legislation. "The common law is a stranger to it, unless in the case of contempts," says Blackstone. At common law all offences must be proceeded against by indictment, and an indictment can only be tried before a jury. Even where an offence is created by statute and is unknown to the common law the procedure must be by indictment, unless the statute creating the offence or some other statute specially makes it summary. The history of the gradual growth of summary jurisdiction will be found in Stephen, *History of the Criminal Law*, vol. i. chap. iv. The summary jurisdiction exercised by justices is the only one of much practical importance. It is unnecessary to do more than mention in passing the two other kinds named by Blackstone, that of the commissioners of taxes for revenue offences and that of the superior courts for Contempt of Court (*q.v.*). A very remarkable case of the latter is the power given to a judge by 12 Geo. I. c. 29, s. 4, to summarily sentence to seven years' penal servitude a solicitor practicing after conviction for perjury, forgery, or barratry.

The principal Acts now dealing with summary jurisdiction are the Summary Jurisdiction Act, 1848[1] (11 and 12 Vict. c. 43), one of what are called Jervis's Acts, and the Summary Jurisdiction Act, 1879 (42 and 43 Vict. c. 49). The former consolidated the law up to that time of a large number of Acts, but only to a certain extent, for a considerable number of previous enactments dealing in a greater or less degree with this subject are still law, the earliest being 5 Hen. IV. c. 10. It also amended the law in several important particulars. The amendment was in the direction of greater simplicity of procedure, and related to both criminal and only quasi-criminal matters. The procedure under the Act is shortly this. In all cases where an information is laid or complaint made the justices are, on proof of a *prima facie* case, to issue a Summons (*q.v.*). An information is laid in criminal matters in which the decision of the justices, if adverse to the defendant, would be a conviction. A complaint is made where the decision of the justices in such an event would be an order for the payment of money or otherwise in what may be called only quasi-criminal matters, *e.g.*, claims under the Employers and Workmen Act. If the summons is disobeyed, a warrant may (in criminal charges only) issue in the first instance at the discretion of a justice. The warrant is good only within the local jurisdiction of the justice issuing it; and, if it is required to be executed in another jurisdiction, it must be backed, *i.e.*, indorsed by a justice of that jurisdiction (unless in case of a fresh pursuit, when it is good for 7 miles beyond the bounds of the jurisdiction in which it was issued). Complaints need not be in writing; informations usually are, though the Act does not make writing necessary. Where a warrant issues in the first instance, the information must be upon oath. In all cases not otherwise provided for, the information must be laid or complaint made within six calendar months from the time at which the matter of the information or complaint arose. The hearing is in open court, and parties may appear by counsel or solicitor. If both parties appear, the justices must hear and determine the case. If the defendant does not appear, the justices may hear and determine in his absence, or may issue a warrant and adjourn the hearing until his apprehension. If the complainant does not appear, the justices may dismiss the complaint or adjourn the hearing. The punishment inflicted may be fine or imprisonment, or both. Imprisonment as a rule cannot exceed six months. The regular mode of proceeding where a conviction adjudges a pecuniary penalty, or an order requires payment of a sum of money, is by issue of a warrant of distress to be levied on the goods of the defendant. The court usually consists of two or more justices, but the lord mayor or an alderman of the City of London, a metropolitan police magistrate, and a stipendiary magistrate have each the authority of two justices. The Act further makes provision for curing defects in form in the proceedings for the payment of costs, for removing difficulties as to the boundaries of jurisdiction, and for various other matters. The schedule gives forms of proceedings, which are as far as possible to be followed. The Act of 1879 amended the Act of 1848 in several important particulars, chiefly in the direction of greater leniency and enlarged jurisdiction and power of appeal. A greater discretion in the infliction of punishment is conferred on the court. A scale of imprisonment in respect of non-payment of a fine or default of distress is fixed at periods varying according to the amount of the fine unpaid, but in no case exceeding three months (except in certain revenue offences, where the limit is six months), and without hard labor, unless hard labor is specially authorized by the Act on which the conviction is founded. Time may be given for payment of money, or it may be ordered to be paid by instalments, or security may be taken. Summary trial of children under twelve is allowed at the discretion of the court in case of any indictable offence other than homicide, unless objection is made by the parent or guardian. A child cannot on summary conviction be imprisoned for more than a month or fined more than 40s. [$9.72]. Summary trial of juvenile offenders between twelve and sixteen and of adults is allowed in certain crimes mentioned in the Act, if the accused assents and foregoes his right to trial by jury. There are cases in which the court can deal summarily with an adult pleading guilty where it would have been necessary to commit him for trial had he pleaded not guilty. The court may in trivial cases discharge the accused without punishment or with only a nominal punishment. Improvements are made in the practice as to sureties, recognizances (see SURETY, RECOGNIZANCE), and the issue and execution of warrants of commitment and distress. The issue of such a warrant may be postponed if the court thinks fit. The wearing apparel and bedding of a person and his family, and the tools and implements of his trade to the value of £5 [$24.30] are exempt from distress. Imprisonment may in certain cases be ordered instead of distress. The right of appeal is much extended. An appeal now lies from every conviction or order adjudging imprisonment without the option of a fine where the accused did not plead guilty. The appeal by the Act of 1884 must be in accordance with the procedure of the Act of 1879, or of any subsequent Act giving a right of appeal in the particular case. The appeal is to QUARTER SESSIONS (*q.v.*). A summons or warrant is not avoided by the death or cesser of office of the justice issuing it. Under the powers of the Act rules and forms were framed which came into effect on 1st January, 1880. The Summary Jurisdiction (Process) Act, 1881 (44 and 45 Vict. c. 24, applying to Great Britain, but not to Ireland), gave additional facilities for serving and executing the process of an English court of summary jurisdiction in Scotland or of a Scotch court in England, on indorsement in the country where it is executed. The Summary Jurisdiction Act, 1884 (47 and 48 Vict. c. 43), repealed a number of enactments rendered obsolete by the Acts of 1848 and 1879 and explained certain sections of those Acts as to which doubts had arisen. There are numerous other enactments dealing less directly with the powers of courts of summary jurisdiction. For instance, the Merchant Shipping Acts give justices large powers in case of salvage claims and of offences by seamen. The Criminal Law Consolidation Acts of 1861 give them limited jurisdiction in larceny, coining, malicious injuries to property, and offences against the person. Among many other Acts conferring summary jurisdiction are the Army, Bastardy, Customs, Employers and Workmen, Game, Highway, Licensing, Post Office, and Vagrant Acts. Some of the latter Acts, such as the Customs and Army Acts, apply to the United Kingdom. The decision of a court of summary jurisdiction may be reviewed by, besides appeal, a writ of certiorari, mandamus, or habeas corpus, or by statement of a special case.

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[1] This name of the Act of 1848 is an example of a title of an Act conferred retrospectively (see Statute). The name was given to it by the Act of 1879. In the same way the name of the Scotch Summary Procedure Act, 1864, was changed to that of the Summary Jurisdiction Act, 1864, by the Summary Jurisdiction Act, 1881.

Scotland.—Summary jurisdiction in Scotland depends chiefly upon the Summary Jurisdiction Acts, 1864 and 1881. A court of summary jurisdiction includes the sheriff court. The Acts follow, *mutatis mutandis*, the lines of English legislation. All proceedings for summary conviction or for recovery of a penalty must be by way of complaint according to one of the forms in the schedule to the Act of 1864. The English summons and warrant are represented in Scotland by the warrant of citation and the warrant of apprehension. Where no punishment is fixed for a statutory offence, the court cannot sentence to more than a fine of £5 or sixty days' imprisonment, in addition to ordering caution to keep the peace. The Act of 1881 adopts many of the provisions of the English Act of 1879. In addition, it confers the discretion as to punishment to a sheriff trying by jury in cases where the prosecution might have been by complaint under the Acts. Appeals from courts of summary jurisdiction are now mainly regulated by 38 and 39 Vict. c. 62, and proceed on case stated by the inferior judge.

Ireland.—The principal Acts dealing with the subject are the Summary Jurisdiction and Petty Sessions Acts, 1851 (14 and 15 Vict. cc. 92, 93). These Acts are more extensive in their purview than the English Acts, as they form in a great degree a code of substantive law as well as of procedure. The exceptional political circumstances of Ireland have led to the appointment of resident magistrates under 6 and 7 Will. IV. c. 13, and to the conferring at different times on courts of summary jurisdiction of an authority generally temporary, greater than that which they can exercise in Great Britain. Recent instances are the Peace Preservation Act, 1881, and the Prevention of Crime Act, 1882. The provisions of the English Act of 1879 as to children were extended to Ireland by 47 and 48 Vict. c. 19.

United States.—By Art. III. s. 2 of the constitution the trial of all crimes, except in cases of impeachment, is to be by jury. By Art. V. of the amendments no person can be held to answer for a capital or otherwise infamous crime unless on a presentment or indictment of a grand jury. Considerable changes have been made by State legislation in the direction of enlarging the powers of courts of summary jurisdiction. (J. W†.)

SUMMONS (*summonitio*) is a legal form demanding the attendance of a person in parliament (see PEERAGE, vol. xviii. pp. 472–3) or before a court of justice. The term as it applies to courts of justice is used both in civil and in criminal procedure, but is not applied universally to all cases of demanding attendance. Thus, in the Probate, Divorce, and Admiralty Division the summons is usually, following the civil law, called a "citation," while a summons to a witness (at least in the superior courts) bears the name of "subpœna," taken from the initial words of the penal clause in its Latin form. Whatever be the name, the principle of law is invariable, that a court before proceeding to adjudicate should bring before itself by some formal legal process all persons interested in the decision or able to influence the decision by giving evidence as material witnesses. The oral summons, like the oral pleading, seems to have been earlier in time than the written form. In Roman law the oral *in jus vocatio* existed centuries before the written *libellus conventionis*. The antiquity and importance of the summons as a legal form in England is shown by the presence of the "sompnour," or summoner of the ecclesiastical court, as one of the characters in the *Canterbury Tales*, and by the comparative frequency of "Sumner" as a surname. In civil procedure a summons may be issued either in the High Court or in an inferior court, such as a county court. In the High Court all actions are commenced by writ of summons. In the High Court the summons (in this case not in the form of a writ) is also a convenient mode of determining interlocutory matters by a judge or some other officer of the court—such as a master in the Queen's Bench Division or a chief clerk in the Chancery Division—without the necessity of bringing the case into court.

The tendency of recent legislation is towards the increased use of the summons as a mode of presenting a case for decision. For instance, under the Vendor and Purchaser Act, 1874, and the Conveyancing Act, 1881, many important questions, even of title to real property, may be raised on summons. It thus approaches very nearly to PLEADING (*q.v.*); in fact, the definition of pleading in the Judicature Act, 1873, s. 100, includes summons. The Rules of the Supreme Court, 1883, introduced two new forms of summons,—(1) the general summons for directions, by which several matters may be included in a single summons which before the rules must have been the subject of separate applications; (2) the originating summons in the Chancery Division, by which proceedings may be commenced without writ for certain kinds of relief specified in the rules (see Ord. lv. r. 3). The originating summons to a great extent supersedes the action for administration of a trust or of the estate of a deceased person.[1] An ordinary summons must be served two, an originating summons seven, clear days before its return. A decision on a summons is generally subject to appeal. In the Chancery Division it is customary to adjourn into court the consideration of a summons of more than ordinary importance. The appendix to the Rules of 1883 contains forms of every kind of summons in the High Court. In the county courts an action is commenced by plaint and summons. Two kinds of summons are in use,—the ordinary and the default summons. The latter is an optional remedy of the plaintiff in actions for debts or liquidated demands exceeding £5 [$24.30], and in all actions for the price or hire of goods sold or let to the defendant to be used in the way of his calling. It may also issue by leave of the judge or registrar in other cases, with the single exception that no leave can be given in claims under £5 [$24.30] where the claim is not for the price or hire of goods sold or let as above, if the affidavit of debt discloses that the defendant is a servant or person engaged in manual labor. The advantage of a default summons is that judgment is entered for the plaintiff without hearing unless the defendant gives notice of defence within a limited time. A default summons must as a rule be served personally on the defendant; an ordinary summons need not be served personally, but may in most cases be delivered to a person at the defendant's house or place of business. A summons is also issued to a witness in the county court. Forms of summons are given in the County Court Rules, 1886. These include certain special forms used in Admiralty and interpleader actions and in proceedings under the Charitable Trusts Acts, the Friendly Societies Act, 1875, and the Married Women's Property Act, 1882. In criminal law a summons is the mode of securing the attendance of the defendant before a court of summary jurisdiction, whether it be sought to obtain a conviction or an order against him. Forms of summons to a defendant, a witness, or a surety will be found in the schedule to the Summary Jurisdiction Act, 1848, and in the rules issued in accordance with the Summary Jurisdiction Act, 1879 (see the article SUMMARY JURISDICTION, *supra*). Forgery of a summons or use of any document falsely purporting to be a summons or professing to act under such a document is punishable as felony under the County Courts Act, 1846, and the Forgery Act of 1861.

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[1] A similar practice existed before 1883 under the powers given by 15 and 16 Vict. c. 86, but was very limited in its operation, as it applied simply to the personal estate of a deceased person.

Scotland.—Summons is a term confined in strictness to the commencement of an action in the Court of Session. Formerly it was the mode of commencing an action in the sheriff court, but such an action is now commenced by PETITION (*q.v.*). In some Acts of Parliament, however—*e.g.*, the Citation Amendment Acts—the term "summons" is certainly used to denote part of the process of an inferior court. The summons is a writ in the sovereign's name, signed by a writer to the signet, citing the defender to appear and answer the claim. The will of the summons calls upon the defender to appear on the proper *induciæ*. A privileged summons is one where the *induciæ* are shortened to six days against defenders within Scotland (6 Geo. IV. c. 120, s. 53). Defects in the summons are cured by amendment or by a supplementary summons. The summons goes more into detail than the English writ of summons, though it no longer states, as it once did, the grounds of action, now stated in the condescendence and pursuer's pleas in law annexed to the summons. The form of the summons is regulated by 13 and 14 Vict. c. 36, s. 1, and Schedule A. After the action has been set on foot by summons, the attendance of the parties and witnesses is obtained by citation. The Citation Amendment Acts, 1871 and 1882, give additional facilities for the execution of citations in civil cases by means of registered letters. In cases in a court of summary jurisdiction the English summons is represented by the warrant of citation.

SUMNER, CHARLES (1811-1874), American statesman, was born at Boston, Mass., on 6th January, 1811. He graduated at Harvard in 1830, and studied law with Judge Story. His natural powers of mind were great, his habits of study intense, and his success immediate and conspicuous. Everything seems to have been expected of him, and he disappointed nobody. In 1834 he had been admitted to the bar, was editor of the *American Jurist*, and was reporting the decisions of Judge Story. For the next three years he was a lecturer in the Harvard law school. He then spent three years in Europe, always, however, studying with an intensity that never relaxed. Returning, he began the practice of law, but gradually drifted into politics during the anti-slavery struggle. In 1851 the few "free-soilers" in the Massachusetts legislature offered to vote for Democrats for other officers in return for Democratic votes for Sumner as United States senator. Sumner was thus sent to the Senate, to which he was regularly re-elected for the rest of his life. He at once became a man of mark, though not of popularity, in the Senate. His fine personal presence, his somewhat florid rhetoric, his wealth of citation from learned and foreign tongues, his wide foreign acquaintance, high culture, and social standing seem to have staggered his Southern colleagues. They could not look down upon him, and they hardly knew what else to do. A long series of speeches brought about an assault upon him, 22d May, 1856, by Preston S. Brooks, a representative from South Carolina, in retaliation for Sumner's criticism of Brooks's uncle, a senator from his State. Brooks found Sumner writing in the Senate chamber, and beat him so cruelly that he narrowly escaped death. He was absent from his place until 1859, and never fully recovered from the effects of the assault. When his party took control of the Senate in 1861 Sumner became one of its foremost members. Like Stevens (see STEVENS), he propounded a theory of the relations of the seceding States to the Union which never was indorsed, but had its influence on the outcome of reconstruction. In the American Union States are autonomous, but Territories are theoretically under the absolute government of Congress, though in practice Congress gives them as much self-government as is possible or prudent. A Territory becomes a State by admission through an Act of Congress. Sumner held that the national boundaries of the Union were so fixed that no State could escape from them by secession, that a State's secession was merely an abandonment of its Statehood, so that it fell back into the condition of a Territory and came under the absolute government of Congress. This "State-suicide" theory was in due time condemned by the Supreme Court, which held that a State could not lose its Statehood; but Congress had really acted upon it already in several points of reconstruction. Sumner's peculiar field was in the Senate committee on foreign relations, of which he was chairman from 1861 until 1871. It was during this period, in 1869, that he urged the "indirect" items of the Alabama claims, sacrificing without hesitation the English popularity which had always been dear to him. Within a year or two he felt compelled to oppose the new administration of President Grant in several particulars. In the expectation of gratifying the president, the Republican senators removed Sumner from his chairmanship; and, like Seward, he passed his later years in general opposition to the party which he had helped to organize. In December, 1872, he introduced a resolution that the names of victories over fellow-citizens should be removed from the regimental flags of the army. For this his State legislature censured him, but the censure was rescinded just before his death. He had been from the beginning of the Civil War the advocate of emancipation and of the grant of full status to the Negroes; and for the last few years of his life his energies were devoted to forwarding his Civil Rights Bill, intended to give the freedmen the same legal rights as the whites. He died at Washington on 11th March, 1874.

Sumner's speeches were collected in 1850 under the title of *Orations and Speeches*, to which was added, in 1856, *Recent Speeches and Addresses*. His *Works*, in twelve volumes, were issued in 1875. See also Lester's *Life of Sumner*, 1874; Harsha's *Life of Sumner*; and Pierce's *Memorial and Letters of Sumner*.

SUMPTUARY LAWS are those intended to limit or regulate the private expenditure of the citizens of a community. They may be dictated by political, or economic, or moral considerations. They have existed both in ancient and in modern states. In Greece, it was amongst the Dorian races, whose temper was austere and rigid, that they most prevailed. All the inhabitants of Laconia were forbidden to attend drinking entertainments, nor could a Lacedæmonian possess a house or furniture which was the work of more elaborate implements than the axe and saw. Amongst the Spartans proper, simple and frugal habits of life were secured rather by the institution of the *pheiditia* (public meals) than by special enactments. The possession of gold or silver was interdicted to the citizens of Sparta, and the use of iron money alone was permitted by the Lycurgean legislation. "Even in the cities which had early departed from the Doric customs," says K. O. Müller, "there were frequent and strict prohibitions against expensiveness of female attire, prostitutes alone being wisely excepted." In the Locrian code of Zaleucus citizens were forbidden to drink undiluted wine. The Solonian sumptuary enactments were directed principally against the extravagance of female apparel and dowries of excessive amount; costly banquets also were forbidden, and expensive funeral solemnities. The Pythagoreans in Magna Græcia not only protested against the luxury of their time but encouraged legislation with a view to restraining it.

At Rome the system of sumptuary edicts and enactments was largely developed, whilst the objects of such legislation were concurrently sought to be attained through the exercise of the censorial power. The code of the Twelve Tables contained provisions limiting the expenditure on funerals. The most important sumptuary laws of the Roman commonwealth were those which follow: (1) The Oppian law, 215 B.C., provided that no woman should possess more than half an ounce of gold, or wear a dress of different colors, or ride in a carriage in the city or within a mile of it except on occasions of public religious ceremonies. This law, which had been partly dictated by the financial necessities of the conflict with Hannibal, was repealed twenty years later, against the advice of Cato. Livy (xxxiv. 1-8) gives an interesting account of the commotion excited by the proposal of the repeal, and of the exertions of the Roman women against the law, which almost amounted to a female *émeute*. (2) The Orchian law, 187 B.C., limited the number of guests at entertainments. An attempt being made to repeal this law, Cato offered strong opposition and delivered a speech on the subject, of which some fragments have been preserved. (3) The Fannian law, 161 B.C., limited the sums to be spent on entertainments; it provided amongst other things that no fowl should be served but a single hen, and that not fattened. (4) The Didian law, 143 B.C., extended to the whole of Italy the provisions of the Fannian law, and made the guests as well as the givers of entertainments at which the law was violated liable to the penalties. After a considerable interval, Sulla anew directed legislation against the luxury of the table and also limited the cost of funerals and of sepulchral monuments. We are told that he violated his own law as to funerals when burying his wife Metella, and also his law on entertainments when seeking to forget his grief for her loss in extravagant drinking and feasting (Plut., *Sull.*, 35). Julius Cæsar, in the capacity of *præfectus moribus*, after the African war re-enacted some of the sumptuary laws which had fallen into neglect; Cicero implies (*Ep. ad Att.*, xiii. 7) that in Cæsar's absence his legislation of this kind was not attended to. Suetonius tells us that Cæsar had officers stationed in the market-places to seize such provisions as were forbidden by law, and sent lictors and soldiers to feasts to remove all illegal eatables (*Jul.*, 43). Augustus fixed anew the expenses to be incurred in entertainments on ordinary and festal days. Tiberius also sought to check inordinate expenses on banquets, and a decree of the senate was passed in his reign forbidding the use of gold vases except in sacred rites, and prohibiting the wearing of silk garments by men. But it appears from Tacitus (*Ann.*, iii. 53-55, where a speech is put into his mouth very much in the spirit of Horace's "Quid leges sine moribus Vanæ proficiunt?"), that he looked more to the improvement of manners than to direct legislative action for the restriction of luxury. Suetonius mentions some regulations made by Nero, and we hear of further legislation of this kind by Hadrian and later emperors. In the time of Tertullian the sumptuary laws appear to have been things of the past (*Apol.*, c. vi.).

In modern times the first important sumptuary legislation was—in Italy that of Frederick II.; in Aragon that of James I., in 1234; in France that of Philip IV.; in England that of Edward II. and Edward III. In 1294 Philip IV. made provisions as to the dress and the table expenditure of the several orders of men in his kingdom, the most remarkable of which may be seen in Guizot's *Civilisation en France*, leç. 15. Charles V. of France forbade the use of long-pointed shoes, a fashion against which popes and councils had protested in vain. Under later kings the use of gold and silver embroidery, silk stuffs, and fine linen wares was restricted,—at first moral and afterwards economic motives being put forward, the latter especially from the rise of the mercantile theory. In England we hear much from the writers of the 14th century of the extravagance of dress at that period. They remark both on the great splendor and expensiveness of the apparel of the higher orders and on the fantastic and deforming fashions adopted by persons of all ranks. The parliament held at Westminster in 1363 made laws (37 Edw. III. c. 8-14) to restrain this undue expenditure and to regulate the dress of the several classes of the people. These statutes were repealed in the following year, but similar ones were passed again in the same reign. They seem, however, to have had little effect, for in the reign of Richard II. the same excesses prevailed, apparently in a still greater degree. Another statute was passed in the year 1463 (3 Edw. IV. c. 5) for the regulation of the dress of persons of all ranks. In this it was stated that "the commons of the realm, as well men as women, wear excessive and inordinate apparel to the great displeasure of God, the enriching of strange realms, and the destruction of this realm." An Act of 1444 had previously regulated the clothing, when it formed a part of the wages, of servants employed in husbandry; a bailiff or overseer was to have an allowance of 5s. [$1.21] a year for his clothing, a hind or principal servant 4s. [97 cts.], and an ordinary servant 3s. 4d. [81 cts.],—sums equivalent respectively to 50s. [$12.15], 40s. [$9.72], and 33s. 4d. [$8.10] of our money (Henry). Already in the reign of Edward II. a proclamation had been issued against the "outrageous and excessive multitude of meats and dishes which the great men of the kingdom had used, and still used, in their castles," as well as "persons of inferior rank imitating their example, beyond what their stations required and their circumstances could afford"; and the rule was laid down that the great men should have but two courses of flesh meat served up to their tables, and on fish days two courses of fish, each course consisting of but two kinds. In 1363, at the same time when costumes were regulated, it was enacted that the servants of gentlemen, merchants, and artificers should have only one meal of flesh or fish in the day, and that their other food should consist of milk, butter, and cheese. Similar Acts to those above mentioned were passed in Scotland also. In 1433 (temp. James I.), by an Act of a parliament which sat at Perth, the manner of living of all orders in Scotland was prescribed, and in particular the use of pies and baked meats, which had been only lately introduced into the country, was forbidden to all under the rank of baron. In 1457 (temp. James II.) an Act was passed against "sumptuous cleithing." A Scottish sumptuary law of 1621 was the last of the kind in Great Britain.

Ferguson and others have pointed out that "luxury" is a term of relative import and that all luxuries do not deserve to be discouraged. Roscher has called attention to the fact that the nature of the prevalent luxury changes with the stage of social development. He endeavors to show that there are three periods in the history of luxury,—one in which it is coarse and profuse; a second in which it aims mainly at comfort and elegance; and a third, proper to periods of decadence, in which it is perverted to vicious and unnatural ends. The second of these began, in modern times, with the emergence of the Western nations from the mediæval period, and in the ancient communities at epochs of similar transition. Roscher holds that the sumptuary legislation which regularly appears at the opening of this stage was then useful as promoting the reformation of habits. He remarks that the contemporary formation of strong Governments, disposed from the consciousness of their strength to interfere with the lives of their subjects, tended to encourage such legislation, as did also the jealousy felt by the hitherto dominant ranks of the rising wealth of the citizen classes, who are apt to imitate the conduct of their superiors. It is certainly desirable that habits of wasteful expenditure and frequent and wanton changes of fashion should be discouraged. But such action belongs more properly to the spiritual than to the temporal power. In ancient, especially Roman, life, when there was a confusion of the two powers in the state system, sumptuary legislation was more natural than in the modern world, in which those powers have been in general really, though imperfectly, separated. How far regulation of this kind could, and might usefully, be carried out by a spiritual power under purely moral sanctions, and whether and to what extent social offices, private as well as public, should be discriminated by costume, are questions which need not be discussed at present. Political economists are practically unanimous in their reprobation of the policy of legislative compulsion in these matters. In a well-known passage Adam Smith protests against the "impertinence and presumption of kings and ministers in pretending to watch over the economy of private people and to restrain their expense, being themselves always and without any exception the greatest spendthrifts in the society." Yet he does not seem to have been averse to all attempts to influence through taxation the expenditure of the humbler classes. The modern taxes on carriages, coats of arms, hair-powder, playing-cards, etc., ought perhaps not to be regarded as resting on the principle of sumptuary laws, but only as means of proportioning taxation to the capacity of bearing the burden.

The *loci classici* on Roman sumptuary laws are Gellius, *Noctes Atticæ*, ii. 24, and Macrobius, *Saturn.*, iii. 17. On the similar English legislation Henry's *History of Great Britain* may usefully be consulted. One of the best extant treatments of the whole subject is that by Roscher, in his essay *Ueber den Luxus*, republished in his *Ansichten der Volkswirthschaft aus dem geschichtlichen Standpunkte* (3d ed., 1878). (J. K. I.)

SUMY, a district town of Little Russia, in the government of Kharkoff, situated 125 miles to the north-west of the chief town of the government, was founded in 1652 by Little Russian Cossacks. It is poorly built, chiefly of wood, but is an important centre for the trade of Great Russia with Little Russia,—cattle and corn being sent to the north in exchange for various kinds of manufactured and grocery wares. It has a classical pro-gymnasium and a technical school. Its inhabitants, who numbered 16,030 in 1884, are engaged in commerce, in various kinds of petty trades, and in agriculture.

SUN. In the article ASTRONOMY (vol. ii. p. 685 *sq.*) the sun has been considered as a member of the solar system, and references are given to various discoveries which have been made from time to time relating to its physical and chemical constitution. In the present article we propose to consider the sun as a star, and to state as briefly as may be the views at present held regarding its structure, and subsequently to refer to the most recent observations dealing with the physics and chemistry of the various phenomena which are open to our study.

Envelopes.

The sun as ordinarily visible to us, bounded by the photosphere, is only a small part of the real sun; from observations made during eclipses it is now known that outside the photosphere are: first, an envelope, namely the chromosphere, which is mainly composed of hydrogen, and outside this another envelope, called the corona, while there is evidence that outside these, and especially along the plane of the sun's equator, there is a considerable extension of matter which may or may not be of the same nature as that of which the corona is composed.

These various parts of the solar economy have been examined by the spectroscope, and from this examination two widely divergent views have arisen.

Extent of sun's atmosphere.

According to the first view, the true atmosphere of the sun is limited by the chromosphere, and the constituents of that atmosphere consist essentially of the vapors of the chemical elements recognized on the earth. It will be seen that on this view the corona and the equatorial extension observed occasionally are merely solar appendages. In the other view the atmosphere of the sun is extended to the confines of the corona, the temperature naturally increasing as we descend; and it is held that towards the photosphere the temperature is so high that the chemical elements are dissociated into finer forms of matter, so that descending vapors get more simple, ascending vapors get more complex, and it is only in the cooler regions of the atmosphere that vapors resembling those of our terrestial elements can exist, while near the confines of the corona these vapors give place to solid particles and masses. Broadly stated, these divergent views have arisen from the application of two distinct methods of inquiry. In one method, light coming from every portion of the sun, and reflected, let us say, by a cloud into the spectroscope, gives us a spectrum full of absorption lines, and these lines are practically constant from year to year. In the other method, each minute portion of the solar economy has been examined bit by bit, and thus we have the spectrum of the spots, the spectrum of the prominences, the spectrum of the chromosphere, the spectrum of the corona. All these spectra vary enormously, not only among themselves, but from year to year; and, when we consider merely the spots and prominences, we may say that they vary from spot to spot and from prominence to prominence.

Mean density.

It will be obvious that the true mean density of the sun cannot be the same on the two hypotheses to which we have referred. If the atmosphere is practically limited by the photosphere, it has been found that the density of the sun is 1.444, water being taken as unity. If we include the corona in the sun's atmosphere, and assume that its height is half a million of miles above the photosphere, then the volume of the sun is ten times that bounded by the photosphere, and the density is reduced to a tenth of the value given above.

We next proceed to discuss the chemical results obtained by the first method of inquiry to which reference has been made. For these results we are of course dependent upon comparisons of the lines given by various incandescent vapors with the Fraunhofer lines seen in the ordinary spectrum of the sun. If by such means complete evidence is afforded of the existence of one of our chemical elements in the sun, it is obvious that no information is given as to its precise locality; further, if the high temperatures used in our laboratories to produce a spectrum should break up the molecules of the vapors as known to the chemist into finer ones, and if the temperature of the sun were to do the same, there would still be a considerable similarity between the solar and the terrestrial spectrum of any one substance.

Chemical constitution of atmosphere.

The first (A) of the following tables gives the substances present in the sun's atmosphere according to (1) Kirchhoff and (2) Ångström and Thalén.

TABLE A.

Kirchoff.	Sodium, Iron, Calcium, Magnesium, Nickel, Barium, Copper, Zinc.
Ångström and Thalén	Sodium, Iron, Calcium, Magnesium, Nickel, Chromium, Cobalt, Hydrogen, Manganese, Titanium.

A subsequent method of inquiry, which was capable of tracing merely a small quantity, gave the additional substances shown in Table B.

TABLE B.

Elements whose Longest Lines coincide with Fraunhofer Lines.

Certainly coincident	Aluminium, Strontium, Lead, Cadmium, Cerium, Uranium, Potassium, Vanadium, Palladium, Molybdenum.
Probably coincident	Indium, Lithium, Rubidium, Cæsium, Bismuth, Tin, Silver, Glucinum, Lanthanum, Yttrium or Erbium.

When we come to bring the chemical evidence together which has been acquired by the examination of separate parts of the solar economy, we find, as has been already hinted, that the apparent similarity in chemical structure suggested by the foregoing tables entirely breaks down. Not only is the chemical nature of each separate solar phenomenon different from that of any other, but the facts of observation are in all cases entirely new and strange, so that very little light is obtained towards the understanding of them from ordinary laboratory work.

We will consider the chemistry of the chief solar features in order.

Chemistry of the Constituent Parts.

Spectra of spots.

The spectrum of the spot differs from that of the ordinary surface of the sun chiefly by the widening of certain of the Fraunhofer lines in the spot spectrum,—some being excessively widened. The lines which are most widened change from spot to spot and from year to year. The most extensive sun-spot observations of this nature have been carried on in Kensington, and the conclusion derived from 700 observations on spots between 1879 and 1885 are as follows:

(1) The spot spectra are very unlike the ordinary spectrum of the sun; some Fraunhofer lines are omitted; new lines appear; and the intensities of the old lines are changed.

(2) Only very few lines, comparatively speaking, of each chemical element, even of those which have many among the Fraunhofer lines, were seen to be most widened. It was as if on a piano only a few notes were played over and over again, always producing a different tune.

(3) An immense variation from spot to spot was observed between the most widened lines seen in the first hundred observations. Change of quality or density will not account for this variation. To investigate this point the individual observations of lines seen in the spectrum of iron were plotted out on strips of paper, and an attempt made to arrange them in order, but without success, for, even when the observations were divided into six groups, about half of them were left outstanding.

(4) If we consider the lines of any one substance, there is as much inversion between them as between the lines of any two metals. By the term "inversion" is meant that of any three lines, A, B, C, we may get A and B without C, A and C without B, B and C without A.

(5) Very few lines are strongly affected at the same time in the same spot, although a great many lines of the same substance may be affected, besides the twelve recorded as most widened on each day.

(6) Many of the lines seen in the spots are visible at low temperatures (some in the oxy-hydrogen flame), and none are brightened or intensified when we pass from the temperature of the electric arc to that of the electric spark.

(7) Certain lines of a substance have indicated rest, while other adjacent lines seen in the spectrum of the same substance in the same field of view have shown change of wave-length.

(8) A large number of the lines seen in spots are common to two or more substances with the dispersion employed.

(9) The lines of iron, cobalt, chromium, manganese, titanium, calcium, and nickel seen in the spectra of spots are usually coincident with lines in the spectra of other metals with the dispersion employed, whilst the lines of tungsten, copper, and zinc seen in spots are not coincident with lines in other spectra.

(10) The lines of iron, manganese, zinc, and titanium most frequently seen in spots are different from those most frequently seen in flames, whilst in cobalt, chromium, and calcium the lines seen in spots are the same as those seen in flames.

(11) Towards the end of the first series of investigations there appeared among the most widened lines a few which are not represented, so far as is known, among the lines seen in the spectra of terrestrial elements. This change took place when there was a marked increase in the solar activity.

(12) The most widened lines in sun spots change with the sun-spot period.

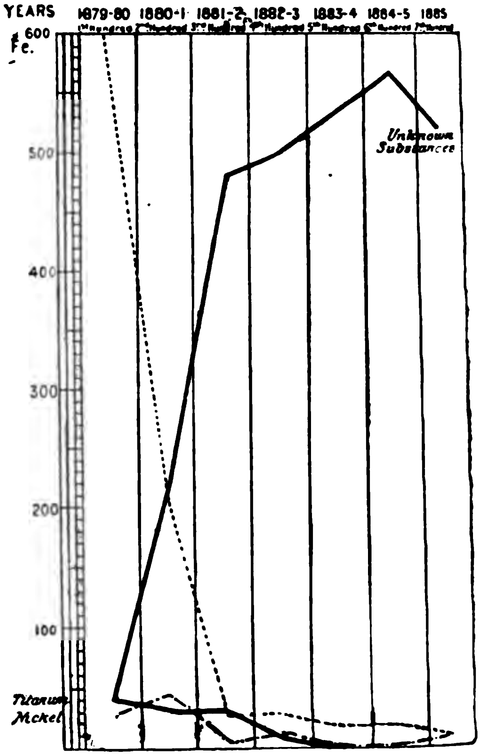
(13) At and slightly after the minimum the lines are chiefly known lines of the various metals.

(14) At and slightly after the maximum the lines are chiefly of unknown origin.

(15) On the hypothesis under discussion the change indicates an increased temperature in the spots at the sun-spot maximum.

The general result is that in passing from minimum to maximum the lines most affected change from those of the ordinary chemical elements to lines whose significance are not known. The accompanying diagram represents graphically the disappearance of the lines of iron, nickel, and titanium and the simultaneous appearance of unknown lines in the spot spectra in passing from minimum to maximum. In the region of the spectrum for which the curves are drawn six lines were recorded in each observation, and therefore 600 in each series of 100 observations. In the curves the vertical ordinates represent not merely the number of individual lines recorded but the number of occurrences of lines of each substance. The dotted curve shows the variation in the frequency of the iron lines; at the minimum in 1879 practically all the 600 lines observed were iron lines: towards the end of 1881 they had dwindled down to 30; and during the three following years they fell to 10. The dot and dash curve shows a similar variation in the nickel lines, and the double line curve that of the titanium lines during the same periods. The continuous curve shows the gradual increase in the number of occurrences of unknown lines in passing from the minimum in 1879 to the maximum in 1884.

Changes in sun-spot spectra.



Most widened lines, F—b region, in sun-spot spectra.

Chromosphere.

The chromosphere when quite quiescent merely gives us a spectrum of hydrogen together with a line in the yellow, which, from its proximity to D_1 and D_2, is called D_3. The chromosphere is disturbed in two ways,—first, by prominences, of which more hereafter, and second, by the formation gradually and peacefully of domes, which are of no great height but sometimes extend over large areas and last for weeks. These last-named phenomena have been termed "wellings up," the idea being that they were produced by the gradual uprise of vapors from below; but it is clear that the same phenomena might be produced by the very slow descent of matter from above. The spectrum of these higher portions of the chromosphere, whether produced from below or above, is more complicated than the ordinary one. The following table (C) gives the principal lines which have been recorded up to 1887.

1869.	Hydrogen D_3	All lines.
	1474 (5315.9)	Unknown.
	b^1 b^2 b^4	Magnesium, 3 out of 7 (Thalén).
	b^3	Nickel, 1 out of 34.
	D_1 D	Sodium, 2 " 8.
	4933.4	Barium, 2 " 26.
	4899.3	
	4923.1	Iron, 2 " 460 (Ångström).
	5017.6	
	5275	Unknown.
	5233.6	
	5179.9	
	4921.3	
	5014.8 bright	
After 1869.	*f* 4471	Unknown.
	4924.5	
	B—C	
	B—*a*	
	5019	Titanium, 1 out of 201 (Thalén).
	H	Calcium, 2 " 74.
	K	

The first new line in this table is called in spectroscopic language 1474, because when this work was begun the only maps available were those made by Professor Kirchoff, and this particular line fell at 1474 on his scale. Since then these artificial scales have been discarded in favor of the natural one, which is given by the wave-lengths of light of different colors. In this the reference number of the same line is 5315.9, which represents the wave-length in ten-millionths of a millimètre of that particular quality of light. After this we observe three lines of magnesium, only 3 out of 7; next a line of nickel, one only, however, out of 34; then two lines of sodium, although we might naturally expect to get all the 8 lines; then two lines of barium out of 26; and so on. Almost all the other lines have origins which are absolutely unknown: that is to say, we never get them in our terrestrial laboratories, and never, therefore, are able to match the bright lines in the chromosphere of the sun with any chemical substance. In 1871 the sun was more active, and this activity resulted in the addition of new lines, all, however, absolutely unknown to us, except one, which represents a line in the spectrum of titanium; but in that case we get one line out of 201 in exactly the same way as we get two only of iron out of 460. It is most important to note that practically none of the lines shown in table C are among those which are widened in spots.

Prominences.

The prominences are of two kinds—those which are relatively quiet and give almost exclusively the lines of hydrogen and those in which the motions are as a rule very violent. The spectrum of the latter class generally includes a large number of metallic lines; hence they are generally called metallic prominences. The first stage of metallic prominence is usually the appearance of three lines of the following wave-lengths—4943, 5031, 5315.9. As the prominence increases in magnitude and violence other lines are added, until at times the spectrum seems full of lines. The rate of uprush of these prominences sometimes reaches 250 miles per second, or nearly a million miles an hour.—figures which convey an idea of the enormous energies involved. The lines seen in these prominences, although many are present in the spectra of the metallic elements, appear with greatly changed intensities: the lines seen brightest in the prominences are frequently dim lines in the terrestrial spectrum. Again it may be remarked that these are not the lines which are most widened in spots. In the case of the spectrum of any one substance the number of lines seen usually in the prominences is very small.

The general conclusions which have been derived from a discussion of the prominence observations made by Profs. Tacchini and Riccò, in connection with the sun-spot observations already mentioned, are as follows:

(1) The chromospheric and prominence spectrum of any one substance, except in the case of hydrogen, is unlike the ordinary spectrum of the substance. For instance, we get two lines of iron out of 460.

(2) There are inversions of lines in the same elements in the prominences as there are inversions in the spots: in certain prominences we see certain lines of a substance without others; in certain other prominences we see the other lines without the first.

(3) Very few lines are strongly affected at once, as a rule, and a very small proportion altogether,—smaller than in the case of spots.

(4) The prominences are less subject to sudden changes than spots, so far as lines of the same element are concerned.

(5) There is a change in the lines affected according to the sun's spot period.

(6) The lines of a substance seen in the prominences are those which in our laboratories become considerably brightened when we change the arc spectrum for the spark spectrum.

(7) None of the iron lines ordinarily visible in prominences are seen at the temperature of the oxy-hydrogen flame. Some of the oxy-hydrogen flame lines are seen in the spots, but none have ever been seen in the prominences.

(8) A relatively large number of the lines ordinarily seen are of unknown origin.

(9) Many of the lines seen are not ordinarily seen amongst the Fraunhofer lines. Some are bright lines.

(10) As in the spots the H and K lines of calcium in the ultra-violet are always bright in the spot spectrum, the other lines of calcium and the other substances being darkened and widened, so it would appear that the lines H and K of calcium are always bright in the prominences in which the other lines are generally unaffected.

(11) Many of the lines are common to two or more elements with the dispersion which has been employed.

Corona.

The spectrum of the inner corona indicates that it is chiefly composed of hydrogen. All the hydrogen lines are seen in it, and up to a certain height the H and K lines of calcium, proving the presence either of calcium or of something that exists in calcium which we cannot get at in our temperature.

In the outer corona most of the hydrogen lines disappear; but one, the green line F, remains for a considerable height side by side with the 1474 line, indicating, as far as we can see where everything is so doubtful that the constituents of the outer corona consist most probably of hydrogen in a cool form and the unknown stuff which gives the 1474 line. We also know that the outer corona contains particles which reflect the ordinary sunlight to us, because in 1871 Dr. Janssen, and in 1878 Professor Barker and others saw the dark Fraunhofer lines in the spectrum of the corona. We must imagine, therefore, that some part of that spectrum depends for its existence on solid particles which not only give a spectrum like that of the lime-light but have the faculty of reflecting to us the light of the underlying photosphere. It was also put beyond all question in the eclipse of 1882 in Egypt that this corona has another spectrum of its own. There are bright bands in the spectrum, showing that with these additions it is not a truly continuous spectrum like that of the lime-light, and that its origin is therefore in all probability very complex.

Association and Distribution of Phenomena.

Connection of phenomena.

Observations of prominences, spots, and other phenomena which require continuous investigation have been carefully made from day to day for several years, and one conclusion arrived at is that when and where the (disturbed) spots are at the maximum the faculæ and metallic prominences are also at the maximum. When the maximum changes from north to south latitude in the spots it also changes from north to south in the metallic prominences and the faculæ. These observations, therefore, establish not only an important connection between spots, metallic prominences and faculæ, but also the fact of the wonderful localization of these phenomena upon the sun. The spots are never seen higher in latitude than 40° north or south, and they are invariably seen in smaller quantity at the equator. Similarly, the faculæ and metallic prominences do not go much beyond 40° north or south, and their minima are also at the equator. But this does not hold good for prominences of the quiet sort and the veiled spots,—that is, spots without umbræ or very highly developed penumbræ. They extend from one pole of the sun to the other; hence there must exist a great difference between metallic and quiet prominences and between disturbed and veiled spots.

Association of localized phenomena.

Although the more important of these solar phenomena are limited to certain zones of the sun's surface, and although they vary very violently, they have a cycle or regular succession of changes, during which the particular zone of the sun on which they appear alters. When there is the smallest number of spots on the sun—that is to say, when there is a sun-spot minimum—the spots that appear are seen in a high latitude, and the latitude decreases gradually until we arrive at the next minimum. Thus there are two perfectly distinct spotted areas, one corresponding to the end of the old period, the other to the beginning of the new period. At the maximum period of sun spots the latitude of the spot zone is about 15°. Activity in the solar atmosphere, therefore, appears to begin in a high latitude—say about 30° or 35°—and very soon reaches the maximum in about latitude 15°; then it gradually dies away until spots, metallic prominences, and faculæ—all of reduced intensity—cling pretty near to the solar equator, and at the same time we get a new wave of activity, beginning again in a high latitude. This association of what may be called localized phenomena is quite in harmony with a similar association of phenomena which are more or less generally distributed over the whole surface of the sun.

Pores, which are in reality nothing but small sun spots, may occur in any part of the sun, and are always accompanied by a slight waviness in the chromosphere. Veiled spots—spots which never attain full development—are also universally distributed over the sun's surface and are accompanied by small prominences (see below).

Period of solar quietude.

The main periodicity on the sun is that of about eleven years which elapses between two successive maxima or minima. When the sun is quietest there are very few of the ordinary tree-like prominences visible, and there is an especial dearth of them near the poles and the equator. There are faculæ, but they do not present their usual bright appearance, and are confined to the regions between latitudes 20° N. and 20° S. On examining the chemical nature of the materials in the chromosphere at such a period by means of a spectroscope, we see only the four lines of hydrogen and the line D_3, whose chemical significance we do not know. Practically speaking, there are no spots visible and the disk appears to be perfectly pure, except the darkening towards the limb produced by absorption in the sun's atmosphere. As there are no spots, or only very small ones in high latitudes, it follows that there are no metallic prominences. The spectroscope searching right round the limb of the sun gathers no indications of violent action—no region giving many lines—nothing but the simple spectrum of hydrogen. Observations and photographs of the corona taken at solar eclipses occurring at minimum spot periods indicate that at two different sun-spot minima the appearances presented by the corona are very much alike. A drawing made during the eclipse of 1867, before the application of photography to solar investigations, exhibits a similar appearance to an absolutely trustworthy photograph obtained at the eclipse of 1878. At the minimum period the chief feature is a very great extension of the corona in the direction of the solar equator, and a wonderfully exquisite outcurving right and left at both poles. It is probable that the equatorial extension pictured in the above-mentioned photograph is, after all, only a part of a much more extended phenomenon, one going to almost incredible distances from the sun itself. At the eclipse of 1878 precaution was taken to shield the eye of the observer from the intense light of the inner corona, which is sometimes so bright as to be mistaken for the sun's limb, by erecting a screen which covered the moon and a space 12′ high around it. The observer, Professor Newcomb, saw on both sides of the dark moon a tremendous extension of the sun's equator, far greater than that recorded in the photographs taken at the same time. But the extended portions may have been so delicately illuminated that they could not impress their image on the photographic plate during the time it was exposed, or that the light itself is poor in chemically active rays. The extension, as observed by the shielded eye, amounted to six or seven times the diameter of the dark moon. In a more favorable situation the same extension, but to a less extent, was observed without the aid of a screen. At a sun-spot minimum, therefore, there exists a great equatorial extension of the corona east and west.

Transition to maximum period.

The time between the minimum and the maximum sun-spot periods is three or four years, and that from maximum to minimum seven or eight years, so that the sun increases in activity much more rapidly than it afterwards decreases in passing to the next minimum. Starting, then, about half way between minimum and maximum, we find an increased activity in every direction. The quiet prominences, consisting of hydrogen, are more numerous, and the faculæ are brighter. If at this time we examine the spectrum of the chromosphere, we find hydrogen and D_3 are not the only constituents: we get other short lines, the chief being the three lines of magnesium, b_1, b_2, b_4. The spots are more numerous and are in a lower latitude, having moved from near 35° to about 25°. Metallic prominences now constantly accompany the spots; and the number of bright lines visible in their spectra gradually increases from month to month. These changes are accompanied by changes in the corona, which affect not only its form but also its spectrum. At the minimum spot period the corona gives an almost continuous spectrum, differing only in the presence of a few dark lines, and occasionally a few not very obvious bright lines, whence we conclude that at the minimum the corona is not entirely gaseous. In passing from the minimum to the maximum the spectrum is no longer continuous: bright lines begin to appear, emanating from the incandescent gaseous portions of the corona, and at the same time there is an increase in brilliancy. At this period there is no longer any remarkable equatorial extension, although here and there streamers of strange outlines occur. A drawing of the eclipse of 1858, a period between minimum and maximum, shows in middle latitudes, both north and south, four remarkable luminous cones standing with their bases on the chromosphere. The amount of light and structure in the corona has increased to such an extent that the beautiful double curves seen at the poles at the minimum are now hidden in a strong radiance.

Maximum period.

During the maximum period all the solar forces are doing their utmost, and we see in prominences and spots, and indeed in every outcome of action that we can refer to, indications of the most gigantic energies being at work. The ordinary prominences, instead of clinging to the equator, now occur most frequently at the poles. The faculæ are brighter and are more widely distributed, and the chromosphere is richer in lines. The spots at this period occupy broad zones with mean latitudes of about 18° N. and 18° S. There are no spots near the poles and none near the equator; but large spots indicating a state of violent agitation, surrounded by gigantic faculæ, follow each other in these zones. Each of these indicators of solar activity is accompanied by a prominence. At this time also we note the greatest velocities of down-rush in the vapors which form the spots and of up-rush in those which form the prominences. These changes are accompanied by corresponding changes in the corona; and, fortunately, we have photographic records for two periods of maximum—1871 and 1882. In these the streamers, instead of being limited to the equator or to mid-latitudes, exist in all latitudes, so that they practically extend to every part of the sun. Their directions, which may be called lines of force, are very varied, some being straight and some curved; but it is difficult to unravel the appearances, because what we see are only projections of the actual things, and this is especially the case when the sun's pole is tipped towards or away from the earth to the greatest extent. In the eclipse of 1882 the corona indicated a more equal distribution of action than that of 1871, but the general result was the same.

After the maximum period there is a gradual falling off of all the various energies, the mean latitudes of the spots decreasing until they reach 8° N. and 8° S.; then another series of spots breaks out about 35° N. and 35° S. lat., and the cycle begins anew.

General Theory.

General theory.

It has been very generally accepted for some time that sun-spots are depressions in the photosphere, produced by downfalls of cool material. The following sketch shows how, if we accept this view and also the hypothesis that the chemical elements are dissociated in the lower parts of the solar atmosphere, many of the more important solar phenomena may be explained and correlated.

We know that small meteorites in our own cold atmosphere are heated to incandescence by friction, that is, by the conversion of their kinetic energy into heat, and it is therefore not difficult to imagine that enormous masses, falling with great velocities through the sun's highly heated atmosphere, would be competent to give rise to such disturbances as those with which we are familiar on the sun's surface. This cool material is produced by the condensation, in the upper cool regions of the sun's atmosphere, of the hot ascending vapors produced at the lower levels, and this is probably the main source of supply of spot-producing material. The faculæ and other disturbances of the general surface do not precede but follow the formation of a spot, so that a spot may be considered as the initial disturbance of the photosphere in the region where it is observed. Large spots almost invariably appear first as little dots, frequently in groups, and then suddenly grow large. The little dots, according to the view of spot formation now under discussion, are formed by small masses which precede the main fall. The heat produced by friction with the atmosphere and the arrested motion causes uprushes of heated vapors, which eventually cool and condense, and afterwards fall to the photosphere and produce fresh disturbances. Down-rushes of cool material must take place all over the sun's surface, and, although the most violent results of such falls are restricted to certain regions, minor disturbances are distributed over the whole surface. These generally distributed phenomena are well known to be merely different degrees of the same kind of energies that operate in producing the more restricted ones.

We will now review the several phenomena in turn, beginning with the most widely distributed.

Effects of down-rushes.

Besides the general darkening near the edge of the sun's disk, the surface is seen to be strangely mottled near the poles, near the equator, and in fact universally. Moreover, small black specks, called *granulations* or *pores*, are everywhere visible, and spectroscopic examination shows that every one of these is a true spot. The fine mottlings frequently indicate the existence of powerful currents in that they take definite directions, sometimes in straight lines, sometimes in lines suggesting cyclonic swirls. In addition to the pores spots of a smudgy kind, called *veiled spots*, are sometimes seen, and it is probable that in such cases the force of the down-rush is insufficient to depress the photosphere to an extent competent to give rise to the ordinary dark spots. Some spots appear as large pores, that is, they consist of nothing but umbra; others appear as well-developed veiled spots, consisting almost entirely of penumbra. The obvious large spots consisting of umbra and penumbra follow next in order of intensity, and, as has been previously pointed out, their appearance is confined to definite spot zones. Minute observation, therefore, shows that the whole of the sun's surface is traversed by down-rushes of varying intensities, from almost infinitesimal dimensions to the most powerful that we can conceive. Some of the ordinary spots do not appear to be in any violent state of agitation: the penumbra and umbra are well defined, and the ridge of faculæ round such a spot does not indicate any disturbance by either lateral or convection currents. Other spots, however, indicate very violent commotion, the penumbra and umbra being tremendously contorted and mixed up. In this kind of spot the disturbance often affects enormous areas of the sun's surface; one spot in 1851 was 140,000 miles across, and the commotions were so great that they could be detected by eye observation with the telescope. It appears as if the material carried in the first instance below the level of the photosphere produces a disturbance in the interior regions, which exhibits itself at the surface by an increase in the quantity and brilliancy of the surrounding faculæ. As a spot dies away it is replaced by faculæ, and these remain long after the spot has closed up. It often happens that new spots break out in the places occupied by previous spots. The spot-producing material in its descent is dissociated either before or when it reaches the photosphere, and the rapidity and energy of the dissociation depend upon the velocity with which it travels. Gravitation is of course the main factor operating in the production of a down-rush. The velocity produced by gravitation in matter falling from great heights above the photosphere must be very great, and in consequence the kinetic energy of the moving mass must also be great. The motion is impeded by friction with the gases in the sun's atmosphere, and some or perhaps all the kinetic energy becomes heat. The heat thus developed must produce sudden expansions, and the initial down-rush is surrounded by up-rushes along the lines of least resistance. The effects of such down-rushes vary in degree according to the quantity of matter falling and the height from which it falls.

Effects of up-rush.

Equally too there are observed different degrees of the effects of up-rushes. All over the sun's surface are seen domes of faculæ, either separate or in groups, and there is indication that they are hotter than the rest of the surface, for the bright lines of hydrogen are seen to surmount them. It is probably owing to this that the chromosphere exhibits a billowy outline when under conditions of little disturbance. The next condition of increased action exhibits itself in the growing complexity of the chemical nature and of the form of the chromosphere. Occasionally the whole level of the chromosphere over a large region seems to be quietly raised, and observation proves this to be due to the intrusion of other vapors. There is either a gradual evaporation from the photosphere or a gradual vaporization or expansion of slowly falling material over large regions, raising the level of the sea of hydrogen. The chromosphere then appears to contain different layers, and the lower we descend towards the photosphere the less we know about the substances that exist there. The next degree of disturbance is seen in what are called the *quiet prominences*, which very frequently occur in regions where the beginning of a disturbance has been previously indicated by the appearance of domes and metallic strata. As a rule the quiet prominences are not very high—not higher than 40,000 miles—and many of them resemble trees. They are almost entirely composed of hydrogen, or at least of a substance which gives some of the lines observed in the spectrum of hydrogen. Such a prominence grows upwards from the photosphere, being first of a small height, then getting higher and often broader, and finally a kind of condensation cloud may form at the top. The upward velocity of the gases forming these prominences is seldom very great. When a prominence disappears it does not follow that the substances of which it was composed have also disappeared, and there is evidence to show that the apparent disappearance is due to a reduction of temperature. The most intense degree of action of an up-rush is exhibited by the metallic prominences, which contain other substances in addition to hydrogen. They are seen mounting upwards to enormous heights with almost incredible velocities, and their ascent is accompanied by violent lateral motions. Such prominences have been seen with an upward velocity of 250 miles a second, and of a height as great as 400,000 miles. There is also evidence that some prominences consist of mixed up-rushes and down-rushes, and it may turn out eventually that this is the case in all the metallic prominences.

Inter-relations of phenomena.

According to the gravitation-dissociation theory of the formation of spots, we ought to find that the effects, in various degrees, produced by down-rushes of associated matter are related to the effects, in like degrees, produced by the corresponding up-rushes of dissociated materials. Comparing, then, the facts already stated, we have:

Effects of Down-rush.	Effects of Up-rush.
1. Pores.	1. Domes.
2. Veiled spots.	2. Metallic strata and small prominences.
3. Quiet spots.	3. Quiet prominences.
4. Disturbed spots.	4. Metallic prominences.

It is a fact that the pores and domes are very closely associated over all parts of the sun, and that the domes are most prominent in places previously occupied by spots. All large spots are seen to be accompanied by metallic prominences, when observed at the edge of the sun. There is also a strict relationship between the intensity of action going on in a spot and the associated prominence, so much so that a very violent change in a spot on the disk sometimes causes the bright prominence lines to become visible in its spectrum. The ordinary metallic prominences, as already stated, may consist of both ascending and descending material; this will be best understood by likening the whole phenomenon to a splash.

Physics of a sun-spot cycle.

We have previously seen that spots and metallic prominences are very intimately connected as regards their occurrence in zones, and this intimacy is easy to explain by supposing things to happen in the way here set forth. The height of the solar atmosphere is greater over the equator than at the poles; particles condensed on the outside at the poles have therefore a relatively small velocity when they fall into the photosphere, and are able to produce only pores or veiled spots. Over the equator the particles attain a higher velocity in their fall, but they also have to pass through a much greater thickness of atmosphere and undergo so much dissociation that on reaching the photosphere they are incompetent to produce spots. In mid-latitudes, therefore, the falls of condensed particles should be most effective in producing spots. In this way the absence of spots at the poles and equator is explained,—one of the best-known facts of solar physics. The falls of the condensed particles, or meteoric matter, into the sun increase the temperature of the atmosphere over the spots and prominences which they produce, so that other falls in the same region are not effective in producing spots on account of the increased dissociation which they must undergo before reaching the photosphere. If the material condensed in those regions is to produce a spot, it must be removed to some place where it can reach the photosphere without being dissociated. Hence from the first appearance of spots after a sun-spot minimum there is a continual change of latitude. From minimum to minimum there is a regular decrease in the latitude of spots; hence it is clear that there must be currents from the poles towards the equator in the upper atmosphere of the sun, causing the removal of condensed materials to lower and relatively cooler latitudes. Assuming the existence of such currents, we ought to find that successive spots have a tendency to form along the same meridians, for the polar currents would carry the condensed materials to lower latitudes in a nearly meridional direction. Examination of sun-spot records for 1878–79 shows that there is a marked tendency for spots to follow each other in meridians. The existence of such currents is further supported by the outcurving of the corona at the solar poles as observed in several eclipses. If these currents exist, there must also be compensating currents towards the poles in the lower parts of the sun's atmosphere, carrying incandescent vapors along with them. Small prominences often give indication of motion towards the poles which such currents would produce, and examination of sun-spot records also shows that the tendency of the proper motion of the spots is polewards. Hence, although the existence of these currents has not been definitely proved, there is strong evidence that there exists some circulation of this nature in the solar atmosphere.

When once the falls have commenced, if this hypothesis is true, they should rapidly increase in intensity, for, as it is the falls which increase the temperature of the lower atmosphere by the conversion of their kinetic energy into heat, the more falls there are the more material will be taken first to the poles and then towards the equator, and therefore there will be more available spot-forming material. But we know that this increase in intensity does not go on forever, and there must therefore be some regulating influence. The increase of temperature and possibly of the height of the solar atmosphere, due to the increased falls, will eventually become such that the descending materials are dissociated before they reach the photosphere. The production of spots must therefore gradually diminish until they finally disappear and end the spot cycle. At the minimum period, therefore, pores and veiled spots, due to less powerful energies, are at a maximum.

Eclipse observations.

Records of eclipses, occurring when the sun was quietest, show that the condensing and condensed materials brought to the equator by the polar currents probably extend far beyond the true atmosphere of the sun and are there collected, possibly in the form of a more or less regular ring the section of which widens towards the sun, the widest part being within the boundary of the sun's atmosphere. If we assume such a ring under absolutely stable conditions, there will be no fall of material, and therefore no prominences or spots. But suppose a disturbance caused, as before, by collisions, which most likely occur where the particles brought by the polar currents meet the surface of the ring. These particles then fall from where the ring first meets the atmosphere on to the photosphere, and form the first spots. Eclipse records show that this action takes place about 30° lat. According to this view, there are usually no spots above 30° lat., because there is no ring, and because the atmosphere is too low to give the height of fall necessary to produce spots. There are no spots at the equator for the reason that the condensed matter has to pass for perhaps millions of miles through strata of increasing temperature, and do not therefore reach the photosphere before being dissociated. Accordingly, we ought to find that at and after the maximum the corona is brighter and more truly a gaseous body on account of the increased temperature. This is in strict accordance with eclipse observations extending over twenty years. According to this view of the solar economy, the sun ought to give out more heat at a maximum than at a minimum period, when the number of falls is greatest; on this point see the article METEOROLOGY (vol. xvi. pp. 187–8 *sq.*).

The Sun's Place among the Stars.

Star absorption of light.

The relative nearness of the sun makes it convenient as a type of those stars which on account of their great distance are less accessible to minute observation. If the sun were at a greater distance, its spectrum would become much fainter and would not show so much detail, but its general character would not be altered: its dark lines would not become bright ones. In the atmospheres of the various members of the solar system, including the earth, there is a very considerable absorption of blue light. We know also that this condition applies to the sun. The light we receive under present conditions we call white; but, if its own atmosphere and ours were removed or became so changed as to no longer absorb blue light, the sun would appear blue. If, on the other hand, the blue absorption were enormously increased, so that it extended into the green, the sun would appear red, because every other kind of light would be absorbed. If two kinds of absorption—one in the red. the other in the blue—were going on together, as they sometimes do in our laboratories, the sun would then appear green. Although these changes are not of actual occurrence in the sun, we find each of these conditions represented among the stars. In the colored stars, which may be red, green, or blue, we are simply dealing with this kind of absorption phenomena. This difference in the conditions of absorption in the stars, however, is by no means the most important one: the difference of temperature as indicated by the spectrum is of primary importance. As in our laboratories the spectrum of a substance is changed by a variation of temperature, and always in a regular way, so the nature of a star's spectrum furnishes a due to its probable state as regards heat. For example, we may submit carbon vapor to a low temperature, and we shall then obtain what is called a spectrum of flutings; on increasing the temperature, the flutings are replaced wholly or partially by lines, according to the amount of increase. From hundreds of observations of this kind, both on carbon and other substances, it may be safely inferred that a fluted spectrum indicates a lower temperature than a line spectrum. There are doubtless substances in the sun's atmosphere which, although represented by lines in its spectrum, can be submitted to low conditions of temperature so as to give fluted spectra. There can be little doubt, therefore, that a cooling of the sun would be followed by a change in its spectrum, which would cease to be one of lines and become one of flutings. While the sun was acquiring its present intensely heated state, it must at some period of its history have been in a condition of temperature in which its spectrum would consist of flutings, and similarly it must give a fluted spectrum at some future period when it has further cooled.

Solar radiation and spectra.

The ordinary Fraunhofer spectrum gives the sum total of the line absorptions of all the various layers in the sun's atmosphere, but by examining individual layers just off the edge of the disk we can single out the absorption lines produced by the lower layer. Thus the absorption produced by the hottest layer, the chromosphere—hottest because nearest the photosphere—is indicated by its usually simple radiation spectrum when examined in this way. If the sun were made hotter, therefore, the gases which give the simple chromosphere spectrum would have a larger share in the absorption, and the main features of the Fraunhofer spectrum would be the few dark lines corresponding to these bright ones. This being so, a star which gives practically the same absorption spectrum as the chromosphere of the sun must be hotter than the average temperature of the sun's atmosphere,—as hot as the hottest part of it. The bright central part of the sun is not very much less than the whole volume, but it is so much hotter that it gives out thousands of times more light than the atmosphere. The cool vapors in the atmosphere give the dark Fraunhofer lines by their absorption, and even if they are hot enough to give bright lines when seen on the sun's edge they can only reduce the intensity of the dark lines. Here the difference of area between the disk representing the central mass and that representing the sun's atmosphere is very small, and, the light from the central mass being so much more intense, we do not ordinarily see the evidences of radiation, but, in place of it, the absorption of the atmosphere. If, however, we suppose the central mass to be very small compared with its atmosphere, the total radiation of the atmosphere may be sufficiently powerful to overcome the intensity of the light from the smaller central part, so that the spectrum of such a star would contain bright lines from the exterior mixed up with the dark lines from the interior. The spectrum of a star, therefore, does not always depend upon its total diameter, but upon the relative diameters of the central mass and the outer atmosphere. It is a question of sectional areas.

Stellar spectra.

Observations of the spectra of a large number of stars show that, although there is a great difference between individual spectra, they still admit of arrangement in family groups. While some stars give line absorption spectra, others give fluted spectra, and others again give bright lines. They may be conveniently arranged as follows:

		Example.
Class I...	Stars whose spectra consist of a few thick absorption lines.	α Lyræ.
Class II..	Stars whose spectra consist of a large number of fine absorption lines.	Sun, Capella, etc.
Class III	Stars with fluted spectra, the maxima of the flutings being towards the red.	152 Schj.
Class IV	Stars with fluted spectra, the maxima being towards the blue.	α Orionis.
Class V..	Stars whose spectra contain bright lines,—(*a*) of hydrogen, (*b*) of unknown substances.	β Lyræ.

This classification probably represents the stars in order of temperature, class I. being the hottest.

Although different stars may contain lines of identical wave-lengths, the thickness of these lines is very liable to variation in passing from one star to another. The thickest lines in the solar spectrum are H and K in the ultra-violet, both of equal thickness; on passing to some of the stars, however, we find H broad with K thin, and in others H without K. This is similar to what occurs in our laboratories when we study the spectrum of calcium, the substance which gives the lines H and K; at the temperature of the electric arc the blue line of calcium is very intense, while H and K are scarcely visible; but on passing to a higher temperature, that of the induction spark, H and K appear. In those stars which give H without K, namely, those in class I., it is probable that there is a very high temperature competent to separate H and K, just as H and K were conjointly separated from the blue line. A further indication of high temperature in the stars belonging to class I. is that the few lines which do occur in their spectra are almost the exact counterparts of those which occur in the hottest layer of the sun, hydrogen lines being especially prominent. The passage from class I. to class II. is by no means sudden: there are stars with every gradation of broad and fine lines. It will readily be understood that the stars of class II. are probably not so hot as those belonging to class I., and the change in the spectrum is supposed to be due to new combinations of the original substances, rendered possible by a reduction of temperature; that is, new lines are formed at the expense of the old ones. The hydrogen lines are very prominent in class II. though not so intense as in class I. The stars of these two classes may be grouped together and called hydrogen stars. Stars belonging to class III. exhibit unmistakable evidence of carbon vapor. Sodium and iron are also often present. All the stars in this class, of which fifty-five are known, agree in having a reddish tint. They are usually faint, and seldom exceed the fourth magnitude. There is evidence of the existence of carbon vapor in the sun's atmosphere, depending upon one solitary fluting, and hence stars of this class probably represent what the sun would become if it were cooled. Class III. therefore represents a lower temperature than classes II. and I. Class IV., containing 475 known members, includes the stars giving fluted spectra with the darkest edges of the flutings towards the violet. The origin of the substances of which they are mainly composed is not at present known. All the principal bands are absolutely unchanging in position, although there is considerable variation in the intensities. The bands in the spectrum appear to result from the rhythmical vibrations of the same substance, probably a complex one. Besides this unknown substance, there are also metallic lines in many of the stars, the complete spectrum consisting of the banded spectrum superposed upon the line spectrum. The metallic lines are generally seen in the spectra of sodium, iron, magnesium, or calcium; the hydrogen lines are very inconspicuous.

Stellar evolution.

These considerations suggest the question of stellar evolution. Comets and nebulæ are now supposed to consist of clouds of stones or small meteorites, and the difference between their spectra may be due to a difference of temperature, that of the nebulæ being highest. Comets ordinarily give the spectrum of carbon, and, if we imagine such cometary matter to surround a central bright nucleus, we have the spectrum of a star of the third class. On the nebular hypothesis, starting with ordinary cometary materials, the small masses resulting from the first condensations gravitate towards each other, and their energy becomes heat by the retardation of their motion on coming in contact. As soon as the condensed mass is hot enough, it gives a fluted spectrum, like stars of the third class. As the energy of condensation increases, the temperature is raised and the spectrum passes from that of a third-class star to that of a second-class star, and then to that of a first-class star. On the subsequent cooling of what is then a star the successive stages will be again passed through in inverse order. According to this view, we ought to find fewer hydrogen stars than carbon stars, because every star is a carbon star at two periods of its existence, but a hydrogen star only once. On this point, however, nothing definite can be stated, as the stars of classes I. and II. have, in consequence of their greater brightness, received more attention than carbon stars.

New and variable stars.

In 1866 a star of the tenth magnitude in the constellation Corona suddenly flashed up into a star of nearly the first magnitude; its spectrum as a tenth magnitude star differed from its spectrum as a first or second,—the latter containing bright lines of hydrogen. In about a month it again became a tenth magnitude star and appeared as if nothing had happened to it. There can be little doubt that here there was a sudden increase of temperature, as evidenced by the spectrum becoming like that of the chromosphere of the sun. Ten years afterwards a new star appeared in Cygnus; it had never been seen before, but appeared suddenly as a third or fourth magnitude star. In about a year it gradually dwindled down to the tenth magnitude, and its spectrum became that of a nebula. This mass was at a stellar distance, but it cannot be considered to have been a large mass of incandescent material, for in that case it would have taken millions of years, instead of only one, to cool down to the tenth magnitude. A possible explanation of most of the new and variable stars is to be found in the meteorite theory; the innumerable components of one group of meteorites colliding with those of another group would be competent to give out light sufficient to make the whole appear as a star. Each meteorite gives only a little light, but the total must be very considerable. The new star in Cygnus, and similarly all new stars, may have been the result of a collision of two groups of meteorites. They die out quickly because the components are small and far apart. The sudden increase in the brilliancy of the star in Corona would be produced by a collision of a meteor swarm with the star already existing. (J. N. L.)

SUN-BIRD, a name more or less in use for many years,[1] and now generally accepted as that of a group of over 100 species of small birds, but when or by whom it was first applied is uncertain. Most of them are remarkable for their gaudy plumage, and, though those known to the older naturalists were for a long while referred to the genus *Certhia* (TREE-CREEPER, *q.v.*), or some other group, they are now fully recognized as forming a valid Family *Nectariniïdæ*, from the name *Nectarinia* invented in 1811 by Illiger. They inhabit the Ethiopian, Indian, and Australian Regions,[2] and, with some notable exceptions, the species mostly have but a limited range. They are considered to have their nearest allies in the *Meliphagidæ* (*cf.* HONEY-EATER, vol. xii. p. 142) and the members of the genus Zosterops; but their relations to the last require further investigation. Some of them are called "Humming-birds" by Anglo-Indians and colonists, but with that group, which, as before indicated (HUMMING-BIRD, vol. xii. p. 371),[3] belongs to the *Picariæ*, the Sun-birds, being true *Passeres*, have nothing to do. Though part of the plumage in many Sun-birds gleams with metallic lustre, they owe much of their beauty to feathers which are not lustrous, though yet almost as vivid,[4] and the most wonderful combination of the brightest colors—scarlet, purple, blue, green, and yellow—is often seen in one and the same bird. One group, however, is dull in hue, and but for the presence in some of its members of yellow or flame-colored precostal tufts, which are very characteristic of the Family, might at first sight be thought not to belong here. Graceful in form and active in motion, Sun-birds flit from flower to flower, feeding chiefly on small insects which are attracted by the nectar; but this is always done while perched, and never on the wing as is the habit of Humming-birds. The extensible tongue, though practically serving the same end in both groups, is essentially different in its quasi-tubular structure, and there is also considerable difference between this organ in the *Nectariniïdæ* and the *Meliphagidæ*.[5] The nests of the Sun-birds, domed with a penthouse porch, and pensile from the end of a bough or leaf, are very neatly built. The eggs are generally three in number, of a dull white covered with confluent specks of greenish gray.

The *Nectariniïdæ* form the subject of a sumptuous *Monograph* by Capt. Shelley (4to, London, 1876–1880), in the colored plates of which full justice is done to the varied beauties which these gloriously arrayed little beings display, while, almost every available source of information having been consulted and the results embodied, the text leaves little to be desired, and of course supersedes all that had before been published about them. This author divides the Family into three subfamilies: *Neodrepaninæ*, consisting of a single genus and species peculiar to Madagascar; *Nectariniinæ*, containing 9 genera, one of which, *Cinnyris*, has more than half the number of species in the whole group; and *Arachnotherinæ* (sometimes known as "Spider-hunters"), with 2 genera including 11 species—all large in size and plain in hue. To these he also adds the genus *Promerops*,[6] composed of 2 species of South-African birds, of very different appearance, and the affinity of which to the rest can as yet hardly be taken as proved. According to Mr. Layard, the habits of the Cape Promerops, its mode of nidification, and the character of its eggs are very unlike those of the ordinary *Nectariniïdæ*. In the British Museum *Catalogue of Birds* (vol. ix. pp. 1–126, and 291) Dr. Gadow has more recently treated of this Family, reducing the number of both genera and species, though adding a new genus discovered since the publication of Capt. Shelley's work. (A. N.)

SUN-BITTERN, otherwise the CAURÂLE,[7] the *Eurypyga helias* of ornithology, a bird that has long exercised systematists and one whose proper place can scarcely yet be said to have been determined to everybody's satisfaction.

According to Pallas, who in 1781 gave (*N. nördl. Beyträge*, ii. pp. 48–54, pl. 3) a good description and fair figure of it, calling it the "Surinamische Sonnenreyger," *Ardea helias*, the first author to notice this form was Fermin, whose account of it, under the name of "Sonnenvogel," was published at Amsterdam in 1759 (*Descr., etc., de Surinam*, ii. p. 192), but was vague and meagre. In 1772, however, it was satisfactorily figured and described in Rozier's *Observations sur la Physique*, etc. (v. pt. 1, p. 212, pl. 1), as the *Petit Paon des roseaux*—by which name it was known in Cayenne.[8] A few years later D'Aubenton figured it in his well-known series (*Pl. Enl.*, 782), and then in 1781 came Buffon (*H. N., Oiseaux*, viii. pp. 169, 170, pl. xiv.), who, calling it "Le Caurâle ou petit Paon des roses," announced it as hitherto undescribed, and placed it among the Rails. In the same year appeared the above-cited paper by Pallas, who, notwithstanding his remote abode, was better informed as to its history than his great contemporary, whose ignorance, real or affected, of his fellow-countryman's priority in the field is inexplicable; and it must have been by inadvertence that, writing "roses" for "roseaux," Buffon turned the colonial name from one that had a good meaning into nonsense. In 1783 Boddaert, equally ignorant of what Pallas had done, called it *Scolopax solaris*,[9] and in referring it to that genus he was followed by Latham (*Synopsis*, iii. p. 156), by whom it was introduced to English readers as the "Caurale Snipe." Thus within a dozen years this bird was referred to three perfectly distinct genera, and in those days genera meant much more than they do now. Not until 1811 was it recognized as forming a genus of its own. This was done by Illiger, whose appellation *Eurypyga* has been generally accepted.

The Sun-Bittern is about as big as a small Curlew, but with much shorter legs and a rather slender, slightly decurved bill, blunt at the tip. The wings are moderate, broad, and rounded, the tail rather long and broad. The head is black with a white stripe over and another under each eye, the chin and throat being also white. The rest of the plumage is not to be described in a limited space otherwise than generally, being variegated with black, brown, chestnut, bay, buff, gray, and white—so mottled, speckled, and belted either in wave-like or zigzag forms as somewhat to resemble certain moths. The bay color forms two conspicuous patches on each wing, and also an antepenultimate bar on the tail, behind which is a subterminal band of black. The irides are red; the bill is greenish olive; and the legs are pale yellow. As in the case of most South-American birds, very little is recorded of its habits in freedom, except that it frequents the muddy and wooded banks of rivers, feeding on small fishes and insects. In captivity it soon becomes tame, and has several times made its nest and reared its young (which, when hatched, are clothed with mottled down; *Proc. Zool. Society*, 1866, p. 76, pl. ix. Fig. 1) in the Zoological Gardens (London), where examples are generally to be seen and their plaintive piping heard. It ordinarily walks with slow and precise steps, keeping its body in a horizontal position, but at times, when excited, it will go through a series of fantastic performances, spreading its broad wings and tail so as to display their beautiful markings. This species inhabits Guiana and the interior of Brazil; but in Colombia and Central America occurs a larger and somewhat differently colored form which is known as *E. major*.

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[1] Certainly since 1826 (*cf.* Stephens, *Gen. Zoology*, xiv. pt. 1, p. 229). Swainson (*Nat. Hist. and Classif. Birds*, i. p. 145) says they are "so called by the natives of Asia in allusion to their splendid and shining plumage," but gives no hint as to the nation or language wherein the name originated. By the French they have been much longer known as "Souimangas," from the Madagascar name of one of the species given in 1658 by Flacourt as *Soumangha*.

[2] One species occurs in Baluchistan, which is perhaps outside of the Indian Region, but the fact of its being found there may be a reason for including that country within the Region, just as the presence of another species in the Jordan valley induces zoographers to regard the Ghór as an outlier of the Ethiopian Region.

[3] [Mr. Newton has not indicated in vol. xii. p. 371 that he places the Humming-bird among the *Picariæ*, but he does in ORNITHOLOGY, vol. xviii. p. 51.—AM. ED.]

[4] *Cf.* Gadow, *Proc. Zool. Society*, 1882, pp. 409–421, pls. xxvii. xxviii.

[5] *Cf.* Gadow, *Proc. Zool. Society*, 1883, pp. 62–69, pl. xvi.

[6] According to Brisson (*Ornithologie*, ii. p. 460), this name was the invention of Réaumur. It seems to have become Anglicized.

[7] A name, says Buffon, intended to mean *Râle à queue*, that is, a tailed Rail.

[8] This figure and description were repeated in the later issue of this work in 1777 (i. pp. 679–681, pl. 1).

[9] Possibly he saw in the bird's variegated plumage a resemblance to the Painted Snipes, *Rhynchæa*. His specific name shows that he must have known how the Dutch in Surinam called it.

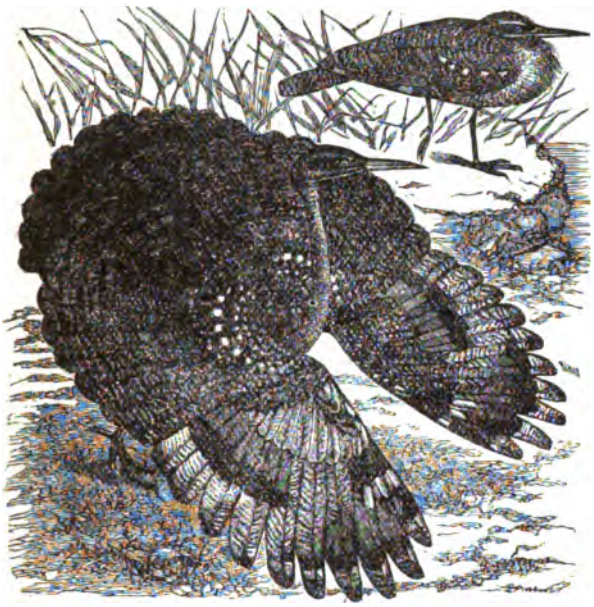

Fig. 1.—Sun-Bittern (*Eurypyga helias*).

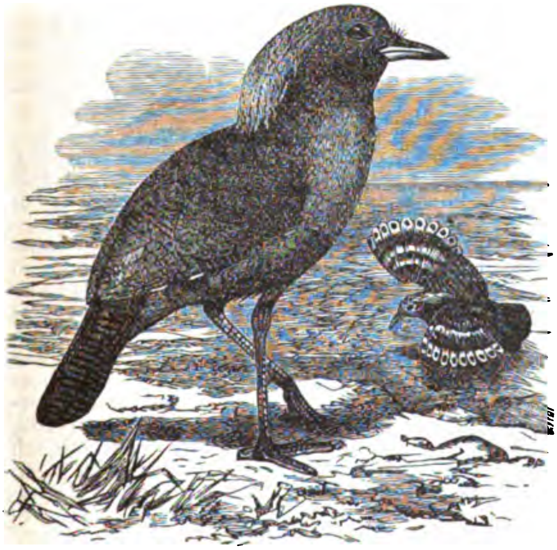

Fig. 2.—Kagu (*Rhinochetus jubatus*).

For a long while it seemed as if *Eurypyga* had no near ally, but, on the colonization of New Caledonia by the French, an extremely curious bird was found inhabiting most parts of that island, to which it is peculiar. This the natives called the Kagu, and it is the *Rhinochetus jubatus* of ornithology. Its original describers, MM. Jules Verreaux and Des Murs, regarded it first as a Heron and then as a Crane (*Rev. et Mag. de Zoologie*, 1860, pp. 439–441, pl. 21; 1862, pp. 142–144); but, on Mr. George Bennett sending two live examples to the Zoological Gardens, Mr. Bartlett quickly detected in them an affinity to *Eurypyga* (*Proc. Zool. Society*, 1862, pp. 218, 219, pl. xxx.), and in due time anatomical investigation showed him to be right. The Kagu, however, would not strike the ordinary observer as having much outward resemblance to the Sun-Bittern, of which it has neither the figure nor posture. It is rather a long-legged bird, about as large as an ordinary Fowl, walking quickly and then standing almost motionless, with bright red bill and legs, large eyes, a full pendent crest, and is generally of a light slate-color, paler beneath, and obscurely barred on its longer wing-coverts and tail with a darker shade. It is only when it spreads its wings that these are seen to be marked and spotted with white, rust-color, and black, somewhat after the pattern of those of the Sun-Bittern. Like that bird too, the Kagu will, in moments of excitement, give up its ordinary placid behavior and execute a variety of violent gesticulations, some of them even of a more extraordinary kind, for it will dance round, holding the tip of its tail or of one of its wings in a way that no other bird is known to do. Its habits in its own country were described at some length in 1863 by M. Jouan (*Mém. Soc. Sc. Nat. Cherbourg*, ix. pp. 97 and 235), and in 1870 by M. Marie (*Actes Soc. Linn. Bordeaux*, xxvii. pp. 323–326), the last of whom predicts the speedy extinction of this interesting form, a fate foreboded also by the statement of Messrs. Layard (*Ibis*, 1882, pp. 534, 535) that it has nearly disappeared from the neighborhood of the more settled and inhabited parts.

The internal and external structure of both these remarkable forms has been treated in much detail by Prof. Parker in the Zoological *Proceedings* (1864, pp. 70–72) and *Transactions* (vi. pp. 501–521, pls. 91, 92; x. pp. 307–310, pl. 54, Figs. 7–9), as also by Dr. Murie in the latter work (vii. pp. 465–492, pls. 56, 57), and the result of their researches shows that they, though separable as distinct Families, *Eurypygidæ* and *Rhinochetidæ* belong to Prof. Huxley's *Geranomorphæ*, of which they must be deemed the relics of very ancient and generalized types. Their inter-relations to the *Rallidæ* (Rail, vol. xx. pp. 229–30), *Psophiidæ* (Trumpeter, *q.v.*), and other groups there is not space here to consider, any more than there is to speculate on the bearings of their geographical position. It is only to be remarked that the eggs of both *Eurypyga* and *Rhinochetus* have a very strong Ralline appearance—stronger even than the figures published (*Proc. Zool. Society*, 1868, pl. xii.) would indicate.

(A. N.)

SUNDA ISLANDS, the collective name of the whole series of islands in the East Indian Archipelago which extend from the peninsula of Malacca to New Guinea. They are divided into the Great Sunda Islands—*i.e.*, Sumatra, Java, Borneo, Celebes, Banca, and Billiton, with their adjacencies—and the Little Sunda Islands, of which the more important are Bali, Lombok, Sumbawa, Flores, Sandalwood Island, Adanara, Solor, Savu, Pantar, etc.

Sunda Strait is the channel separating Sumatra from Java, and uniting the Indian Ocean with the Java Sea. It is 15 miles broad between the southmost point of Sumatra and the town of Anjer in Java. Right in the middle is the low-lying, well-wooded island of Dwars in den Weg, otherwise Middle Island or Sungian. In 1883 Sunda Strait was the scene of the most terrific results of the eruption of Krakatoa, a volcano on the west side of the strait. The greater part of the island of Krakatoa was destroyed and two new islands, Steers Island and Calmeyer Island, were thrown up.

SUNDARBANS. See Ganges, vol. x. p. 62.

SUNDAY, or The Lord's Day (ἡ τοῦ ἡλίου ἡμέρα, *dies Solis*; ἡ κυριακὴ ἡμέρα, *dies dominica*, *dies domini-*

cus[1]). According to all the four evangelists, the resurrection of our Lord took place on the first day of the week after His crucifixion (*ἡ μία [τῶν] σαββάτων*: Matt. xxviii. 1, Mark xvi. 2, Luke xxiv. 1, John xx. 1; *πρώτῃ σαββάτου*: Mark xvi. 9), and the Fourth Gospel describes a second appearance to His disciples as having occurred eight days afterwards (John xx. 26). Apart from this central fact of the Christian faith, the Pentecostal outpouring of the Spirit, seven weeks later, described in Acts ii., cannot have failed to give an additional sacredness to the day in the eyes of the earliest converts.[2] Whether the primitive church in Jerusalem had any special mode of observing it in its daily meetings held in the temple (Acts ii. 46) we cannot tell; but as there is no doubt that in these gatherings the recurrence of the Sabbath was marked by appropriate Jewish observances, so it is not improbable that the worship on the first day of the week had also some distinguishing feature. Afterwards, at all events, when Christianity had been carried to other places where from the nature of the case daily meetings for worship were impossible, the first day of the week was everywhere set apart for this purpose. Thus Acts xx. 7 shows that the disciples in Troas met weekly on the first day of the week for exhortation and the breaking of bread; 1 Cor. xvi. 2 implies at least some observance of the day; and the solemn commemorative character it had very early acquired is strikingly indicated by an incidental expression of the writer of the Apocalypse (i. 10), who for the first time gives it that name ("the Lord's day") by which it is almost invariably referred to by all writers of the century immediately succeeding apostolic times.[3] Among the indications of the nature and universality of its observance during this period may be mentioned the precept in the (recently discovered) *Teaching of the Apostles* (c. 14): "And on the Lord's day of the Lord (*κατὰ κυριακὴν κυρίου*) come together and break bread and give thanks after confessing your transgressions, that your sacrifice may be pure." Ignatius (*Ad magn.*, c. 9) speaks of those whom he addresses as "no longer Sabbatizing, but living in the observance of the Lord's day (*κατὰ κυριακὴν ζῶντες*), on which also our life sprang up again."[4] Eusebius (*H. E.*, iv. 23) has preserved a letter of Dionysius of Corinth (175 A.D.) to Soter, bishop of Rome, in which he says: "To-day we have passed the Lord's holy day, in which we have read your epistle"; and the same historian (*H.E.*, iv. 26) mentions that Melito of Sardis (170 A.D.) had written a treatise on the Lord's day. Pliny's letter to Trajan in which he speaks of the meetings of the Christians "on a stated day" need only be alluded to. The first writer who mentions the name of Sunday as applicable to the Lord's day is Justin Martyr; this designation of the first day of the week, which is of heathen origin (see SABBATH, vol. xxi. p. 134), had come into general use in the Roman world shortly before Justin wrote. The passage is too well known to need quotation (*Apol.* i., 67) in which he describes how "on the day called Sunday" town and country Christians alike gathered together in one place for instruction and prayer and charitable offerings and the distribution of bread and wine; they thus meet together on that day, he says, because it is the first day in which God made the world, and because Jesus Christ on the same day rose from the dead.

As long as the Jewish Christian element continued to have any prominence or influence in the church, a tendency more or less strong to observe Sabbath as well as Sunday would of course persist. Eusebius (*H. E.*, iii. 27) mentions that the Ebionites continued to keep both days, and there is abundant evidence from Tertullian onwards that so far as public worship and abstention from fasting are concerned the practice was widely spread among the Gentile churches. Thus we learn from Socrates (*H. E.*, vi. c. 8) that in his time public worship was held in the churches of Constantinople on both days; the *Apostolic Canons* (can. 66 [65]) sternly prohibit fasting on Sunday or Saturday (except Holy Saturday); and the injunction of the *Apostolic Constitutions* (v. 20; cp. ii. 59, vii. 23) is to "hold your solemn assemblies and rejoice every Sabbath day (excepting one), and every Lord's day." In the primitive church the social conditions were such as hardly to admit of the question being raised, in Gentile circles at any rate, as to the manner in which either the Lord's day or the Sabbath ought further to be kept after the duty of congregational worship (usually early in the morning or late in the evening) had been discharged; but the whole matter was placed on an entirely new footing when the civil power, by the constitution of Constantine mentioned below, began to legislate as to the Sunday rest. The fourth commandment, holding as it does a conspicuous place in the decalogue, the precepts of which could not for the most part be regarded as of merely transitory obligation, had never of course escaped the attention of the fathers of the church; but, remembering the liberty given in the Pauline writings "in respect of a feast day or a new moon or a Sabbath" (Col. ii. 16; cf. Rom. xiv. 5, Gal. iv. 10, 11), they usually explained the "Sabbath day" of the commandment as meaning the new era that had been introduced by the advent of Christ, and interpreted the rest enjoined as meaning cessation from sin.[5] But, when a series of imperial decrees had enjoined with increasing stringency an abstinence from labor on Sunday, it was inevitable that the Christian conscience should be roused on the subject of the Sabbath rest also, and in many minds the tendency would be such as finds expression in the *Apostolic Constitutions* (viii. 33): "Let the slaves work five days; but on the Sabbath day and the Lord's day let them have leisure to go to church for instruction in piety." There is evidence of the same tendency in the opposite canon (29) of the council of Laodicea (363), which forbids Christians from Judaizing and resting on the Sabbath day, and actually enjoins them to work on that day, preferring the Lord's day and so far as possible resting as Christians. About this time accordingly we find traces of a disposition in Christian thinkers to try to distinguish between a temporary and a permanent element in the Sabbath day precept; thus Chrysostom (10th homily on Genesis) discerns the fundamental principle of that precept to be that we should dedicate one whole day in the circle of the week and set it apart for exercise in spiritual things. The view that the Christian Lord's day or Sunday is but the Christian Sabbath deliberately transferred from the seventh to the first day of the week does not indeed find categorical expression till a much later period, Alcuin being apparently the first to allege of the Jewish Sabbath that "ejus observationem mos Christianus ad diem dominicam competentius transtulit" (compare DECALOGUE, vol. vii. p. 17). But the subjoined sketch will incidentally show how soon and to how large an extent this idea has influenced the course of civil legislation on the subject.

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[1] The Teutonic and Scandinavian nations adopt the former designation (*Sunday*, *Sonntag*, *Söndag*, etc.), the Latin nations the latter (*Dimanche*, *Domenica*, *Domingo*, etc.).

[2] From an expression in the Epistle of Barnabas (c. 15), it would almost seem as if the ascension also was believed by some to have taken place on a Sunday.

[3] In the Epistle of Barnabas already referred to (c. 15) it is called "the eighth day": "We keep the eighth day with joyfulness, the day also in which Jesus rose again from the dead." Comp. Justin Martyr, *Dial. c. Tryph.*, c. 138.

[4] The longer recension runs: "But let every one of you keep the Sabbath after a spiritual manner. . . . And after the observance of the Sabbath let every friend of Christ keep the Lord's day as a festival, the resurrection day, the queen and chief of all the days." The writer finds a reference to the Lord's day in the titles to Pss. vi. and xii., which are "set to the eighth."

[5] See Ignat., *Ad Magn.*, *ut supra*, and Ep. of Barnabas (c. 15): "Your present Sabbaths are not acceptable unto me, but that is which I have made when, giving rest to all things, I shall make a beginning of the eighth day." So practically Tertullian (*Resp. ad Jud.*, c. 4) and Clement of Alexandria. According to Augustine also (*De Sp. et Lit.*, 14), the observance of the Sabbath is to be taken in a spiritual sense.

Law relating to Sunday.

The earliest recognition of the observance of Sunday as a legal duty is a constitution of Constantine in 321 A.D., enacting that all courts of justice, inhabitants of towns, and workshops were to be at rest on Sunday (*venerabili die Solis*), with an exception in favor of those engaged in agricultural labor. This was the first of a long series of imperial constitutions, most of which are incorporated in the Code of Justinian, bk. iii. tit. 12 (*De Feriis*). The constitutions comprised in this title of the code begin with that of Constantine, and further provide that emancipation and manumission were the only legal proceedings permissible on the Lord's day (*die dominico*), though contracts and compromises might be made between the parties where no intervention of the court was necessary. Pleasure was forbidden as well as business. No spectacle was to be exhibited in a theatre or circus. If the emperor's birthday fell on a Sunday, its celebration was to be postponed. The seven days before and after Easter were to be kept as Sundays. In Cod. i. 4, 9, appears the humane regulation that prisoners were to be brought up for examination and interrogation on Sunday. On the other hand, Cod. iii. 12, 10, distinctly directs the torture of robbers and pirates, even on Easter Sunday, the divine pardon (says the law) being hoped for where the safety of society was thus assured. After the time of Justinian the observance of Sunday appears to have become stricter. In the West Charlemagne forbade labor of any kind. A century later in the Eastern empire No. liv. of the Leonine constitutions abolished the exemption of agricultural labor contained in the constitution of Constantine. It is worthy of notice that this exemption was specially preserved in England by a constitution of Archbishop Meopham. The canon law followed the lines of Roman law. The decrees of ecclesiastical councils on the subject have been very numerous. Much of the law is contained in the Decretals of Gregory, bk. ii. tit. 9 (*De Feriis*), c. 1 of which (translated) runs thus: "We decree that all Sundays be observed from vespers to vespers (*a vespera ad vesperam*), and that all unlawful work be abstained from, so that in them trading or legal proceedings be not carried on, or any one condemned to death or punishment, or any oaths be administered, except for peace or other necessary reason." Works of necessity (especially in the case of perishable materials or where time was important, as in fishing) were allowed, on condition that a due proportion of the gain made by work so done was given to the church and the poor. The consent of parties was insufficient to give jurisdiction to a court of law to proceed on Sunday, though it was sufficient in the case of a day sanctified by the ecclesiastical authority for a temporary purpose, *e.g.*, a thanksgiving for vintage or harvest.

In England legislation on the subject began early and continues down to the most modern times. As early as the 7th century the laws of Ina, king of the West Saxons, provided that, if a "theowman" worked on Sunday by his lord's command, he was to be free and the lord to be fined 30s. [$7.29]; if a freeman worked without his lord's command, the penalty was forfeiture of freedom or a fine of 60s. [$14.58], and twice as much in the case of a priest. The laws of Æthelstan forbade marketing, of Æthelred folkmoots and hunting, on the Sunday. In almost all the pre-Conquest compilations there are admonitions to keep the day holy. The first allusion to Sunday in statute law proper is the Act of 28 Edw. III. c. 14 (now repealed), forbidding the sale of wool at the staple on Sunday. The mass of legislation from that date downwards may be divided, if not with strict accuracy, at least for purposes of convenience, into five classes,—ecclesiastical, constitutional, judicial, social, and commercial. The following sketch of the legislation can scarcely presume to be exhaustive, but it will probably be found not to omit any statute of importance. It should be noticed that the terms "Sunday" and "Lord's day" are used in statutes. The term "Sabbath" occurs only in ordinances of the Long Parliament. "Sabbath-breaking" is sometimes used as a popular expression for a violation of the Acts for Sunday observance, but it is objected to by Blackstone as being legally incorrect. Good Friday and Christmas Day are as a rule in the same legal position as Sunday. In English law Sunday is reckoned from midnight to midnight, not as in canon law *a vespera ad vesperam*. The Acts mentioned below are still law unless repeal of any of them is specially mentioned.

Ecclesiastical.—Before the Reformation there appears to be little or no statutory recognition of Sunday, except as a day on which trade was interdicted or national sports directed to be held. Thus the repealed Acts 12 Ric. II. c. 6 and 11 Hen. IV. c. 4 enjoined the practice of archery on Sunday. The church itself by provincial constitutions and other means declared the sanctity of the day, and was strong enough to visit with its own censures those who failed to observe Sunday. With the Reformation, however, it became necessary to enforce the observance of Sunday by the state in face of the question mooted at the time as to the divine or merely human institution of the day as a holy day. Sunday observance was directed by injunctions of both Edward VI. and Elizabeth, as well as by Acts of Parliament in their reigns. 5 and 6 Edw. VI. c. 1 (the second Act of Uniformity) enacted that all inhabitants of the realm were to endeavor themselves to resort to their parish church or chapel accustomed, or upon reasonable let thereof to some usual place where common prayer is used every Sunday, upon pain of punishment by the censures of the church. This is still law except as to Dissenters (see 9 and 10 Vict. c. 59). The same principle was re-enacted in the Act of Uniformity of Elizabeth (1 Eliz. c. 2), with the addition of a temporal punishment, viz., a fine of twelve pence for each offence. This section of the Act is, however, no longer law, and it appears that the only penalty now incurred by non-attendance at church is the shadowy one of ecclesiastical censure. 5 and 6 Edw. VI. c. 3 directed the keeping of all Sundays as holy days, with an exception in favor of husbandmen, laborers, fishermen, and other persons in harvest or other time of necessity. At the end of the reign of Elizabeth canon 13 of the canons of 1603 (which are certainly binding upon the clergy, and probably upon the laity as far as they are not contrary to the law, statutes, and customs of the realm, or the royal prerogative) provided that "all manner of persons within the Church of England shall celebrate and keep the Lord's day, commonly called Sunday, according to God's holy will and pleasure and the orders of the Church of England prescribed in that behalf, that is, in hearing the word of God read and taught, in private and public prayers, in acknowledging their offences to God and amendment of the same, in reconciling themselves charitably to their neighbors where displeasure hath been, in oftentimes receiving the communion of the body and blood of Christ, in visiting the poor and sick, using all godly and sober conversation." The Long Parliament, as might be expected, occupied itself with the Sunday question. An ordinance of 1644, c. 51, directed the Lord's day to be celebrated as holy, as being the Christian Sabbath. Ordinances of 1650, c. 9, and 1656, c. 15, contained various minute descriptions of crimes against the sanctity of the Lord's day, including travelling and "vainly and profanely walking." The Act of Uniformity of Charles II. (13 and 14 Car. II. c. 4) enforced the reading on every Lord's day of the morning and evening prayer according to the form in the book of Common Prayer,—a duty which had been previously enjoined by canon 14. By the first of the Church Building Acts (58 Geo. III. c. 45, s. 65) the bishop may direct a third service, morning or evening, where necessary, in any church built under the Act. By 1 and 2 Vict. c. 106, s. 80, he may order the performance of two full services, each if he so direct to include a sermon. The Burial Laws Amendment Act, 1880, forbids any burial under the Act taking place on Sunday.

Constitutional.—Parliament has occasionally sat on Sunday in cases of great emergency, as on the demise of the crown. In one or two cases in recent years divisions in the House of Commons have taken place early on Sunday morning. The Ballot Act, 1872, enacts that in reckoning time for election proceedings Sundays are to be excluded. A similar provision is contained in the Municipal Corporations Act, 1882, as to proceedings under that Act.

Judicial.—As a general rule Sunday for the purpose of judicial proceedings is a *dies non*. Legal process cannot be served or executed on Sunday, except in cases of treason, felony, or breach of the peace (29 Car. II. c. 7, s. 6). Proceedings which do not need the intervention of the court are good, *e.g.*, service of a citation or notice to quit or claim to vote. By 11 and 12 Vict. c. 42, s. 4, a justice may issue a warrant of apprehension or a search warrant on Sunday. The Rules of the Supreme Court, 1883, provide that the offices of the Supreme Court shall be closed on Sundays, that Sunday is not to be reckoned in the computation of any limited time less than six days allowed for doing any act or taking any proceeding, and that, where the time for doing any act or taking any proceeding expires on Sunday, such act or proceeding is good if done or taken on the next day. By the County Court Rules, 1886, the only county court process which can be executed on Sunday is a warrant of arrest in an Admiralty action.

Social.—Under this head may be grouped the enactments having for their object the regulation of Sunday travelling and amusements. The earliest example of non-ecclesiastical interference with recreation appears to be the *Book of Sports* issued by James I. in 1618. Royal authority was given to all but recusants to exercise themselves after evening service in dancing, archery, leaping, vaulting, May-games, Whitsun-ales, morris-dances, and setting up of May-poles; but bear and bull baiting, interludes, and bowling by the meaner sort were prohibited. In 1625 the first Act of the reign of Charles I. (1 Car. I. c. 1), following the lines of the *Book of Sports*, inhibited meetings, assemblies, or concourse of people out of their own parishes on the Lord's day for any sports and pastimes whatsoever, and any bear-baiting, bull-baiting, interludes, common plays, or other unlawful exercises and pastimes used by any person or persons within their own parishes, under a penalty of 3s. 4d. for every offence. The Act, it will be noticed, impliedly allows sports other than the excepted ones as long as only parishioners take part in them. An Act which has had more important consequences in recent years is 21 Geo. III. c. 49 (drawn by Dr. Porteus, bishop of London). It enacts that any place opened or used for public entertainment and amusement or for public debate upon any part of the Lord's day called Sunday, to which persons are admitted by payment of money or by tickets sold for money, is to be deemed a disorderly house. The keeper is to forfeit £200 [$972] for every day on which it is opened or used as aforesaid on the Lord's day, the manager or master of the ceremonies £100 [$486], and every doorkeeper or servant £50 [$243]. The advertising or publishing any advertisement of such an entertainment is made subject to a penalty of £50 [$243]. It has been held that a meeting the object of which was not pecuniary gain (though there was a charge for admission), but an honest intention to introduce religious worship, though not according to any established or usual form, was not within the Act. On this principle forms of worship most directly opposed to the prevailing feeling of the country, such as Mormonism or Mohammedanism, are protected. In 1875 actions were brought in the Courts of Queen's Bench and Exchequer against the Brighton Aquarium Company, and penalties recovered under the Act. The penalties were remitted by the crown; but, as doubts were felt as to the power of the crown to remit in such a case, 38 and 39 Vict. c. 80 was passed to remove such doubts and to enable the sovereign to remit in whole or in part penalties recovered for offences against the Act of Geo. III. The rules made by justices and the by-laws made by local authorities for the government of theatres and places of public entertainment usually provide for closing on Sunday. The Sunday opening of museums and art galleries is governed by local regulations; there is no general law on the subject, though attempts have been made in that direction. The House of Lords recently passed a resolution in favor of the principle. A public billiard table must not be used on Sunday (8 and 9 Vict. c. 109). The Game Act (1 and 2 Will. IV. c. 32, s. 3) makes it punishable with a fine of £5 [$24.30] to kill game or use a dog or net for sporting purposes on Sunday. Provisions for the regulation of street traffic on Sundays during divine service in the metropolis and provincial towns may be made by the local authorities under the powers of the Metropolis Management Acts, the Town Police Clauses Act, and the Public Health Act. Hackney carriages may ply for hire in London (1 and 2 Will. IV. c. 22). Where a railway company runs trains on Sunday one cheap train each way is to be provided (7 and 8 Vict. c. 85, s. 10). Most of the railway companies' own Acts also provide for the running of Sunday trains.

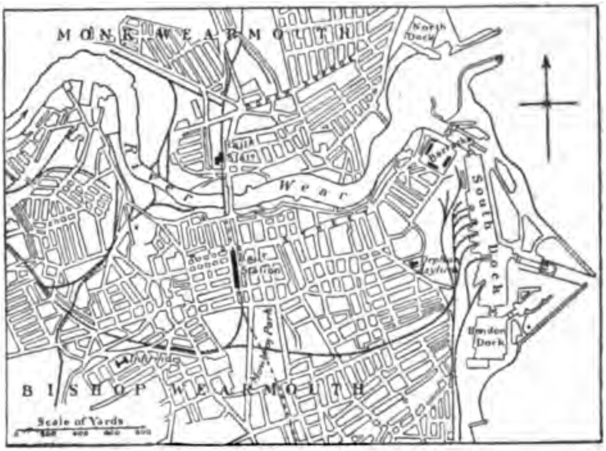
Commercial.—At common law a contract made on Sunday is not void, nor is Sunday trading or labor unlawful. At an early period, however, the legislature began to impose restrictions, at first by making Sunday trade impossible by closing the places of ordinary business, later by declaring certain kinds of trade and labor illegal, still later by attempting to prohibit all trade and labor. 28 Edw. III. c. 14 (referred to above) closed the wool market on Sunday. 27 Hen. VI. c. 5 (the earliest Sunday Act still in force) prohibited fairs and markets on Sunday (necessary victual only excepted), unless on the four Sundays in harvest,—an exemption since repealed by 13 and 14 Vict. c. 23. 4 Edw. IV. c. 7 (now repealed) restrained the shoemakers of London from carrying on their business on Sunday. 3 Car. I. c. 1 inflicted a penalty of 20s. [$4.86] on any carrier or drover travelling on the Lord's day, and a penalty of 6s. 8d. [$1.62] on any butcher killing or selling on that day. Both this and the previous Act of 1625 were originally passed only for a limited period, but by subsequent legislation they have become perpetual. Next in order is the most comprehensive Act on the subject, 29 Car. II. c. 7, "An Act for the better observance of the Lord's day, commonly called Sunday." After an exhortation to the observation of the Lord's day by exercises in the duties of piety and true religion, publicly and privately, the Act provides as follows: No tradesman, artificer, workman, laborer, or other person whatsoever shall do or exercise any worldly labor, business, or work of their ordinary callings upon the Lord's day or any part thereof (works of necessity and charity only excepted); and every person being of the age of fourteen years or upwards offending in the premises shall for every such offence forfeit the sum of 5s. [$1.21]; and no person or persons whatsoever shall publicly cry, show forth, or expose to sale any wares, merchandises, fruit, herbs, goods, or chattels whatsoever upon the Lord's day or any part thereof upon pain that every person so offending shall forfeit the same goods so cried, or showed forth, or exposed to sale (s. 1). No drover, horse-courser, wagoner, butcher, higgler, their or any of their servants, shall travel or come into his or their lodging upon the Lord's day or any part thereof, upon pain that each and every such offender shall forfeit 20s. [$4.86] for every such offence; and no person or persons shall use, employ, or travel upon the Lord's day with any boat, wherry, lighter, or barge, except it be upon extraordinary occasion to be allowed by some justice of the peace, etc., upon pain that every person so offending shall forfeit and lose the sum of 5s. [$1.21] for every such offence. In default of distress or non-payment of forfeiture or penalty the offender may be set publicly in the stocks for two hours (s. 2). Nothing in the Act is to extend to the prohibiting of dressing of meat in families, or dressing or selling of meat in inns, cooks' shops, or victualling houses for such as cannot be otherwise provided, nor to the crying or selling of milk before nine in the morning or after four in the afternoon (s. 3). Prosecutions must be within ten days after the offence (s. 4). The hundred is not responsible for robbery of persons travelling upon the Lord's day (s. 5). Service of process on the Lord's day is void; see above (s. 6). This Act has frequently received judicial construction. The use of the word "ordinary" in section 1 has led to the establishment by a series of decisions of the principle that work done out of the course of the ordinary calling of the person doing it is not within the Act. Thus the sale of a horse on Sunday by a horse-dealer would not be enforcible by him and he would be liable to the penalty, but these results would not follow in the case of a sale by a person not a horse-dealer. Certain acts were held to fall within the exception as to works of necessity and charity, *e.g.*, baking provisions for customers, running stage-coaches, hiring farm-laborers. The legislature also intervened to obviate some of the inconveniences caused by the Act. By 10 and 11 Will. III. c. 24 mackerel was allowed to be sold before and after service. By 11 and 12 Will. III. c. 21 forty watermen were allowed to ply on the Thames on Sunday. By 9 Anne c. 23 licensed coachmen or chairmen might be hired on Sunday. By 34 Geo. III. bakers were allowed to bake and sell bread at certain hours. These Acts are all repealed. Still law are 2 Geo. III. c. 15 s. 7, allowing fish carriages to travel on Sunday in London and Westminster; 7 and 8 Geo. IV. c. 75, repealing section 2 of the Act of Charles II. as far as regards Thames boatmen; and 6 and 7 Will. IV. c. 37, permitting bakers out of London to carry on their trade up to 1.30 P.M. The penalty of the stocks denounced by sect. 2 is practically obsolete (see STOCKS). The prosecution of offences under the Act of Charles II. is now subject to 34 and 35 Vict. c. 87 (an Act which was passed for a year, but has since been annually continued by the Expiring Laws Continuance Act of each session), by which no prosecution or proceeding for penalties under that Act can be instituted except with the consent in writing of the chief officer of a police district or the consent of two justices or a stipendiary magistrate. This is surely a more reasonable means of providing against any hardship caused by the Act than the *ex post facto* power of remission of penalties incurred under 21 Geo. III. c. 49. Besides the general Act of Charles II., there are various Acts dealing with special trades; of these the Licensing Acts and the Factory and Workshop Act are the most important. By the Licensing Act, 1874, premises licensed for the sale of intoxicating liquors by retail are to be open on Sunday only at certain hours, varying according as the premises are situate in the metropolitan district, a town or populous place, or elsewhere. An exception is made in favor of a person lodging in the house or a *bona fide* traveller, who may be served with refreshment during prohibited hours, unless in a house with a six-day license. Attempts have often been made, but hitherto without success, to induce the legislature to adopt the principle of complete Sunday closing in England as a whole, or in particular counties.[1] In the session of 1886 a Bill for Sunday closing in Durham was passed by the Commons, but rejected by the Lords. The advocates of Sunday closing in Ireland and Wales have been more successful. The Sale of Liquors on Sunday (Ire-

[1] The Act 1 James I. c. 9 (now repealed) appears, however, to have provided for closing ale-houses in most cases, except on usual working days.

land) Act, 1878, prohibits the opening of licensed premises on Sunday, except in Dublin, Cork, Limerick, Waterford, and Belfast. In these towns such premises may be opened from 2 P.M. to 7 P.M. Exemptions are also made in favor of lodgers and travellers, of packet-boats and railway stations. The Sunday Closing (Wales) Act, 1881, contains no exceptions of towns, like the Irish Act, and the only exemption is the sale of intoxicating liquors at railway stations. The Factory and Workshop Act, 1878, forbids the employment of a child, young person, or woman on Sunday in a factory or workshop. But a young person or woman of the Jewish religion may be employed on Sunday by a Jewish manufacturer, provided that the factory or workshop be not open for traffic on Sunday. There are a few other legislative provisions of less importance which may be noticed. Fishing for salmon on Sunday by any means other than a rod and line is an offence under the Salmon Fishery Act, 1861. By the same Act a free passage for the salmon through all cribs, etc., used for fishery is to be left during the whole of Sunday. Carrying on the business of a pawnbroker on Sunday is an offence within the Pawnbrokers Act, 1872. Distilling and rectifying spirits on Sunday is forbidden by the Spirits Act, 1880. The effect of Sunday upon bills of exchange is declared by the Bills of Exchange Act, 1882. A bill is not invalid by reason only of its bearing date on a Sunday (s. 13). Where the last day of grace falls on a Sunday, the bill is payable on the preceding business day (s. 14). Sunday is a "non-business day" for the purposes of the Act (s. 92). This review of Sunday legislation pretty clearly shows that its tendency at present is opposed to extending facilities to trade on Sunday, but that as to recreation the tendency is rather in the other direction.[1]

Scotland.—The two earliest Acts dealing with Sunday are somewhat out of harmony with the general legislation on the subject. 1457, c. 6, ordered the practice of archery on Sunday; 1526, c. 3, allowed markets for the sale of flesh to be held on Sunday at Edinburgh. Then came a long series of Acts forbidding the profanation of the day, especially by salmon fishing, holding fairs and markets, and working in mills and salt-pans. 1579, c. 70, and 1661, c. 18, prohibited all work and trading on the Sabbath. The later legislation introduced an exception in favor of duties of necessity and mercy, in accordance with ch. 21 of the Confession of Faith. In more modern times the exigencies of travelling have led to a still further extension of the exception. The Sabbath Observance Acts were frequently confirmed, the last time in 1696. These Acts were held by the High Court of Justiciary in 1870 to be still subsisting as far as they declare the keeping open shop on Sunday to be an offence by the law of Scotland (Bute's Case, 1 Couper's *Reports*, 495). The forms of certificate in the schedule to the Public Houses Acts Amendment Act, 1862 (superseding those in the Forbes Mackenzie Act of 1853), provide for the closing on Sunday of public-houses and of premises licensed for the sale of excisable liquors, and of inns and hotels, except for the accommodation of lodgers and travellers. Scots law is stricter than English in the matter of Sunday fishing. By 55 Geo. III. c. 94 the setting or hauling of a herring-net on Sunday renders the net liable to forfeiture. By the Salmon Fisheries (Scotland) Act, 1862, fishing for salmon on Sunday, even with a rod and line, is an offence. As to contracts and legal process, the law is in general accordance with that of England. Contracts are not void, apart from statute, simply because they are made on Sunday. Diligence cannot be executed, but a warrant of imprisonment or *meditatio fugæ* is exercisable. It should be noticed that, contrary to the English custom, the term "Sabbath" was generally used in the legislation of the Scottish parliament.

United States.—Some of the early colonial ordinances enforced the obligation of attendance at church, as in England. In most States there is legislation on the subject of Sunday, following, as a general rule, the lines of the English Act of Charles II. In Massachusetts travelling, except from necessity or charity, is punishable with a fine of ten dollars. Provision is sometimes made, as in the Massachusetts laws, for the benefit of persons observing Saturday as the Sabbath, on condition that they disturb no other person. The number of Sunday trains is often limited by State legislation. In some of the New England States Sunday is from sunset to sunset. In most States, however, it is reckoned, as in England, from midnight to midnight. By the constitution of the United States, art. I. s. 7, Sundays are to be excluded from the ten days allowed the president to return a Bill. A similar provision is often contained in State constitutions as to the return of a Bill by the governor. The United States legislation on the subject of Sunday is not important. It directs that naval and military studies are not to be pursued, and that the day is not to be reckoned in bankruptcy proceedings. (J. W†.)



Plan of Sunderland.

SUNDERLAND, a municipal and parliamentary borough, market town, and large seaport of Durham, England, is situated at the mouth of the river Wear and on the North-Eastern Railway, 12 miles southeast of Newcastle-on-Tyne and 77 north-northwest of York. The municipal borough includes, besides the township of Sunderland proper on the south bank of the river, the adjoining township of Bishopwearmouth, which embraces about three-fifths of the total inhabitants, and the township of Monkwearmouth, on the north bank of the river. Sunderland proper consists chiefly of the High Street and other streets near the docks. It is connected with Monkwearmouth by a cast-iron bridge, designed by Rowland Burdon, and consisting of one arch with a span of 236 feet and a height above low water of 100 feet. It was opened in 1796 and widened in 1858. The only ecclesiastical building of antiquarian interest is St. Peter's church, Monkwearmouth, which still retains the tower with other portions of the ancient Saxon building attached to the monastery founded by Benedict Biscop in 674. The modern public buildings embrace the custom-house (1837), the Sunderland and North Durham Liberal club in the Ionic style (1839), the corporation offices, the workmen's hall, the new general market, the Victoria hall (1871), the assembly hall, and two theatres. The charitable and benevolent institutions are numerous, including Gibson's almshouses (1725) for twelve poor persons, Bowe almshouses (1725), Trinity Church almshouses (1719, rebuilt in 1876) for eight aged poor, the marine almshouses (1820), the eye infirmary (1836), the sailors' home (1856), the orphan asylum (1853), the infirmary and dispensary (erected in 1868 and extended in 1882), and the blind institute, for which a new building has recently been erected. For the literary society and subscription library, originally founded in 1793, a new building was erected in 1877. The people's park at Bishopwearmouth, 17 acres in extent, contains a bronze statue of Sir Henry Havelock, who was born at Ford Hall in the neighborhood. The park was lately increased by an addition of 10 acres, called the Extension Park, in which there is a statue of Alderman Candlish, and a free library, museum, art gallery, and winter garden. Roker, on the north side of Sunderland, is a favorite bathing-place. The population of the municipal borough (area, 3306 acres) in 1871 was 98,242, and in 1881 it was 116,542 (males 57,131, females 59,411). The population of the parliamentary borough (area, 5130 acres) in the same years was 104,409 and 124,841 respectively.

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[1] See, in addition to the authorities cited, Lyndewode, *Provincial Constitutions*, bk. ii. chap. iii.; Ayliffe, *Parergon*, p. 470; Gibson, *Codex*, tit. x. chap. i.; Heylin, *History of the Sabbath*, part ii.; the article "Lord's Day" (by Bishop Barry) in the *Dictionary of Christian Antiquities*; and Hessey, *Sunday* (Bampton Lectures, 1860); also Robert Cox's works on the Sabbath

Much of the prosperity of Sunderland is due to the coal and limestone in the neighborhood of the river Wear, of which it is the port. Its export of coal began in the reign of Henry VII., the trade being principally with London and the western coasts of England, although large quantities were also shipped to Holland, France, and other parts of the Continent. The coal trade is still of great importance, and the Monkwearmouth colliery is one of the deepest coal-pits in the world,—381 fathoms. Sunderland vies with the Clyde for its iron shipbuilding. The number of iron ships built in 1885 was 31 with a tonnage of 30,520 for home and 2 with a tonnage of 1255 for foreigners; of steel ships, 9 with a tonnage of 8099 for home and 3 with a tonnage of 3635 for foreigners. Along both banks of the Wear numerous extensive works of various kinds are situated, including anchor and chain cable works, glass and bottle works, roperies, forges, iron-works, chemical works, paper-mills, breweries, and lime-kilns. The modern prosperity of the town has been largely promoted by the enterprise of George Hudson, the "railway king." The conservation of the port is vested in the Wear commissioners, to whose care the South Dock was transferred by the Wear Navigation and Sunderland Dock Act of 1859. Under their auspices great extensions and improvements have been made, and there are now three large deep-water docks, embracing a total area of 43 acres, viz., Hudson dock north (18), Hudson dock south (14), and Hendon dock (11). Monkwearmouth dock, 6 acres in extent and the property of the railway company, is chiefly used for the export of coal. New piers over half a mile in length are now (1887) being erected. The average annual value of the imports of foreign and colonial merchandise for the five years ending 1886 was a little over £700,000 [$3,402,000], and of the exports of produce of the United Kingdom a little over £600,000 [$2,916,000]. The coasting trade, in regard to which specific details are wanting, is, however, more important. The total number of British and foreign vessels, sailing and steam, that entered the port of Sunderland with cargoes or in ballast from foreign countries, British possessions, and coastwise in 1876 was 9708 of 2,329,576 tons and in 1885 9451 of 2,764,174 tons. The numbers that cleared in the same years were respectively 9430 of 2,357,430 tons and 9419 of 2,824,218 tons.

The early history of the borough is associated with Monkwearmouth, which existed long before the town on the other side of the river, and had its origin in a convent which was founded by St. Bega in the 7th century and converted into a monastery for Benedictines by Biscop in 674. Bede was born at Wearmouth in 673, and in his seventh year was placed under the charge of Biscop. The monastery was reconstituted as a cell of Durham in 1084. About the close of the 12th century the inhabitants of Sunderland received from Bishop Pudsey a charter of free customs and privileges similar to those of Newcastle-on-Tyne. In 1634 the town was incorporated under the title of "mayor, aldermen, and commonalty," with the privilege of holding a market and annual fairs. In the preamble of the charter it is stated to have been a borough from time immemorial under the name of New Monkwearmouth, and to have been in the enjoyment of various liberties and free customs conferred by the bishops of Durham. Under a special Act in 1851 the town council was constituted the urban sanitary authority. Extensive drainage works have been carried out, as well as important street improvements. Sunderland has returned two members to the House of Commons since 1832. A large number of Scotch families settled in the town in 1640 and gave a considerable impulse to its trade. During the Civil War the inhabitants embraced the cause of the Parliament, while the neighboring Newcastle held out for the king for two years. The Scottish army under Leslie, earl of Leven, entered Sunderland on 4th March, 1644, and the king's forces followed them; but no engagement took place beyond desultory firing.

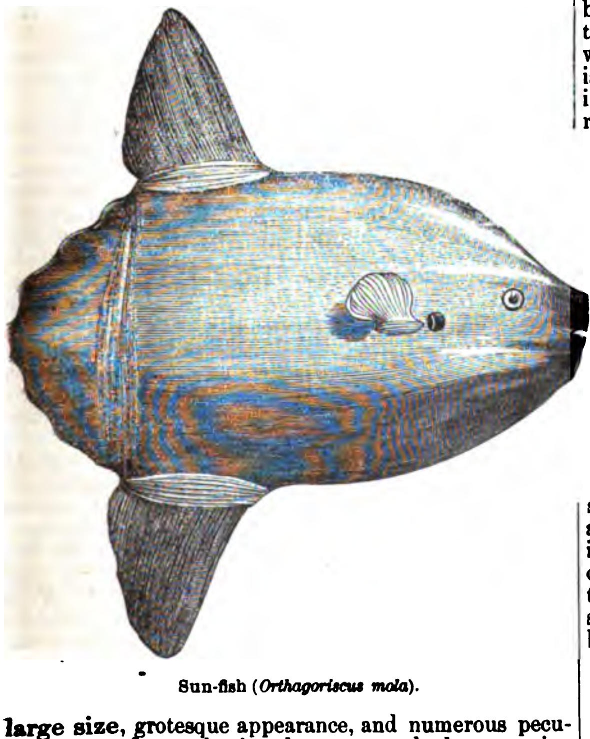
SUNDERLAND, Robert Spencer, Second Earl of (1640–1702), was the eldest son of Henry, the first earl, and Lady Dorothy Sidney, eldest daughter of Robert, second earl of Leicester. He was born in 1640 and succeeded his father (who was killed at Newbury) in the title on 20th September, 1643. During the years 1671–73 he acted as ambassador at Madrid, Paris, and Cologne consecutively, and in 1678 went to Paris as ambassador extraordinary. It was during this period of his life that he acquired that suppleness of feeling and love of finesse which may be traced throughout his subsequent career. From February, 1679, to January, 1681, a period when the country was rent in twain by real or fancied dangers to the Protestant faith he held the post of secretary of state for the northern department; but his conduct in office was not marked by discretion. He voted for the exclusion of the duke of York from the succession to the throne, and the ill-feeling which this action created in the mind of Charles II. was augmented by the overtures which Sunderland made to the prince of Orange, whilst differences of opinion on the subject of the Exclusion Bill brought about a fierce quarrel between Sunderland and Halifax, the head of the "trimmers." Early in 1683, having been reconciled to the duke of York and having secured a warm friend in the duchess of Portsmouth, Sunderland regained his place as secretary for the northern department. When James II. succeeded to the throne, Sunderland became secretary for the southern department, from March, 1685, to 27th October, 1688, for most of which period he held the additional post of president of the council, and was a member of the high commission for ecclesiastical causes. He afterwards claimed that he had used his influence to mitigate the proceedings of this obnoxious body, but he went sufficiently far with his royal master to sign the warrant for the committal of the bishops and to appear as a witness against them. Though Lord Sunderland was in sympathy, if not in actual communion, with Roman Catholicism, he hesitated to commit himself entirely to the acts of the fierce devotees who surrounded James II., and through their opposition he was dismissed in disgrace and sought security in Holland. He had been too much engaged in the acts of James II. to find a place among the advisers of William and Mary.

The visit which William paid to Althorp in Northamptonshire, the country seat of Sunderland, in 1695 was the prelude of a reconciliation between the king and his ambitious subject and of Sunderland's recall into public affairs. From April to December, 1697, he discharged the duties of lord chamberlain of the household and for the greater part of that time he was also lord justice of England; but he finally retired from active life in the close of 1697 through disgust at the check which William received in the retention of a standing army. The rest of his life was passed in strict seclusion at Althorp, and there he died on 28th September, 1702.

Lord Sunderland possessed a keen intellect and was consumed by intense restlessness; but his character was wanting in steadfastness, and he yielded too easily to opposition. His adroitness in intrigue and his fascinating manners were exceptional even in an age when such qualities formed part of every statesman's education; but the characteristics which insured him success in the House of Lords and in the royal closet led to failure in his attempts to understand the feelings of the mass of his countrymen. Consistency of conduct was not among the objects which he aimed at, nor did he shrink from thwarting in secret a policy which he supported in public. A large share of the discredit attaching to the measures of James II. must be assigned to the earl of Sunderland.

SUNDERLAND, Charles Spencer, Third Earl of (1675–1722), was the second son of the second earl, but on the death of his elder brother at Paris, on 5th September, 1688, he became the heir to the peerage. He was born in 1675, and when twenty years old was sent to the House of Commons by the two constituencies of Hedon in Yorkshire and Tiverton in Devonshire. He chose the latter, and represented it until his succession to the earldom of Sunderland in 1702. Throughout this period of his life his career was undistinguished; his first start in the world of politics occurred in 1705, when he was sent to Vienna as envoy extraordinary, a mission which he discharged with signal ability. Although Sunderland was tinged with republican feeling and had rendered himself personally obnoxious to Anne, he was foisted by the all-powerful influence of his father-in-law, the duke of Marlborough, into the ministry as secretary of state for the southern department. This office he held from 3d December, 1706, to 14th June, 1710, when he fell, as he rose, through his connection with the duke and duchess of Marlborough. The queen offered him a pension of £3000 a year [$14,580], but he proudly refused the temptation saying that, if he could not serve, he would not plunder, his country. After the accession of George I. he was lord lieutenant of Ireland (1714–15), lord keeper of the privy seal (1715–17), and secretary of state for the northern department (April, 1717, to March, 1718). At the latter date he was raised to the post of prime minister, holding with the office of first lord of the treasury the position of lord president of the council. Sir Robert Walpole had been shelved, and he revenged himself on the new administration by resisting and defeating the Bill which was designed to limit the numbers of the House of Lords,—a victory over Sunderland which led to a partial reconciliation between him and Townshend and Walpole, his rivals. Lord Sunderland was at the head of affairs during the South Sea mania, and the bursting of the financial bubble led to his political ruin. Through Walpole's influence he was acquitted of personal corruption, but he was forced to resign his place as first lord of the treasury on 1st April, 1721. The passion for intrigue which characterized the father had descended to the son: he was ever plotting, and within a few months after Walpole had saved him from disgrace, if not from a worse fate, he was engaged in scheming against the friend who had saved him. But his plots were interrupted by his death, which occurred on 19th April, 1722. Lord Sunderland's manners were repelling and his disposition was harsh, but he stands high among his compeers for disinterestedness. The love of books ranked among the ruling passions of his life, and he spent his leisure hours and his wealth in forming the great collection at Althorp.

SUN-FISH. This name is chiefly and properly applied to a marine fish (*Orthagoriscus*) which by its large size, grotesque appearance, and numerous peculiarities of organization has attracted the attention equally of fishermen as of naturalists. Only two species are known,—the rough or short sun-fish (*O. mola*), which is found in all seas of the temperate and tropical zones; and the much smaller and scarcer smooth or oblong sun-fish (*O. truncatus*), of which only a small number of specimens have been obtained from the Atlantic and Indian Oceans. That this genus belongs to the order *Plectognathi* and is allied more especially to the globe-fishes (*Diodon* and *Tetrodon*) has been indicated in the article ICHTHYOLOGY (vol. xii. pp. 701, 733), where also the principal anatomical peculiarities have been noticed, and where illustrations of the young have been given (see Figs. 64, 65).



Sun-fish (*Orthagoriscus mola*).

Sun-fishes have the appearance of tailless fish. This is due to the extreme shortening of the tail, which is supported by only a few short vertebræ and reduced to a broad fringe of the trunk. Directly in front of it rise dorsal and anal fins, high and broad, similar to each other in size and triangular in form. The head is completely merged in the trunk, the boundary between them being indicated only by a very small and narrow gill opening and a comparatively small pectoral fin. This fin can be of but little use in locomotion, and the horizontal and vertical movements of the fish, as well as the maintenance of its body in a vertical position, are evidently executed by the powerful dorsal and anal fins. The small mouth, situated in front of the head, is armed with an undivided dental plate above and below, similar to but weaker than the teeth of the globe-fish (*Diodon*).

Sun-fishes are truly pelagic, propagating their species in the open sea, and only occasionally approach the coast. During the stormy season they live probably at some depth, but in calm bright weather they rise and rest or play on the surface with their dorsal fin high above the water. This habit has given rise to the popular name "sun-fish," a term also sometimes applied to the basking-shark (vol. xxi. p. 814), which in like manner enjoys the warmth of a sunny day. In some years the rough sun-fish is by no means scarce on the south coast of England and on the Irish coasts, where it appears principally in the summer months. The usual size is from 3 to 4 feet in length, but this species attains to 7 feet and more. One of the largest specimens (see the accompanying figure) was caught near Portland (Dorsetshire) in 1846, and is now in the British Museum; its length is 7 feet 6 inches. The sun-fish has no economic value, and is rarely, if ever, eaten.

Whilst the rough sun-fish has a granulated, rough, shagreen-like skin, the second species (*O. truncatus*) has the surface of the body smooth and polished, with its small dermal scutes arranged in a tesselated fashion. It is oblong in shape, the body being much longer than it is deep. The sides are finely ornamented with transverse silvery, black-edged stripes running downwards to the lower part of the abdomen. It has not been found to exceed 2 feet in length, but is very scarce, only a few specimens having been captured on the coasts of Europe, at the Cape of Good Hope, and off Mauritius.

SUNFLOWER. In the modern vernacular this name is most commonly applied to various species of *Helianthus*, especially to *H. annuus;* but, as this is a tropical American herb, and the word "sunflower" or something corresponding to it existed in English literature prior to its introduction, or at any rate prior to its general diffusion in gardens, it is obvious that some other flower than the *Helianthus* must have been intended. The marigold (*Calendula officinalis*) is considered by Dr. Prior to have been the plant intended by Ovid (*Met.*, iv. 269–70):

"... . Illa suum, quamvis radice tenetur,
Vertitur ad solem; mutataque servat amorem"—

and likewise the *solsœce* of the Anglo-Saxon, a word equivalent to *solsequium* (sun-following). But this movement with the sun is more imaginary than real, the better explanation being afforded by the resemblance to "the radiant beams of the sun," as Gerard expresses it. The central disk of tubular hermaphrodite flowers, encompassed by the spreading neuter florets of the ray, has, indeed, a marked resemblance to the sun as conventionally depicted. The florets are provided with two or three dry, sharply pointed scales, which serve as pappus, and the whole mass of florets is encircled by a close involucre of leafy bracts. There are numerous varieties of the common sunflower in cultivation, the so-called double form being one in which the ordinarily tubular florets in the centre become spreading and "ligulate" like those at the circumference. The seeds, or more strictly speaking the fruits, contain much oil, for which the plant is cultivated in southern Russia. The oil is used in the manufacture of soap. The seeds are also valued for their agreeable flavor, and are much used as food for poultry, etc. The so-called "Jerusalem artichoke" (*Helianthus tuberosus*) belongs to the same genus. It is believed to be a native of Canada, or perhaps a modified form of *H. doronicoides*. The tubers are rich in inulin and sugar, and the plant deserves more attention at the hands of cultivators than it has yet received. The word "Jerusalem" is evidently a corruption, while "artichoke" applies to the flavor of the tuber, which is not unlike that of the artichoke.

Geographical distribution.

SUNNITES AND SHI'ITES. The religion of Mohammed is at present professed by 150 to 200 million souls, spread over great parts of Asia (including the Indian Archipelago), Africa, and southern Europe,[1]—over Asia Minor, Armenia, Syria, Palestine, Arabia, Mesopotamia, the Caucasus, Persia, all upper Asia (including Siberia), the steppes of southern Russia, Afghanistan, Beluchistan, Tibet, China, Japan, India, Egypt, the Soudan as far as the equatorial lakes, the whole north coast of Africa and thence deep into the interior, European Turkey, Bulgaria, Bosnia, and Herzegovina. In most of these regions Moslems live side by side with men of other confessions, even where Islam is the ruling creed; it is found unmixed in Central Asia and some parts of Arabia.

Mohammedans fall into the two great divisions of Sunnites and Shí'ites (Shí'a), separated by such bitter hatred as belongs to two hostile religions, or such as some Catholic populations feel towards a Protestant.[2] The Sunnites, who accept the orthodox tradition (*Sunna*) as well as the Koran as a source of theologico-juristic doctrines, predominate in Arabia, the Turkish empire, the north of Africa, Turkestan, Afghanistan, and the Mohammedan parts of India and the east of Asia; the Shí'ites, whose origin has been explained in MOHAMMEDANISM (vol. xvi. pp. 591, 592, 615), have their main seat in Persia, where their confession is the state religion, but are also scattered over the whole sphere of Islam, especially in India and the regions bordering on Persia, except among the nomad Tatars, who are all nominally Sunnite. Even in Turkey there are many native Shí'ites, generally men of the upper classes, and often men in high office. The Shí'ites are less numerous and less important than the Sunnites, but on the whole may amount to 20 millions.

SUNNITES.

Sunnites.

Orthodox Islam preserves unchanged the form of doctrine established in the 10th century by Abú 'l-Ḥasan al-Ash'arí (see vol. xvi. p. 615, and also pp. 577 *sq.*, 606, 615). The attacks of rationalism, aided by Greek philosophy, were repelled and vanquished by the weapons of scholastic dialectic borrowed from the enemy; on most points of dispute discussion was forbidden altogether, and faith in what is written in Koran and tradition was enjoined without question as to how these things were true (bilá kaifa). Freer allegorical views, however, were admitted on some specially perplexing points, such as the doctrine of the eternity of the Koran, the crude anthropomorphisms of the sacred text, etc.; and, since Mo'tazilite views had never taken deep root among the masses, while the caliphs required the help of the clergy, and from the time of Motawakkil (847 A.D.) became even more closely bound to orthodox views, the freethinking tendency was thoroughly put down, and to the present day no rationalizing movement has failed to be crushed in the bud. Philosophy still means no more than scholastic dialectic, and is the humble servant of orthodoxy, no man venturing on devious paths except in secret. In the years 1872–78 the Afghan Jamál al-Dín, a professor in the Azhar mosque at Cairo, attempted to read Avicenna with his scholars, and to exercise them in things that went beyond theology, bringing, for example, a globe into the mosque to explain the form of the earth. But the other professors rose in arms, forbade him to enter the mosque, and in 1879 procured his exile on the pretext that he entertained democratic and revolutionary ideas. Thus the later movements of thought in Islam never touch on the great questions that exercised Mohammedanism in its first centuries, *e.g.*, the being and attributes of God, the freedom of the will, sin, heaven and hell, etc. Religious earnestness, ceasing to touch the higher problems of speculative thought, has expressed itself in later times exclusively in protest against the extravagances of the dervishes, of the worship of saints, and so forth, and has thus given rise to movements analogous to Puritanism.

Ulema.

That even in early times the masses were never shaken in their attachment to the traditional faith, with all its crude and grotesque conceptions, is due to the zeal of the ulema, or clergy, for the protection of Islam from every alien influence. Mohammedanism has no priesthood standing between God and the congregation, but Koran and Sunna are full of minute rules for the details of private and civil life, the knowledge of which is necessarily in the hands of a class of professed theologians. These are the *'ulemá* ("knowers," singular *'álim*), theology being briefly named "the knowledge" (*'ilm*). Their influence is still enormous and hardly has a parallel in the history of religions. For it is not supported by temporal agencies like the spiritual authority of the Christian priesthood in the Middle Ages, but is a pure power of knowledge over the ignorant masses, who do nothing without consulting their spiritual advisers. When the vigorous Spanish sultan Manṣúr b. Abí 'Ámir proposed to confiscate a religious foundation and the assembled ulema refused to approve the act, and were threatened by his vizier, one of them replied, "All the evil you say of us applies to yourself; you seek unjust gains and support your injustice by threats; you take bribes and practice ungodliness in the world. But we are guides on the path of righteousness, lights in the darkness, and bulwarks of Islam; we decide what is just or unjust and declare the right; through us the precepts of religion are maintained. We know that the sultan will soon think better of the matter; but, if he persists, every act of his government will be null, for every treaty of peace and war, every act of sale and purchase, is valid only through our testimony." With this answer they left the assembly, and the sultan's apology overtook them before they had passed the palace gate.[3] The same consciousness of independent authority and strength still survives among the ulema. Thus the sheikhu 'l-Islám 'Abbásí (who was deposed by the professors of the Azhar in 1882) had in the first period of his presidency a sharp conflict with 'Abbás Pasha, viceroy of Egypt, who asked of him an unjust legal opinion in matters of inheritance. When bribes and threats failed, the sheikh was thrown into chains and treated with great severity, but it was the pasha who finally yielded, and 'Abbásí was recalled to honors and rich rewards.

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[1] Exact statistics are unattainable because we lack details as to the great advances which Islam has recently made and is still making in Central Africa.

[2] Generally speaking the Sunnites are the more bitter party. The relation is least strained in India, where the Sunnites approach the Shí'ites in reverence for 'Alí, Ḥasan, and Ḥosain, and share the feasts of these saints

[3] Von Kremer, *Gesch. d. herrschenden Ideen d. Islams*, Leipsic, 1868, p. 464.

The way in which the ulema are recruited and formed into a hierarchy with a vigorous *esprit de corps* throws an instructive light on the whole subject before us. The brilliant days are past when the universities of Damascus,[1] Baghdád, Níshápúr, Cairo, Ḳairowán (Kairwan), Seville, Cordova, were thronged by thousands of students of theology, when a professor had often hundreds or even, like Bokhárí, thousands of hearers, and when vast estates in the hands of the clergy fed both masters and scholars. Of the great universities but one survives—the Azhar mosque at Cairo—where thousands of students still gather to follow a course of study which gives an accurate picture of the Mohammedan ideal of theological education.[1]

Theological students.

The students of theology generally begin their course in early youth, but not seldom in riper years. Almost all come from the lowest orders, a few from the middle classes, and none from the highest ranks of society,—a fact which in itself excludes all elements of freer and more refined education. These sons of poor peasants, artisans, or tradesmen are already disposed to narrow fanaticism, and generally take up study as a means of livelihood rather than from genuine religious interest. The scholar appears before the president's secretary with his poor belongings tied up in a red handkerchief, and after a brief interrogatory is entered on the list of one of the four orthodox rites,—Sháfi'ite, Ḥanafite, Málikite, and Ḥanbalite. If he is lucky he gets a sleeping-place within the mosque, a chest to hold his things, and a daily ration of bread. The less fortunate make shift to live outside as best they can, but are all day in the mosque, and are seldom deserted by Moslem charity. Having kissed the hands of the sheikh and teachers of his school, the pupil awaits the beginning of the lectures. For books a few compendiums suffice him. Professors and students gather every morning for the daily prayer; then the professors take their seats at the foot of the pillars of the great court and the students crouch on mats at their feet. The beginner takes first a course in the grammar of classical Arabic, for he has hitherto learned only to read, write, and count. The rules of grammar are read out in the memorial verses of the Ajrúmíya, and the teacher adds an exposition, generally read from a printed commentary. The student's chief task is to know the rules by heart; this accomplished, he is dismissed at the end of the year with a certificate (*ijáza*), entered in his text-book, which permits him to teach it to others. The second year is devoted to dogmatic (*kalám* and *tawḥíd*), taught in the same mechanical way. The dogmas of Islam are not copious, and the attributes of God are the chief subject taken up. They are demonstrated by scholastic dialectic, and at the end of his second year the student, receiving his certificate, deems himself a pillar of the faith. The study of law (*fiḳh*), which rests on Koran and tradition, is more difficult and complex, and begins, but is often not completed, in the third year. The student had learned the Koran by heart at school and has often repeated it since, but only now is the sense of its words explained to him. Of the traditions of the Prophet he has learned something incidentally in other lectures; he is now regularly introduced to their vast and artificial system. From these two sources are derived all religious and civil laws, for Islam is a political as well as a religious institution. The five main points of religious law, "the pillars of Islam," have been enumerated in *vol.* xvi. p. 577 *sq.*; the civil law, on the development of which Roman law had some influence, is treated under heads similar to those of Western jurisprudence. It is here that the differences between the four schools (vol. xvi. p. 616 *sq.*) come most into notice: the Ḥanafite praxis is the least rigorous, then the Sháfi'ite; the Ḥanbalites, whose system is the strictest, have practically disappeared in the Málikites. The Ḥanafite rite is official in the Turkish empire, and is followed in all Government offices whenever a decision still depends on the sacred law, as well as by all Mohammedans of Turkish race. In Egypt and North Africa Sháfi'ites are more numerous than Málikites, while the opposite is the case in Arabia. In 1878 the Azhar had 7691 students,—3723 Sháfi'ites with 106 sheikhs, 2855 Málikites with 75 sheikhs, 1090 Ḥanafites with 49 sheikhs, 23 Ḥanbalites with 1 sheikh. In this as in the previous studies a compendium is learned by heart, and explanations are given from commentaries and noted down by the students word for word. The professors are expressly forbidden to add anything of their own. The recognized books of jurisprudence, some of which run to over twenty folio volumes, are vastly learned, and occasionally show sound sense, but excel mainly in useless hair-splitting and feats of scholastic gymnastics, for which the Arabian race has a natural gift.

Besides the three main disciplines the student takes up according to his tastes other subjects, such as rhetoric (*ma'ání wabayán*), logic (*manṭiḳ*), prosody (*'arúḍ*), and the doctrine of the correct pronunciation of the Koran (*ḳirá'a watajwíd*). After three or four years, fortified with the certificates of his various professors, he seeks a place in a law-court or as a teacher, preacher, cadi, or mufti of a village or minor town, or else one of the innumerable posts of confidence for which the complicated ceremonial of Mohammedanism demands a theologian, and which are generally paid out of pious foundations. A place is not hard to find, for the powerful corporation of the ulema seeks to put its own members into all posts, and, though the remuneration is at first small, the young 'álim gradually accumulates the revenues of several offices. Gifts, too, fall in, and with his native avarice and economy he rises in wealth, position, and reputation for piety. The commonalty revere him and kiss his hand; the rich show him at least outward respect; and even the Government treats him as a person to whom consideration is due for his influence with the masses.

This sketch of his education is enough to explain the narrow-mindedness of the 'álim. He deems all non-theological science to be vain or hurtful, has no notion of progress, and regards true science—*i.e.*, theology—as having reached finality, so that a new super-commentary or a new students' manual is the only thing that is perhaps still worth writing. How the mental faculties are blunted by scholasticism and mere memory work must be seen to be believed; such an education is enough to spoil the best head. All originality is crushed out and a blind and ludicrous dependence on written tradition—even in things profane—takes its place. Acuteness degenerates into hair-splitting and clever plays on words after the manner of the rabbins. The Azhar students not seldom enter Government offices and even hold important administrative posts, but they never lose the stamp of their education—the narrow unteachable spirit, incapable of progress, always lost in external details, and never able to grasp principles and get behind forms to the substance of a matter. (W. S.-B.)

Schools.

Yet it is but a small fraction of the ulema of the Moslem world that enjoy even such an education as the Azhar affords. It draws few students from foreign parts,[2] where the local schools are of the poorest kind, except in India (thanks to the British Government) and perhaps in Constantinople.[1] Bokhárá was once a chief seat of learning, but is now so sunk in narrow fanaticism that its eighty *madrasas* with their 5000 students only turn out a bigoted and foolish clergy (Vámbéry).[2] But for this very reason Bokhárá is famed as a luminary of pure theology and spreads its influence over Turkestan, Siberia, China, Kashmir, Afghanistan, and even over India. Minor schools attached to mosques are found in other places, but teach still less than the great schools already mentioned.

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[1] Of the 126 madrasa or colleges which once belonged to the university of Damascus but five remained in 1880.

[2] In 1878 seventeen lecture-rooms of the Azhar had 3707 students, of whom only 64 came from Constantinople and the northern parts of the Ottoman Empire, 8 from north Arabia, 1 from the government of Baghdád, 12 from Kurdistan, and 7 from India with its thirty million Sunnites.

Caliphate and temporal sovereignty.

Except in India, where it is controlled by the Government, the organization of the priestly and judicial persons trained in the schools is a compromise between what theological principles dictate and what the state demands. Neither Koran nor Sunna distinguishes between temporal and spiritual powers, and no such distinction was known as long as the caliphs acted in all things as successors of the prophets and heads of the community of the faithful. But, as the power of the 'Abbásids declined (see vol. xvi. p. 607 *sq.*) and external authority fell in the provinces into the hands of the governors and in the capital into those of the *amír al-omará*, the distinction became more and more palpable, especially when the Búyids (Buwaihids), who were disposed to Shí'ite views, proclaimed themselves sultans, *i.e.*, possessors of all real authority. The theologians tried to uphold the orthodox theory by declaring the sultanate to be subordinate to the imámate or sovereignty of the caliphs, and dependent on the latter especially in all religious matters; but their artificial theories have never modified facts. The various dynasties of sultans (Búyids, Ghaznevids, Seljúks, and finally the Mongols) never paid heed to the caliphs and at length abolished them; but the fall of the theocracy only increased the influence of the clergy, the expounders and practical administrators of that legislation of Koran and Sunna which had become part of the life of the Mohammedan world. The Mamelukes in Egypt tried to make their own government appear more legitimate by nominally recognizing a continuation of the spiritual dignity of the caliphate in a surviving branch of the 'Abbásid line which they protected, and in 923 A.H. (1517) the Ottoman Selim, who destroyed the Mameluke power, constrained the 'Abbásid Mutawakkil III., who lived in Cairo, to make over to him his nominal caliphate. The Ottoman sultans still bear the title of "successors of the Prophet," and still find it useful in foreign relations, since there is or may be some advantage in the right of the caliph to nominate the chief cadi (*kádí*) of Egypt and in the fact that the spiritual head of Khiva calls himself only the *nakíb* (vicegerent) of the sultan.[3] In India too the sultan owes something perhaps to his spiritual title. But among his own subjects he is compelled to defer to the ulema and has no considerable influence on the composition of that body. He nominates the *sheikhu 'l-Islám* (senior, *i.e.*, president of Islam) or mufti of Constantinople (grand mufti), who is his representative in the imámate and issues judgments in points of faith and law from which there is no appeal; but the nomination must fall on one of the *mollahs*,[4] who form the upper stratum of the hierarchy of ulema. And, though the various places of religious dignity are conferred by the sultan, no one can hold office who has not been examined and certified by older ulema, so that the corporation is self-propagating, and palace intrigues, though not without influence, can never break through its iron bonds. The deposition of 'Abd al-Azíz is an example of the tremendous power that can be wielded by the ulema at the head of their thousands of pupils[5] when they choose to stir up the masses; nor would Maḥmúd II. in 1826 have ventured to enter on his struggle with the Janissaries unless he had had the hierarchy with him.

Judicial offices.

The student who has passed his examinations at Constantinople or Cairo may take up the purely religious office of *imám* (president in worship) or *khatíb* (preacher) at a mosque. These offices, however, are purely ministerial, are not necessarily limited to students, and give no place in the hierarchy and no particular consideration or social status. On the other hand, he may become a judge or cadi. Every place of any importance has at least one cadi, who is nominated by the Government,[6] but has no further dependence on it, and is answerable only to a member of the third class of the ulema, viz., the mufti or pronouncer of *fetwas*. A fetwa is a decision according to Koran and Sunna, but without reasons, on an abstract case of law which is brought before the mufti by appeal from the cadi's judgment or by reference from the cadi himself. For example, a dispute between master and slave may be found by the cadi to turn on the general question, "Has Zaid, the master of 'Amr,[7] the absolute right to dispose of his slave's earnings?" When this is put to the mufti, the answer will be simply "Yes," and from this decision there is no appeal, so that the mufti is supreme judge in his own district. The grand mufti of Constantinople is, as we have seen, nominated by the sultan, but his hold on the people makes him quite an independent power in the state; in Cairo he is not even nominated by the Government, but each school of law chooses its own sheikh, who is also mufti, and the Hanafite is head mufti because his school is official in the Turkish empire.

Modern changes.

All this gives the judges great private and political influence. But the former is tainted by venality, the plague-spot of the East, which, aggravated by the scantiness of judicial salaries or in some cases by the judge having no salary at all, is almost universal among the administrators of justice. Their political influence, again, which arises from the fusion of private and political law in Koran and Sunna, is highly inconvenient to the state, and often becomes intolerable now that relations with Western states are multiplied. And even in such distant parts as Central Asia the law founded on the conditions of the Prophet's lifetime proves so unsuited to modern life that cases are often referred to civil authorities rather than to canonical jurists. Thus a customary law (*'orf*) has there sprung up side by side with the official sacred law (*sharí'a*), much to the displeasure of the mollahs. In Turkey, and lately above all in Egypt, it has been found necessary greatly to limit the sphere and influence of the canonical jurists and introduce institutions nearer to Western legal usage. We do not here speak of the paper constitutions (*khatt-i-sheríf*) and the like, created to dupe Western diplomatists and amuse their authors, but of such things as consular and commercial courts, criminal codes, and so forth. The present sultan seems also to aim at diminishing the power of the ulema by such measures as frequent changes of the sheikhu 'l-islám, though this policy is perhaps less likely to confirm his power than to rob it of its last supports.

The official hierarchy, strong as it is, divides its power with the dervishes. A religion which subdues to itself a race with strongly marked individuality is

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[1] In Kazan also the standard of learning seems to have been raised by Russian and Western scholars.

[2] The *madrasa* is here a college, generally attached to a mosque, with lands whose revenues provide the means of instruction and in part also food and residence for scholars and teachers.

[3] Till the Russians gained preponderating influence the khán of Khiva also acknowledged the sultan as his suzerain.

[4] Mollah is the Perso-Turkish pronunciation of the Arabic *maulá*, literally "patron," a term applied to heads of orders and other religious dignitaries of various grades.

[5] Called in Constantinople *softa*, Persian, *sókhta*, "burned up," *scil.*, with zeal or love to God.

[6] In Egypt before the time of Sa'íd Pasha (1854-63) the local judges were appointed by the chief cadi of Cairo, who is sent from Constantinople. Since then they have been nominated by the Egyptian Government.

[7] Zaid and 'Amr are the Caius and Sempronius of Arabian law.

Ṣúfis and dervishes.

always influenced in cultus and dogma by the previous views and tendencies of that race, to which it must in some measure accommodate itself. Mohammed himself made a concession to heathen traditions when he recognized the Kaaba and the black stone; and the worship of saints, which is now spread throughout Islam and supported by obviously forged traditions, is an example of the same thing. So too are the religious orders now found everywhere except in some parts of Arabia. Mystical tendencies in Mohammedanism arose mainly on Persian soil (see vol. xvi. p. 616) and Von Kremer has shown that these Eastern tendencies fell in with a disposition to asceticism and flight from the world which had arisen among the Arabs before Islam under Christian influence.[1] Intercourse with India had given Persian mysticism the form of Buddhistic monkery, while the Arabs imitated the Christian anchorites; thus the two movements had an inner kinship and an outer form so nearly identical that they naturally coalesced, and that even the earliest organizations of orders of dervishes, whether in the East or the West, appeared to Mohammedan judgment to be of one type. Thus, though the name of *Ṣúfí* (see vol. xvi. p. 616) is first applied to Abú Háshim, who died in Syria in 150 A. H. (767), we find it transferred without question to the mystical brotherhood which appears in Khorásán under Abú Sa'íd about 200 A.H. (815/6). Yet these two schools of Ṣúfís were never quite similar; on Sunnite soil Ṣúfism could not openly impugn orthodox views, while in Persia it was saturated with Shí'ite heresy and the pantheism of the extreme devotees of 'Alí (see vol. xvi. p. 616). Thus there have always been two kinds of Ṣúfís, and, though the course of history and the wandering habits which various orders borrowed from Buddhism have tended to bring them closer to one another, we still find that of the thirty-six chief orders three claim an origin from the caliph Abúbekr, whom the Sunnites honor, and the rest from 'Alí, the idol of the Shí'ites.[2] Mystic absorption in the being of God, with an increasing tendency to Pantheism and ascetic practices, are the main scope of all Ṣúfism, which is not necessarily confined to members of orders; indeed the secret practice of contemplation of the love of God and contempt of the world is sometimes viewed as specially meritorious. And so ultimately the word *ṣúfí* has come to denote all who have this religious direction, while those who follow the special rules of an order are known as dervishes ("beggars," in Arabic *fuḳará*, sing. *faḳír*—names originally designating only the mendicant orders). In Persia at the present day a Ṣúfí is much the same as a freethinker. Several of the chief dervish orders arose in the evil times before and after the invasion of the Mongols: thus 'Abd al-Ḳádir al-Jílání (d. 561 A. H.; 1165/66) founded the Ḳádiríya order, Aḥmad al-Rifá'í (d. 578 A.H.; 1182/3) the Rifa'íya, Jalálu 'l-dín Rúmí (see RÚMÍ) the Mawlawíya, Abú 'l-Ḥasan al-Shádhilí (d. 656 A.H.; 1258) the Shádhilíya, Aḥmad al-Badawí (d. 675 A.H.; 1276) the Aḥmadíya or Badawíya, an order still very widely spread in Egypt. While civil distress drove men to flee from the world, the stupid fanaticism of Turkish rule has helped on the belief in miracles so often associated with mysticism and all those deceits that go with the spread of enthusiastic notions. Of later orders we may name the Naḳshbendíya, now the most important in the khanates of Turkestan, whose founder died 719 A.H. (1319), the Sa'díya (736 A.H.; 1335), the Bektashíya (758 A.H.; 1357), the Khalwatíya (800 A.H.; 1397).[3]

The modern dervishes have sunk as low as the modern ulema. The idea of absorbed contemplation of the divine being, freed from all earthly conceptions, and of mortification of the flesh in order to become one with God, is grossly caricatured in the insane howlings *hu hu* ("he, he") and self-torture with red-hot knives, etc., practiced by the "howling" Rifá'íya and in the dizzy whirling of the "dancing" Mawlawíya. Very pestilent too is their traditional reputation for holiness with the common people, while ecstatic piety easily passes into deceit where it is still generally believed that a saint (*walí*) can work miracles. The wandering dervishes especially, who move constantly from place to place, are noted for all sorts of juggling impostures, by the aid of which, like the Yogis of India, they live at the cost of the people.[4] But they are no longer trusted or held in much esteem even by the populace, whereas the conventual orders are usually regarded as pious and inspired men. Sheikh Aḥmad, the founder of the Badawíya, is the national saint of Egypt, and his tomb at Tanta is a great place of pilgrimage. The ulema dislike these rivals, but can do little against their influence.

The bright side in the modern world of Islam is found among the lower classes. The ruling classes of Turkey are utterly corrupt, and for centuries their one art of administration has been to suck the provinces dry. Taxes are exorbitant and bad laws check the production of wealth, while what remains of the useful institutions and public works of old time daily decays. To this is added the recklessness born of a more or less clear consciousness that things cannot last as they are. The effendi of Constantinople has lost faith in his religion and the future of his race; as for a sense of honor, as we understand it, that does not exist in the East. In Egypt things have not been quite so bad since Mohammed 'Alí destroyed the Mamelukes and founded a state with some pretensions to order and solidity; selfish as he was, he saw that to maintain the revenue it was necessary to stimulate production, and to this end, amid many mistakes, he took not a few useful steps. His successors were less wise and skilful, yet prosperity increased, and for the first time for centuries national feeling began to assert itself. But this movement fell into the hands of the ignorant and fanatical 'Orábí Pasha (1882) and led to the English occupation and the entire disorganization of the country, so that Cairo is now little better than Constantinople.

Poorer classes.

Yet with all this the poorer classes have not lost their vigor, and among them Islam has still a deep-rooted strength. The common Turk of Roumelia or Asia Minor is still a solid sober honest fellow and a brave soldier, always ready to make every sacrifice for his religion. In Egypt the morality of the people has suffered from the great foreign immigration, which has introduced many evil elements as well as some good; yet even here the great mass of both townsmen and peasants are loyal to the old faith and to the traditional sobriety and parsimony which the nature of the country itself prescribes. These qualities taken with the undoubted intelligence of the Arabian population give hope of a revival of prosperity on the Nile under more favorable political conditions. The people have a persuasion of the superiority of their religion, which, while it often makes necessary reforms difficult, prevents them from losing national individuality and self-reliance, and the belief in predestination gives a certain dignity and self-possession under calamities, without excluding foresight and activity in daily duty. But whether all this is enough to secure the political revival of the Sunnite commonwealths is doubtful in face of the preponderating influence on all the coasts of the Levant of Western civilization, which as yet is almost entirely a disintegrating force and seems certain to prevent a redintegration of Islam in Turkey, and probably also in Egypt. The khanates, again, are sunk in incredible moral corruption cloaked by blind fanaticism, while most of the Bedouin tribes of Arabia have known little about Koran and religion for the last eight centuries.[1] Islam has certainly still a great future in Central Africa, but this can hardly lead to veritable reformation of its system. Still there are many evidences that the faith is not yet dead even in its old realms. We lay no stress on the existence of various sects opposed to the current Sunnite orthodoxy, such as the puritanical Wahhabites of Arabia and India, or the DRUSES (*q.v.*), Noṣairíya, Isma'ílíya, and Metwálíya of Syria, who are tinged with Shí'ite views and belong only politically to the Sunnite section of Islam. But in India there are still living seeds of further development within Islam proper. Under English control the ulema are unable to maintain the same spiritual tyranny over men's minds as elsewhere, and we find more mutual toleration between Sunna and Shí'a, an easy accommodation to local tradition,[2] and even an ability to leave the grooves of Al-Ash'arí's scholasticism and approach the ideas of the old rationalistic Mo'tazilites. Movements in this direction have come to light quite recently; but their further growth need not here be speculated on.[3]

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[1] *Op. cit.*, p. 52 *sq.*

[2] These claims to early origin are mere fables, like the claim of the Oweisi order to spring from Oweis, one of the oldest traditionalists, and so forth.

[3] The best account of the dervishes is still that in D'Ohsson, *Tableau Général de l'Emp. Ottoman*, vol. ii., Paris, 1790.

[4] These mendicants belong in part to orders like the Bektashíya and Rifá'íya, whose other members live in convents (Khangah, Takíya); in part they are Ḳalanderíya (Calanders), *i.e.*, bound by the rule of Ḳalander, a disciple of Bektash, which enjoins constant wandering.

SHÍ'ITES.

The extreme Shí'ite view that 'Alí is to be regarded as an incarnation of the Godhead (see vol. xvi. pp. 586, 615) maintained its predominance only in times when and places where the opposition to the sovereignty of the Omayyads and 'Abbásids was intense, or where pantheistic influences from India were at work. From the first there existed also a milder form of Shí'ite faith, which soon was at open war with the fanatical Ismá'ílíya and their disciples, the Fáṭimites and Assassins (vol. xvi. p. 616 *sq.*).[4]

Shí'ite dynasties in Persia.

It was through the moderate Shí'ites that the caliph Ma'mún thought to reconcile his dynasty with the house of 'Alí (vol. xvi. p. 606), and it was this party that became dominant in Persia in the 10th Christian century under the Búyids. When they conquered Baghdád the Búyids abstained from interfering with the Sunnite orthodoxy of the populations of the capital and Arabian 'Irák, but the Shí'ite faith was openly professed in their courts at Rai, Shiráz, and Kirmán. But in the next century the power of the Shí'ite dynasty crumbled and fell before the Ghaznevids and Seljúks, who as Turks were Sunnites, and repressed the opposing views. In the 13th century the Mohammedan East was overrun by the Mongols, who at first were indifferent to all religion, and gave the Persian Shí'ites perfect liberty; later on the great-grandson of Jenghis Khán, Mohammed Khodahbende Oeljitu (1303–16), himself became a Shí'ite; nor was the progress of the sect checked by the fall of the dynasty and the conquests of Tímúr (1387), who veiled his religious indifference by proclaiming himself an admirer of 'Alí. Thus the mass of the Persian population remained Shí'ites, and the Tímúrides accommodated themselves to the religious feelings of their subjects. Tímúr's son, Sháh Rokh, even built and furnished forth the tomb of the imám Riẓá in Meshhed (Meshed). The troublous times that followed and the intervention in Persian affairs of the Sunnite Ak-Koyunlu (see vol. xviii. p. 632 *sq.*) must have been unfavorable to Shí'ite principles; but they gained a final victory through the Safawi dynasty, whose founder, Sháh Ismá'íl (1499-1523), gave the Shí'ite doctrine, in the form in which it is held by the Ithná-'Asharíya, the position it still has as the state religion of Persia.

The Ithná-'Asharíya.

The Ithná-'Asharíya, or "Twelvers," a sect of the moderate Shí'ites, have their name from the respect they pay to 'Alí and his eleven immediate heirs through Fáṭima, daughter of the Prophet. Like all Shí'ites, they hold that 'Alí was designated as his successor by Mohammed,[5] and unjustly thrust aside by the three actual caliphs, Abúbekr, 'Omar, and 'Othmán. Still more do they hate the Omayyad enemies of 'Alí and his house (see vol. xvi. p. 587). They and the 'Abbásids were usurpers, the true caliphs *de jure* being the imáms—(1) 'Alí; (2) Ḥasan; (3) Ḥosain, then his heirs in the direct line—(4) 'Alí II.; (5) Mohammed al-Bákir; (6) Ja'far al-Ṣádiḳ; (7) Músá al-Káẓim; (8) 'Alí III. al-Riḍá (in modern pronunciation Riza); (9) Mohammed II. al-Jawád; (10) 'Alí IV. al-'Askarí; (11) Ḥasan II. al-Khamṭ; (12) Mohammed III. al-Mahdí, who lived in the second half of the 3d century of the Flight (9th century A.D.), and to whom his Shí'ite partisans looked to free them from the 'Abbásid yoke. These hopes failed and he himself disappeared, whence the belief grew that he was concealed in a cave at Samarra and would return at the end of days. Meantime the sovereignty belongs to the other descendants of 'Alí, the Sayyids (lords). In fact the Safawis claimed descent from the seventh imám, and neither the Afghan Nadir Sháh, who overthrew their power, nor the Kajars, who now reign, are regarded as legitimate. The false position which the royal house stands in with the clergy is an important element in the weakness of the crumbling state of Persia.

Shí'ite tenets.

All other points in which Shí'ites differ from Sunnites depend on their legitimistic opinions, or are accommodations of the rites of Islam to the Persian nationality, or else are petty matters affecting ceremonial. The rejection of the whole Sunnite traditions goes with the repudiation of the caliphs under whose protection these were handed down.[6] An allegorical and mystical interpretation reconciles the words of the Koran with the inordinate respect paid to 'Alí; the Sunnite doctrine of the uncreated Koran is denied. To the Mohammedan confession "There is no god but God and Mohammed is His ambassador" they add "and 'Alí is the vicegerent of God" (*walí*, properly "confidant"). There are some modifications in detail as to the four main religious duties of Islam,—the prescriptions of ritual purity, in particular, being absurdly exaggerated and made the main duty of the faithful. The prayers are almost exactly the same, but to take part in public worship is not obligatory, as there is at present no legitimate imám whose authority can direct the prayer of the congregation. Pilgrimage to Mecca, to which the Sunnite indwellers of 'Irák and Arabia oppose difficulties, though since the reign of 'Abd al-Mejíd it is officially thrown open to all, may be performed by a hired substitute,[7] or its place can be taken by a visit to the tombs of Shí'ite saints, *e.g.*, that of 'Alí at Nejef, of Ḥosain at Kerbelá, of Riẓá at Meshhed, or of the "unstained Fáṭima" at Ḳum (Fáṭima-i-ma'aṣúm, daughter of Músá, the 7th imám). The Shí'ites are much the most zealous of Moslems in the worship of saints (real or supposed descendants of 'Alí) and in pilgrimages to their graves, and they have a characteristic eagerness to be buried in those holy places. The Persians have an hereditary love for pomps and festivities, and so the Shí'ites have devised many religious feasts. Of these the great sacrificial feast (*'íd-i-Ḳurbán*; Turkish *Ḳurbán Bairám*) is also Sunnite; the first ten days of the month Moḥarram are dedicated to the mourning for the death of Ḥosain at Kerbelá (vol. xvi. p. 591), which is celebrated by passion-plays (*ta'zíya*; see vol. xviii. p. 672), while the universal joy of the Nauroz, or the New Year of the Old Persian calendar, receives a Mohammedan sanction by the tradition that on this day the Prophet conferred the caliphate on 'Alí.[1]

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[1] *Sefer Nameh*, ed. Schefer, Paris, 1881, pp. 30 *sq.*, 233.

[2] See Garcin de Tassy, "Sur les particularités de la rel. mus. dans l'Inde," reprinted in *L'Islamisme*, 3d ed., Paris, 1874, pp. 290 *sq.*, 296 *sq.* The Wahhabites protest against this laxity.

[3] See Syed Ameer 'Alí, *Personal Law of Mohammedans*, London, 1880, preface.

[4] When the Fáṭimite lords of Egypt tried to enter into relations with the moderate Shí'ite Búyids in Baghdád they were met with polite reserve, and subsequently public protests against them emanated from the 'Alide circles of that city (Wüstenfeld, *Geschichte der Fatimiden-Chalifen*, Göttingen. 1881, pp. 197, 237).

[5] To make this credible divers passages of the Koran have been changed from the received readings, and ultimately a special súra was forged out of Koran phrases. See Nöldeke, *Gesch. des Qorans*, p. 220 *sq.*

[6] But the comparison of Shí'ites with Protestants is futile. Shí'ites have their own tradition (*ḥadís*) referred to 'Alí, which is grossly distorted,—indeed a tissue of lies.

[7] This the Sunnites also allow under certain conditions.

Ecclesiastical officers.

Judicial officers.

While they naturally reject the four Sunnite schools of jurisprudence, the Shí'ites also derive all law from the Koran, and their trained clergy (mollahs) are the only class that can give legitimate legal responses. The training of the mollah resembles that of the Sunnite 'álim. The course at the madrasa embraces grammar, with some rhetoric and prosody, logic, dogmatic, Koran exegesis, tradition, and jurisprudence, and finally some arithmetic and algebra. The best madrasa is at Kerbelá.[2] But the best students of Kerbelá are no match even for the Sunnite disciples of Bokhárá.[3] The scholar discharged from his studies becomes first a simple mollah, *i.e.*, local judge and notary.[4] A small place has one such judge, larger towns a college of judges under a head called the *sheikhu 'l-Islám*. The place of the Sunnite muftis is filled by certain of the *imám-jum'a*, *i.e.*, presidents of the chief mosques in the leading towns, who in respect of this function bear the title of *imám mujtehid*. This is a dignity conferred by the tacit consent of people and clergy, and is held at one time only by a very few distinguished men. At the beginning of the 19th century there were but five mujtehids in Persia; now (1887) they seem to be more numerous. In Persia the cadi (*ḳáẓi*) is an inferior judge who acts for the sheikhu 'l-Islám in special cases, and a mufti is a solicitor acting under the judge to prepare cases for court.

Under the Safawis, when the clergy had great influence, they had at their head the *ṣadru 'ṣṣodúr*, who administered all pious foundations and was the highest judicial authority. But so great a power was found dangerous; 'Abbás the Great (1586–1628) abstained from filling up a vacancy which occurred in it, and, though Sháh Sefí (1628–1641) restored the office, he placed it in commission. Nádir Sháh abolished it in his attempt to get rid of the Shí'ite hierarchy (1736), and since then it has not been restored. Yet the imám-jum'a of Ispáhán, the old Safawi capital, is tacitly regarded as representative of the invisible imám of the house of 'Alí, who is the true head of the church. Various vain attempts have been made in the 19th century to subordinate the authority of the clergy to the Government. These attempts had the sympathy of the better classes, for the venality and moral corruption of the mollahs and their disposition to the most vulgar fraud are proverbial. But, on the other hand, the clerical power and the right of asylum at Meshhed, Ḳum, and some other sanctuaries are the only protection of the masses against the arbitrary tyranny of the court and the officials. There is now a sort of truce between the Government and the clergy, though the former is always suspicious of the latter. Only the venality of the spiritual courts has led, as in Turkestan, to a limitation of their jurisdiction, and judicial decisions are given also by civil magistrates according to *'orf* or customary law and, although their decisions are often arbitrary, they are commonly resorted to in cases affecting property, in which the spiritual judge would think it his duty to "eat up" the sum in dispute. The main prop of the mollahs against the Government are the scum of the population, the *lúṭís* or foul rowdies. In 1862, according to Vámbéry, the imám-jum'a of Ispáhán had at his orders a thousand of these scoundrels.

Dervishes.

The rivals of the clergy in popular influence are the dervishes, whose show of holiness cloaks an immorality and propensity to crime far exceeding what is found among their brethren in Egypt and Turkey. So it has been for centuries, as appears in Olearius's account of the Calanders of his time (1637). Supported by popular superstition, the Persian dervishes are much more pretentious than those of the West. At the great feasts especially they quarter themselves impudently in wealthy houses and deafen the indwellers with their unceasing cry of *Yá ḥakk* ("O Truth!" the mystical equivalent of "O God!"). The wise and modest dervish who in Sa'dí's poems tells the greatest sultan the truth as to the hollowness of his royal state has degenerated into the half-mad and insolent hanger-on who thrusts himself into audience-chambers and claims the seat of honor beside the grandees. The multitude of these motley vagabonds, some harmless, others dangerous, is explained by the love for idleness, buffoonery, and story-telling, which is even more marked in Persia than in other parts of the East.

Religious observance by both sects.

The great practical difference between the Sunnite and Shí'ite communities is that among the former it is only with the upper classes, who are few in number, and with the worse sort of dervishes that obedience to the precepts of religion is a mere formal profession. Most of the ulema and the middle and lower classes are sincere Moslems. In Persia it is the other way; the praise of religion is always on men's lips, but the inner conviction is that it is all a mockery. The clergy laugh inwardly at their own functions; the educated classes either believe nothing at all or hold secretly to a Ṣúfí pantheism. Sa'dí and Ḥáfiz are much more to them than the Koran; and, while the the Sunnite take his *sortes biblicæ* from the Koran, the Shí'ite uses a copy of the songs of Ḥáfiz. With the common people it is not the proper precepts of Islam, but the Shí'ite tenets directed against Sunnites and Jews, that find hearty adherence. The death-feast of Ḥasan and Ḥosain excites them far more than the great sacrificial feast; and 'Alí, the national saint is much more popular than Mohammed. Islam, as it was forced on Persia by 'Omar, was the faith of foreign conquerors and oppressors; and the people have revenged themselves by travestying it and veiling their old convictions under its outward forms. And so Islam has never had any considerable influence on conduct save that it has confirmed the natural turn of the Persians for lying and hypocrisy. As it was long necessary to profess orthodoxy for fear of the Arabs, it came to be an established Shí'ite doctrine that it is lawful to deny one's faith in case of danger. This "caution" (*taḳíya*) or "concealment" (*ketmán*) has become a second nature with the Persians. And with this it goes that no one shrinks from secret sins, though outwardly professing the utmost devotion. The preparation of wine and spirits, for example, is confined to Jews and Armenian Christians, but private drunkenness is most common. Very conscientious or pious people, however—*e. g.*, the dervishes—use rather opium or *ḥashísh* and confound the narcotic intoxication with mystic ecstasy. Another mischievous thing is the permission of temporary marriages,—marriages for a few hours on a money payment. This legitimized harlotry (*mot'a*) is forbidden by the Sunna, but the Shí'ites allow it, and the mollahs adjust the contract and share the women's profits.

With all this, modern observers are agreed that the middle and lower classes of Persia are not hopeless, and that their natural intelligence, though combined with lack of perseverance, would make it much easier for them than for the Turks to take a new start if they were freed from the wretched civil and ecclesiastical administration. There is still mental life and vigor among them, as appears—though in an unfavorable aspect—among the sects, which, allowance being made for "taḳíya," play no inconsiderable part. The Akhbárís (traditionalists), who adopt a semi-philosophical way of explaining away the plainest doctrines (such as the resurrection of the flesh) on the authority of false traditions of 'Alí, are not so much a sect as a school of theology within the same pale as the orthodox Shí'a or *mujtehidís*.[1] A real dissenting sect, however, is the Sheikhís, of whose doctrines we have but imperfect and discrepant accounts.[2] Representatives of the old extreme Shí'ites, who held 'Alí for a divine incarnation, are found all over Persia in the 'Alí-Iláhí or 'Alí-Alláhí sect ("'Alí deifiers").[3]

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[1] Without this sanction the Nauroz was celebrated even at court under the 'Abbásids. It is the only feast still celebrated by the poor as well as the rich.

[2] On Turkish soil; but the Shí'ite foundations there are tolerated.

[3] Polak, *Persien*, Leipsic, 1865, i. 290.

[4] No contract, especially no contract of marriage, is valid unless made before a mollah. An ordinary inferior judge is called *darúgha*.

Shí'ite sects.

Bábí movement.

Finally, in the year 1848 there broke out a violent reaction against the wretched condition of state and church at a moment when a new succession to the throne had (as is wont) involved great part of the land in anarchy (comp. vol. xviii. p. 662–3). As early as 1837 a young enthusiast, 'Alí (son of) Mohammed, imbued with pantheistic and communistic ideas,[4] had begun a peaceable but zealous propaganda. Consistently enough with ultra-Shí'ite principles, he deemed himself inspired by the spirit of God, and claimed to be the Mahdí, the twelfth imám, issued from his obscurity to lead the world to salvation. He took the title of Báb al-dín ("portal of the faith"), and his followers are know as Bábís. Báb was a man of profound sincerity and averse to violent measures; he avoided all open polemic against the Government, which in turn at first tolerated him in its jealousy of the clergy. In 1844 the too great zeal of his follower Mollah Ḥosain occasioned Báb's imprisonment; but Ḥosain and his emissaries continued the propaganda and made many converts in all provinces. When the troubles of 1848 broke out Ḥosain raised open rebellion in Mazenderán. Terrible conflicts ensued, made only more bitter by the execution of Báb (18th July, 1849). Apparently suppressed, the movement proved that it was not extinct in an attempt to assassinate the sháh in 1852. A new proscription followed; but there is no doubt the Bábism still lives in secrecy, and the universal sympathy felt for the martyr Báb among generously minded Persians may still give it a future.[5]

Less dangerous than these bold communists are the Ishmaelites, direct descendants of the old Ismá'ílíya, whose nihilist doctrines are now diluted into a harmless doctrine of incarnation. They are pretty numerous in India, at Bombay, Surat, and Burhampur, but hardly are found in Persia.[6]

Despite their mutual feuds, Sunnites and Shí'ites are at one in their hatred and contempt for the professors of other religions. Holding that faith and unbelief are matter of predestination, Islam is not given to forcible proselytizing, and on certain conditions Christians and Jews (and later on Zoroastrians also) have always been tolerated in the Mohammedan empire, except that 'Omar, mainly on political grounds, expelled all non-Moslems from Arabia. But none the less the adherents of other faiths are hated and despised as children of hell and enemies of true religion. To reconcile the present decay of Islam and prosperity of the unbeliever with their feelings and convictions, Sunnites and Shí'ites alike take refuge in the doctrine of a restoration of Islam before the end of the world through the "divinely guided" Mahdí. In view of the interest in the subject excited by recent events, some addition may here be made to the brief statement in the article Mahdi.[7] Originally, as has been shown in that article, the idea of a god-sent deliverer from the illegitimate caliphs was attached by the Shí'ites to actual pretenders of the house of 'Alí; but later on, and especially since the days of the Mongols, the figure of the Mahdí was projected into the far future, and ultimately his arrival was made a sign of the end of the world. Among the Sunnites, on the other hand, who could not accept the Shí'ite pretenders, some of those who felt that the Omayyad sovereignty was not truly spiritual and worthy of Islam borrowed the Christian hope of the second coming of Christ, whom Islam acknowledges as a prophet and precursor of Mohammed, and whose return at the end of the world seemed to accord with some vague passages of the Koran; others looked, like the Shí'ites, for a deliverer from earthly tyranny, but did not tie themselves to the belief that he must spring from the house of 'Alí. When the theologians of 'Abbásid times began to systematize the religious traditions they found some that spoke of a return of Jesus and others referring to a Mahdí. These they combined together, so that Sunnites now believe that, when unrighteousness is at its height upon earth and the victory of the enemies of Islam seems sure, the Mahdí will appear to destroy the unbelievers and establish God's kingdom on earth. Then the Antichrist (*dajjál*) will work new mischief, but be destroyed by Jesus, who appears as precursor of the last judgment. Sunnite theologians have not all been at one in expecting a Mahdí as well as Jesus, but this is the view generally current in recent times; and Sunnites and Shí'ites are agreed that the Mahdí will destroy the external foes of Islam, *i.e.*, all non-Mohammedan powers. Theologians have tried by artificial interpretation of Koran and Sunna to fix when and how the Mahdí is to appear, and have concluded that he must be looked for at the close of a century. Of this widespread belief Mohammed Ahmed, the Sudanese Mahdí, availed himself in coming forward in the year 1300 of the Flight (1882–83). Theological opinion is so unsettled as to all the details of the Mahdí's work that, according to trustworthy information, his death has not seriously impaired the impression produced by his victories. In Mecca, for example, in 1885 it was commonly held to be conceivable that the Sudanese fighting in his name might destroy England and the Western powers; and it is possible that the belief in this latest Mahdí has still an important part to play in the Eastern question. (A. MÜ.)

Coming of the Mahdí.

SUNSTROKE (*Heatstroke; Insolation; Coup de Soleil; Thermic Fever*), a term applied to the effects produced upon the central nervous system, and through it upon other organs of the body, by exposure to the sun or to overheated air. Although most frequently observed in tropical regions, this disease occurs also in temperate climates during hot weather. A moist condition of the atmosphere, which interferes with cooling of the overheated body, greatly increases the liability to suffer from this ailment.

Sunstroke has been chiefly observed and investigated as occurring among soldiers in India, where formerly, both in active service and in the routine of ordinary duty, cases of this disease constituted a considerable item of sickness and mortality. The increased attention now paid by military authorities to the personal health and comfort of the soldier, particularly as regards barrack accommodation and dress, together with the care taken in adjusting the time and mode of movement of troops, has done much to lessen the mortality from this cause. It would appear that, while any one exposed to the influence of strong solar heat may suffer from the symptoms of sunstroke, there are certain conditions which greatly predispose to it in the case of individuals. Causes calculated to depress the health, such as previous disease, particularly affections of the nervous system,—anxiety, worry, or overwork, irregularities in food, and in a marked degree intemperance—have a powerful predisposing influence, while personal uncleanliness, which prevents among other things the healthy action of the skin, the wearing of tight garments, which impede the functions alike of heart and lungs, and living in overcrowded and insanitary dwellings have an equally hurtful tendency.

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[1] The orthodox are so called because they allow the authority of the mujtehid (*supra*, p. 699). See Gobineau, *Les Religions*, etc., *dans l'Asie Centrale*, Paris, 1866, p. 28 *sq*.

[2] Gobineau (*op. cit.*, p. 30) reckons them as orthodox; but see Polak, *Persien*, Leipsic, 1865, i. 348; comp. also Von Kremer, *Gesch. d. herrschenden Ideen des Islams*. p. 206 *sq*. (after Kazen Beg).

[3] See Polak, *op. cit.*, p. 349; Malcolm, *Hist. of Persia*, ii. 382; Rehatsek, in *Journ. R.S.A.* (Bombay branch), 1880, p. 424. Langlès, in Chardin, *Voyages*, 1811, x. 241, says that at the beginning of the 19th century their chief seats were north of Kandahar and Kabul (Cabul), and at Kashan.

[4] The fusion of these two tendencies is in Persia as old as Mazdak (vol. xviii. p. 622). Communistic risings constantly took place in various parts of Persia under the caliphs, and that of Bábek endangered the empire for twenty years (till 837 A.D.). The communists were afterwards absorbed in the Ishmaelites (see vol. xvi. p. 615 *sq*.), whose power was extinguished by the Mongols (1256).

[5] See on Báb and Bábism, Mirza Kazem Beg, in *Journ. Asiatique*, ser. 6, vols. vii. viii.; Gobineau. *op. cit.*, where there is a translation of Báb's new Koran; Von Kremer, *op. cit.*, p. 202 *sq*.

[6] See Garcin de Tassy, *L'Islamisme*, 3d ed. (1874), p. 298 and Rehatsek, *ut sup*.

[7] Compare especially Snouck Hurgronje, "Der Mahdi," in *Revue Coloniale Internationale*, 1885, an article based on wide reading and personal observations at Jeddah and Mecca.

While attacks of sunstroke are frequently precipitated by exposure, especially during fatigue, to the direct rays of the sun, in a large number of instances they come on under other circumstances. Cases are of not unfrequent occurrence among soldiers in hot climates when there is overcrowding or bad ventilation in their barracks, and sometimes several will be attacked in the course of a single night. The same remark applies to similar conditions existing on shipboard. Further, persons whose occupation exposes them to excessive heat, such as stokers, laundry workers, etc., are apt to suffer, particularly in hot seasons. In the tropics Europeans, especially those who have recently arrived, are more readily affected than natives. But natives are not exempt.

The symptoms of heatstroke, which obviously depend upon the disorganization of the normal heat-regulating mechanism, as well as of the functions of circulation and respiration (see PATHOLOGY, vol. xviii. p. 403), vary in their intensity and likewise to some extent in their form. Three chief types of the disease are usually described.

(1) *Heat Syncope.*—In this form the symptoms are those of exhaustion, with a tendency towards fainting or its actual occurrence. A fully developed attack of this description is usually preceded by sickness, giddiness, some amount of mental excitement followed by drowsiness, and then the passage into the syncopal condition, in which there are pallor and coldness of the skin, a weak, quick, and intermittent pulse, and gasping or sighing respiration. The pupils are often contracted. Death may quickly occur; but if timely treatment is available recovery may take place.

(2) *Heat Apoplexy or Asphyxia.*—In this variety the attack, whether preceded or not by the premonitory symptoms already mentioned, is usually sudden, and occurs in the form of an apoplectic seizure, with great vascular engorgement, as seen in the flushed face, congested eyes, quick full pulse, and stertorous breathing. There is usually insensibility, and convulsions are not unfrequent. Death is often very sudden. This form, however, is also amenable to treatment.

(3) *Ardent Thermic Fever.*—This variety is characterized chiefly by the excessive development of fever (hyperpyrexia), the temperature of the body rising at such times to 108° to 110° Fahr. or more. Accompanying this are the other symptoms of high febrile disturbance, such as great thirst, quick full pulse, pains throughout the body, headache, nausea, and vomiting, together with respiratory embarrassment. After the attack has lasted for a variable period, often one or two days, death may ensue from collapse or from the case assuming the apoplectic form already described. But here too treatment may be successful if it is promptly applied.

Besides these, other varieties depending on the prominence of certain symptoms are occasionally met with. The chief changes in the body after death from heatstroke are those of anæmia of the brain and congestion of the lungs, together with softness of the heart and of the muscular tissues generally. The blood is dark and fluid and the blood corpuscles are somewhat altered in shape. Attacks of sunstroke are apt to leave traces of their effects upon the constitution, especially upon the nervous system. A liability to severe headache, which in many cases would seem to depend upon a condition of chronic meningitis, epileptic fits, mental irritability, and alterations in the disposition are among the more important. It is often observed that heat in any form is ever afterwards ill borne, while there also appears to be an abnormal susceptibility to the action of stimulants. The mortality from sunstroke is estimated at from 40 to 50 per cent.

Treatment.—In respect of this disease means should be adopted to prevent attacks in the case of those who must necessarily be exposed to the sun. These consist in the wearing of loose clothing, with the exception of the head-dress, which ought to be worn close to the head, in due attention to the function of the skin, and in the avoidance of alcoholic and other excesses. Cold water may be drunk in small quantities at frequent intervals. Sleeping in the open air in very hot seasons is recommended. The treatment of a patient suffering from an attack necessarily depends upon the form it has assumed. In all cases he should if possible be at once removed into a shaded or cool place. Where the symptoms are mostly those of syncope and there is a tendency to death from heart failure, rest in the recumbent position, the use of diffusible stimulants, such as ammonia or ether, etc., together with friction or warmth applied to the extremities, are the means to be adopted. Where, on the other hand, the symptoms are those of apoplexy or of hyperpyrexia, by far the most successful results are obtained by the use of cold (the cold affusion, rubbing the surface with ice, enemata of ice-cold water). The effect is a marked lowering of the temperature, while at the same time a stimulus is given to the respiratory function. Mustard or turpentine applied to the nape of the neck or chest is a useful adjuvant. Should the temperature be lowered in this way but unconsciousness still persist, removal of the hair and blistering the scalp are recommended. The subsequent treatment will depend upon the nature of the resulting symptoms, but change to a cool climate is often followed by marked benefit. (J. O. A.)

SUPERIOR, LAKE. See LAKE and ST. LAWRENCE.

SURABAYA. See JAVA, vol. xiii. p. 617 *sq.* The population in 1880 was 122,234.

SURAKARTA, or SOLO. See JAVA, vol. xiii. pp. 611, 617 *sq.* Its population was 124,041 in 1880.

SURAT, a district of British India, in the Guzerat division of Bombay presidency, lying between 20° 15′ and 21° 28′ N. lat. and 72° 38′ and 73° 30′ E. long. It has an area of 1662 square miles, and is bounded on the N. by Broach district and the native state of Baroda; on the E. by the states of Rájpipla, the Gáikwár Bánsda, and Dharampur; on the S. by Thána district and the Portuguese territory of Daman; and on the W. by the Arabian Sea. It has a coast-line of 80 miles, consisting of a barren stretch of sand drift and salt marsh; behind that is a rich highly cultivated plain, nearly 60 miles in breadth at the embouchure of the Tápti, but narrowing to only 15 miles in the southern part; and on the northeast are the wild hills and jungle of the Dangs. The only important rivers are the Tápti and the Kim, the former of which is ordinarily navigable for native craft of from 18 to 36 tons. The district contains a large number of tanks for irrigation; and a canal is projected from the Tápti with head works at Kamlápur, 35 miles from Surat. The fauna of the district consists of a few tigers, stragglers from the jungles of Bánsda and Dharampur, besides leopards, bears, wild boars, wolves, hyenas, spotted deer, and antelopes. The climate of Surat varies with the distance from the sea. Near the coast, under the influence of the sea-breeze, an equable temperature prevails, but 8 to 11 miles inland the breeze ceases to blow. The coast also possesses a much lighter rainfall than the interior, the annual average ranging from 30 inches in Olpád to 72 in Chikhli, while at Surat city the average is 46 inches. The Bombay, Baroda, and Central India Railway runs through the district from north to south. A magnificent iron-girder bridge crosses the Tápti at Surat city.

The census of 1881 returned the population of Surat at 614,198 (306,015 males, 308,183 females), of whom Hindus numbered 415,031 Mohammedans 55,547, Parsis 12,593, and aboriginals 118,664. There are only two towns in the district with a population exceeding 5000,—namely, SURAT (*q.v.*) and Bulsar (13,229). The cultivated area in 1884-85 was returned at 726,583 acres, and the area available for cultivation at 81,663. The total area of crops in 1884-85 was 550,233 acres, including 66,096 twice cropped. Rice occupied 103,972 acres, wheat 38,617 and *joár* 108,644; cotton is also largely cultivated, and its culture is greatly increasing. Grain, cotton, timber, oil, sugar and molasses, and piece goods are the chief articles of export. Almost the whole female population is engaged in spinning cotton thread, and the weaving of cotton cloth in hand looms is carried on in the chief towns; silk is also manufactured in considerable quantities, as well as brocades and embroidery. In 1884–85 the revenue of the district amounted to £378,061 [$1,837,376.-46], of which the land-tax contributed £268,644 [$1,305,609.-84]. Surat was one of the earliest parts of India brought into close relations with European countries, and its history merges almost entirely into that of its capital, long the greatest maritime city of the peninsula. By an arrangement made in 1799 the English were placed in possession of Surat city and the town of Rander; subsequent cessions under the treaties of Bassien (1802) and Poona (1817), together with the lapse of the Mandvi state in 1839, brought the district into its present shape. Since the introduction of British rule the district has remained comparatively tranquil; and even during the period of the mutiny peace was not disturbed, owing in a great measure to the steadfast loyalty of its leading Mohammedan families.

SURAT, capital and administrative headquarters of the above district, is situated in 21° 9′ 30″ N. lat. and 72° 54′ 15″ E. long., on the southern bank of the Tápti, distant from the sea 14 miles by water and 10 by land. Its origin appears to be comparatively modern, tradition assigning the foundation of the town to the beginning of the 16th century. As early as 1514 it was described by the Portuguese traveller Barbosa as a "very important seaport." During the reigns of Akbar, Jahángír, and Sháh Jahán it rose to be the chief commercial city of India. From 1573 to 1612 the Portuguese were undisputed masters of the Surat seas and part of the seaboard. But shortly after 1612 the city of Surat became the seat of a presidency under the English East India Company, and the Dutch also had made it their principal factory in India. During the 18th century it probably ranked as the most populous city of India, its population being at one time estimated as high as 800,000; but with the transfer of its trade to Bombay the numbers rapidly fell off, until in 1847 its inhabitants numbered only 80,000. Thenceforward the city began to retrieve its position, and in 1881 its population numbered 107,154 (54,524 males and 52,630 females).

SURBITON, a suburb of Kingston in Surrey, England, is finely situated on the river Thames, 12 miles southwest of London by the London and South-Western Railway. It consists chiefly of villa residences embosomed in woods and gardens. Along the river an esplanade has been constructed, forming a pleasant promenade. Surbiton is the headquarters of the Kingston Rowing Club and the Thames Sailing Club. The recreation ground, in connection with which there is a reading-room and library, is much frequented for athletic meetings and bicycle races. In the town there is a cottage hospital. The population of the urban sanitary district (area, 1000 acres) in 1871 was 7642, and in 1881 it was 9406.

SURETY, in law, is the party liable under a contract of Guarantee (*q.v.*). In criminal practice sureties bound by Recognizance (*q.v.*) are a means of obtaining compliance with the order of a court of justice, whether to keep the peace or otherwise.

SURFACE, CONGRUENCE, COMPLEX. In the article Curve the subject was treated from an historical point of view, for the purpose of showing how the leading ideas of the theory were successively arrived at. These leading ideas apply to surfaces, but the ideas peculiar to surfaces are scarcely of the like fundamental nature, being rather developments of the former set in their application to a more advanced portion of geometry; there is consequently less occasion for the historical mode of treatment. Curves in space were briefly considered in the same article, and they will not be discussed here; but it is proper to refer to them in connection with the other notions of solid geometry. In plane geometry the elementary figures are the point and the line; and we then have the curve, which may be regarded as a singly infinite system of points, and also as a singly infinite system of lines. In solid geometry the elementary figures are the point, the line, and the plane; we have, moreover, first, that which under one aspect is the curve, and under another aspect the developable (or torse), and which may be regarded as a singly infinite system of points, of lines, or of planes; and secondly, the surface, which may be regarded as a doubly infinite system of points or of planes, and also as a special triply infinite system of lines. (The tangent lines of a surface are a special complex.) As distinct particular cases of the first figure, we have the plane curve and the cone, and as a particular case of the second figure the ruled surface, regulus, or singly infinite system of lines; we have, besides, the congruence or doubly infinite system of lines and the complex or triply infinite system of lines. And thus crowds of theories arise which have hardly any analogues in plane geometry; the relation of a curve to the various surfaces which can be drawn through it, and that of a surface to the various curves which can be drawn upon it, are different in kind from those which in plane geometry most nearly correspond to them,—the relation of a system of points to the different curves through them and that of a curve to the systems of points upon it. In particular, there is nothing in plane geometry to correspond to the theory of the curves of curvature of a surface. Again, to the single theorem of plane geometry, that a line is the shortest distance between two points, there correspond in solid geometry two extensive and difficult theories,—that of the geodesic lines on a surface and that of the minimal surface, or surface of minimum area, for a given boundary. And it would be easy to say more in illustration of the great extent and complexity of the subject.

Surfaces in General; Torses, etc.

1. A surface may be regarded as the locus of a doubly infinite system of points,—that is, the locus of the system of points determined by a single equation $U = (*)(x, y, z, 1)^n$, $= 0$, between the Cartesian coordinates (to fix the ideas, say rectangular coordinates) x, y, z; or, if we please, by a single homogeneous relation $U = (*)(x, y, z, w)^n$, $= 0$, between the quadriplanar coordinates x, y, z, w. The degree n of the equation is the order of the surface; and this definition of the order agrees with the geometrical one, that the order of the surface is equal to the number of the intersections of the surface by an arbitrary line. Starting from the foregoing point definition of the surface, we might develop the notions of the tangent line and the tangent plane; but it will be more convenient to consider the surface *ab initio* from the more general point of view in its relation to the point, the line, and the plane.

2. Mention has been made of the plane curve and the cone; it is proper to recall that the *order* of a plane curve is equal to the number of its intersections by an arbitrary line (in the plane of the curve), and that its *class* is equal to the number of tangents to the curve which pass through an arbitrary point (in the plane of the curve). The cone is a figure correlative to the plane curve; corresponding to the plane of the curve we have the vertex of the cone, to its tangents the generating lines of the cone, and to its points the tangent planes of the cone. But from a different point of view we may consider the generating lines of the cone as corresponding to the points of the curve and its tangent planes as corresponding to the tangents of the curve. From this point of view we define the order of the cone as equal to the number of its intersections (generating lines) by an arbitrary plane through the vertex, and its class as equal to the number of the tangent planes which pass through an arbitrary line through the vertex. And in the same way that a plane curve has singularities (singular points

and singular tangents) so a cone has singularities (singular generating lines and singular tangent planes).

3. Consider now a surface in connection with an arbitrary line. The line meets the surface in a certain number of points, and, as already mentioned, the *order* of the surface is equal to the number of these intersections. We have through the line a certain number of tangent planes of the surface, and the *class* of the surface is equal to the number of these tangent planes.

But, further, through the line imagine a plane; this meets the surface in a curve the order of which is equal (as is at once seen) to the order of the surface. Again, on the line imagine a point; this is the vertex of a cone circumscribing the surface, and the class of this cone is equal (as is at once seen) to the class of the surface. The tangent lines of the surface which lie in the plane are nothing else than the tangents of the plane section, and thus form a singly infinite series of lines; similarly, the tangent lines of the surface which pass through the point are nothing else than the generating lines of the circumscribed cone, and thus form a singly infinite series of lines. But, if we consider those tangent lines of the surface which are at once in the plane and through the point, we see that they are finite in number; and we define the *rank* of a surface as equal to the number of tangent lines which lie in a given plane and pass through a given point in that plane. It at once follows that the class of the plane section and the order of the circumscribed cone are each equal to the rank of the surface, and are thus equal to each other. It may be noticed that for a general surface $(*\between x,y,z,w)^n, =0$, of order n without point singularities the rank is $a, =n(n-1)$, and the class is $n', =n(n-1)^2$; this implies (what is in fact the case) that the circumscribed cone has line singularities, for otherwise its class, that is the class of the surface, would be $a(a-1)$, which is not $=n(n-1)^2$.

4. In the last preceding number the notions of the tangent line and the tangent plane have been assumed as known, but they require to be further explained in reference to the original point definition of the surface. Speaking generally, we may say that the points of the surface consecutive to a given point on it lie in a plane which is the tangent plane at the given point, and conversely the given point is the point of contact of this tangent plane, and that any line through the point of contact and in the tangent plane is a tangent line touching the surface at the point of contact. Hence we see at once that the tangent line is any line meeting the surface in two consecutive points, or—what is the same thing—a line meeting the surface in the point of contact counting as two intersections and in $n-2$ other points. But from the foregoing notion of the tangent plane as a plane containing the point of contact and the consecutive points of the surface, the passage to the true definition of the tangent plane is not equally obvious. A plane in general meets the surface of the order n in a curve of that order without double points; but the plane may be such that the curve has a double point, and when this is so the plane is a tangent plane having the double point for its point of contact. The double point is either an acnode (isolated point), then the surface at the point in question is convex towards (that is, concave away from) the tangent plane; or else it is a crunode, and the surface at the point in question is then concavo-convex, that is, it has its two curvatures in opposite senses (see *infra*, No. 16). Observe that in either case any line whatever in the plane and through the point meets the surface in the points in which it meets the plane curve, namely, in the point of contact, which *qua* double point counts as two intersections, and in $n-2$ other points; that is, we have the preceding definition of the tangent line.

5. The complete enumeration and discussion of the singularities of a surface is a question of extreme difficulty which has not yet been solved.[1] A plane curve has point singularities and line singularities; corresponding to these we have for the surface isolated point singularities and isolated plane singularities, but there are besides continuous singularities applying to curves on or torses circumscribed to the surface, and it is among these that we have the non-special singularities which play the most important part in the theory. Thus the plane curve represented by the general equation $(*\between x, y, z)^n=0$, of any given order n, has the non-special line singularities of inflections and double tangents; corresponding to this the surface represented by the general equation $(*\between x, y, z, w)^n=0$, of any given order n, has, not the isolated plane singularities, but the continuous singularities of the spinode curve or torse and the node-couple curve or torse. A plane may meet the surface in a curve having (1) a cusp (spinode) or (2) a pair of double points; in each case there is a singly infinite system of such singular tangent planes, and the locus of the points of contact is the curve, the envelope of the tangent planes the torse. The reciprocal singularities to these are the nodal curve and the cuspidal curve; the surface may intersect or touch itself along a curve in such wise that, cutting the surface by an arbitrary plane, the curve of intersection has at each intersection of the plane with the curve on the surface (1) a double point (node) or (2) a cusp. Observe that these are singularities not occurring in the surface represented by the general equation $(*\between x, y, z, w)^n=0$ of any order; observe further that in the case of both or either of these singularities the definition of the tangent plane must be modified. A tangent plane is a plane such that there is in the plane section a double point in addition to the nodes or cusps at the intersections with the singular lines on the surface.

6. As regards isolated singularities, it will be sufficent to mention the point singularity of the conical point (or cnicnode) and the corresponding plane singularity of the conic of contact (or cnictrope). In the former case we have a point such that the consecutive points, instead of lying in a tangent plane, lie on a quadric cone, having the point for its vertex; in the latter case we have a plane touching the surface along a conic; that is, the complete intersection of the surface by the plane is made up of the conic taken twice and of a residual curve of the order $n-4$.

7. We may, in the general theory of surfaces, consider either a surface and its reciprocal surface, the reciprocal surface being taken to be the surface enveloped by the polar planes (in regard to a given quadric surface) of the points of the original surface; or—what is better—we may consider a given surface in reference to the reciprocal relations of its order, rank, class, and singularities. In either case we have a series of unaccented letters and a corresponding series of accented letters, and the relations between them are such that we may in any equation interchange the accented and the unaccented letters; in some cases an unaccented letter may be equal to the corresponding accented letter. Thus, let n, n' be as before the order and the class of the surface, but, instead of immediately defining the rank, let a be used to denote the class of the plane section and a' the order of the circumscribed cone; also let S, S' be numbers referring to the singularities. The form of the relations is $a=a'(=\text{rank of surface})$; $a'=n(n-1)-S$; $n'=n(n-1)^2-S$; $a=n'(n'-1)-S'$; $n=n'(n'-1)^2-S'$. In these last equations S, S' are merely written down to denote proper corresponding combinations of the several numbers referring to the singularities collectively denoted by S, S' respectively. The theory, as already mentioned, is a complex and

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[1] In a plane curve the only singularities which need to be considered are those that present themselves in Plücker's equations, for every higher singularity whatever is equivalent to a certain number of nodes, cusps, inflections, and double tangents. As regards a surface, no such reduction of the higher singularities has as yet been made.

difficult one, and it is not the intention to further develop it here.

8. A developable or torse corresponds to a curve in space in the same manner as a cone corresponds to a plane curve; although capable of representation by an equation $U = (*\between x, y, z, w,)^n, = 0$, and so of coming under the foregoing point definition of a surface, it is an entirely distinct geometrical conception. We may indeed, *qua* surface, regard it as a surface characterized by the property that each of its tangent planes touches it, not at a single point, but along a line; this is equivalent to saying that it is the envelope, not of a doubly infinite series of planes, as is a proper surface, but of a single infinite system of planes. But it is perhaps easier to regard it as the locus of a singly infinite system of lines, each line meeting the consecutive line, or, what is the same thing, the lines being tangent lines of a curve in space. The tangent plane is then the plane through two consecutive lines, or what is the same thing, an osculating plane of the curve, whence also the tangent plane intersects the surface in the generating line counting twice, and in a residual curve of the order $n-2$. The curve is said to be the edge of regression of the developable, and it is a cuspidal curve thereof; that is to say, any plane section of the developable has at each point of intersection with the edge of regression a cusp. A sheet of paper bent in any manner without crumpling gives a developable; but we cannot with a single sheet of paper properly exhibit the form in the neighborhood of the edge of regression: we need two sheets connected along a plane curve, which when the paper is bent, becomes the edge of regression and appears as a cuspidal curve on the surface.

It may be mentioned that the condition which must be satisfied in order that the equation $U = 0$ shall represent a developable is $H(U) = 0$; that is, the Hessian or functional determinant formed with the second differential coefficients of U must vanish in virtue of the equation $U = 0$, or—what is the same thing—$H(U)$ must contain U as a factor. If in Cartesian coordinates the equation is taken in the form $z - f(x, y) = 0$, then the condition is $rt - s^2 = 0$ identically, where r, s, t denote as usual the second differential coefficients of z in regard to x, y respectively.

9. A ruled surface or regulus is the locus of a singly infinite system of lines, where the consecutive lines do not intersect; this is a true surface, for there is a doubly infinite series of tangent planes,—in fact any plane through any one of the lines is a tangent plane of the surface, touching it at a point on the line, and in such wise that, as the tangent plane turns about the line, the point of contact moves along the line. The complete intersection of the surface by the tangent plane is made up of the line counting once and of a residual curve of the order $n-1$. A quadric surface is a regulus in a twofold manner, for there are on the surface two systems of lines each of which is a regulus. A cubic surface may be a regulus (see No. 11 *infra*).

Surfaces of the Orders 2, 3, *and* 4.

10. A surface of the second order or a quadric surface is a surface such that every line meets it in two points, or—what comes to the same thing—such that every plane section thereof is a conic or quadric curve. Such surfaces have been studied from every point of view. The only singular forms are when there is (1) a conical point (cnicnode), when the surface is a cone of the second order or quadricone; (2) a conic of contact (cnictrope), when the surface is this conic; from a different point of view it is a *surface aplatie* or flattened surface. Excluding these degenerate forms, the surface is of the order, rank, and class each $= 2$, and it has no singularities. Distinguishing the forms according to *reality*, we have the ellipsoid, the hyperboloid of two sheets, the hyperboloid of one sheet, the elliptic paraboloid, and the hyperbolic paraboloid (see GEOMETRY, ANALYTICAL). A particular case of the ellipsoid is the sphere; in abstract geometry this is a quadric surface passing through a given quadric curve, the circle at infinity. The tangent plane of a quadric surface meets it in a quadric curve having a node, that is, in a pair of lines; hence there are on the surface two singly infinite sets of lines. Two lines of the same set do not meet, but each line of the one set meets each line of the other set; the surface is thus a regulus in a twofold manner. The lines are real for the hyperboloid of one sheet and for the hyperbolic paraboloid; for the other forms of surface they are imaginary.

11. We have next the surface of the third order or cubic surface, which has also been very completely studied. Such a surface may have isolated point singularities (cnicnodes or points of higher singularity), or it may have a nodal line; we have thus $21 + 2, = 23$ cases. In the general case of a surface without any singularities, the order, rank, and class are $= 3$, 6, 12, respectively. The surface has upon it 27 lines, lying by threes in 45 planes, which are triple tangent planes. Observe that the tangent plane is a plane meeting the surface in a curve having a node. For a surface of any given order n there will be a certain number of planes each meeting the surface in a curve with 3 nodes, that is, triple tangent planes; and, in the particular case where $n = 3$, the cubic curve with 3 nodes is of course a set of 3 lines; it is found that the number of triple tangent planes is, as just mentioned, $= 45$. This would give 135 lines, but through each line we have 5 such planes, and the number of lines is thus $= 27$. The theory of the 27 lines is an extensive and interesting one; in particular, it may be noticed that we can, in thirty-six ways, select a system of 6×6 lines, or "double sixer," such that no 2 lines of the same set intersect each other, but that each line of the one set intersects each line of the other set.

A cubic surface having a nodal line is a ruled surface or regulus; in fact any plane through the nodal line meets the surface in this line counting twice and in a residual line, and there is thus on the surface a singly infinite set of lines. There are two forms; but the distinction between them need not be referred to here.

12. As regards quartic surfaces, only particular forms have been much studied. A quartic surface can have at most 16 conical points (cnicnodes); an instance of such a surface is Fresnel's wave surface, which has 4 real cnicnodes in one of the principal planes, 4×2 imaginary ones in the other two principal planes, and 4 imaginary ones at infinity,—in all 16 cnicnodes; the same surface has also 4 real + 12 imaginary planes each touching the surface along a circle (cnictropes),—in all 16 cnictropes. It was easy by a mere homographic transformation to pass to the more general surface called the tetrahedroid; but this was itself only a particular form of the general surface with 16 cnicnodes and 16 cnictropes first studied by Kummer. Quartic surfaces with a smaller number of cnicnodes have also been considered.

Another very important form is the quartic surface having a nodal conic; the nodal conic may be the circle at infinity, and we have then the so-called anallagmatic surface, otherwise the cyclide (which includes the particular form called Dupin's cyclide). These correspond to the bicircular quartic curve of plane geometry. Other forms of quartic surface might be referred to.

Congruences and Complexes.

13. A congruence is a doubly infinite system of lines. A line depends on four parameters and can therefore be determined so as to satisfy four conditions; if only two conditions are imposed on the line we have a doubly infinite system of lines or a congruence. For instance, the lines meeting each of two given lines form a congruence. It is hardly necessary to remark that, imposing on the line one more condition, we have a ruled surface or regulus; thus we can in an in-

finity of ways separate the congruence into a singly infinite system of reguli or of torses (see *infra*, No. 16).

Considering in connection with the congruence two arbitrary lines, there will be in the congruence a determinate number of lines which meet each of these two lines; and the number of lines thus meeting the two lines is said to be the *order-class* of the congruence. If the two arbitrary lines are taken to intersect each other, the congruence lines which meet each of the two lines separate themselves into two sets,—those which lie in the plane of the two lines and those which pass through their intersection. There will be in the former set a determinate number of congruence lines which is the *order* of the congruence, and in the latter set a determinate number of congruence lines which is the *class* of the congruence. In other words, the order of the congruence is equal to the number of congruence lines lying in an arbitrary plane, and its class to the number of congruence lines passing through an arbitrary point.

The following systems of lines form each of them a congruence: (A) lines meeting each of two given curves; (B) lines meeting a given curve twice; (C) lines meeting a given curve and touching a given surface; (D) lines touching each of two given surfaces; (E) lines touching a given surface twice, or, say, the bitangents of a given surface.

The last case is the most general one; and conversely for a given congruence there will be in general a surface having the congruence lines for bitangents. This surface is said to be the *focal surface* of the congruence; the general surface with 16 cnicnodes first presented itself in this manner as the focal surface of a congruence. But the focal surface may degenerate into the forms belonging to the other cases A, B, C, D.

14. A complex is a triply infinite system of lines,—for instance, the tangent lines of a surface. Considering an arbitrary point in connection with the complex, the complex lines which pass through the point form a cone; considering a plane in connection with it, the complex lines which lie in the plane envelope a curve. It is easy to see that the class of the curve is equal to the order of the cone; in fact each of these numbers is equal to the number of complex lines which lie in an arbitrary plane and pass through an arbitrary point of that plane; and we then say *order* of complex = order of curve; *rank* of complex = class of curve = order of cone; *class* of complex = class of cone. It is to be observed that, while for a congruence there is in general a surface having the congruence lines for bitangents, for a complex there is not in general any surface having the complex lines for tangents; the tangent lines of a surface are thus only a special form of the complex. The theory of complexes first presented itself in the researches of Malus on systems of rays of light in connection with double refraction.

15. The analytical theory as well of congruences as of complexes is most easily carried out by means of the six coordinates of a line; viz., there are coordinates (a, b, c, f, g, h) connected by the equation $af + bg + ch = 0$, and therefore such that the ratios $a : b : c : f : g : h$ constitute a system of four arbitrary parameters. We have thus a congruence of the order n represented by a single homogeneous equation of that order $(* \between a, b, c, f, g, h)^n = 0$ between the six coordinates; two such relations determine a congruence. But we have in regard to congruences the same difficulty as that which presents itself in regard to curves in space; it is not every congruence which can be represented completely and precisely by *two* such equations.

The linear equation $(* \between a, b, c, f, g, h) = 0$ represents a congruence of the first order or linear congruence; such congruences are interesting both in geometry and in connection with the theory of forces acting on a rigid body.

Curves of Curvature; Asymptotic Lines.

16. The normals of a surface form a congruence. In any congruence the lines consecutive to a given congruence line do not in general meet this line; but there is a determinate number of consecutive lines which do meet it; or, attending for the moment to only one of these, say the congruence line is met by a consecutive congruence line. In particular, each normal is met by a consecutive normal; this again is met by a consecutive normal, and so on. That is, we have a singly infinite system of normals each meeting the consecutive normal, and so forming a torse; starting from different normals successively, we obtain a singly infinite system of such torses. But each normal is in fact met by two consecutive normals, and, using in the construction first the one and then the other of these, we obtain two singly infinite systems of torses each intersecting the given surface at right angles. In other words, if in place of the normal we consider the point on the surface, we obtain on the surface two singly infinite systems of curves such that for any curve of either system the normals at consecutive points intersect each other; moreover, for each normal the torses of the two systems intersect each other at right angles; and therefore for each point of the surface the curves of the two systems intersect each other at right angles. The two systems of curves are said to be the curves of curvature of the surface.

The normal is met by the two consecutive normals in two points which are the centres of curvature for the point on the surface; these lie either on the same side of the point or on opposite sides, and the surface has at the point in question like curvatures or opposite curvatures in the two cases respectively (see *supra*, No. 4).

17. In immediate connection with the curves of curvature we have the so-called asymptotic curves (Haupt-tangentenlinien). The tangent plane at a point of the surface cuts the surface in a curve having at that point a node. Thus we have at the point of the surface two directions of passage to a consecutive point, or, say, two elements of arc; and, passing along one of these to the consecutive point, and thence to a consecutive point, and so on, we obtain on the surface a curve. Starting successively from different points of the surface we thus obtain a singly infinite system of curves; or, using first one and then the other of the two directions, we obtain two singly infinite systems of curves, which are the curves above referred to. The two curves at any point are equally inclined to the two curves of curvature at that point, or—what is the same thing—the supplementary angles formed by the two asymptotic lines are bisected by the two curves of curvature. In the case of a quadric surface the asymptotic curves are the two systems of lines on the surface.

Geodesic Lines.

18. A geodesic line (or curve) is a shortest curve on a surface; more accurately, the element of arc between two consecutive points of a geodesic line is a shortest arc on the surface. We are thus led to the fundamental property that at each point of the curve the osculating plane of the curve passes through the normal of the surface; in other words, any two consecutive arcs PP', $P'P''$ are *in plano* with the normal at P'. Starting from a given point P on the surface, we have a singly infinite system of geodesics proceeding along the surface in the direction of the several tangent lines at the point P; and, if the direction PP' is given, the property gives a construction by successive elements of arc for the required geodesic line.

Considering the geodesic lines which proceed from a given point P of the surface, any particular geodesic line is or is not again intersected by the consecutive generating line; if it is thus intersected, the generating line is a shortest line on the surface up to, but not beyond, the point at which it is first intersected by the consecutive generating line; if it is not intersected, it continues a shortest line for the whole course.

In the analytical theory both of geodesic lines and of the curves of curvature, and in other parts of the theory of surfaces, it is very convenient to consider the rectangular coordinates x, y, z of a point of the surface as given functions of two independent parameters p, q; the form of these functions of course determines the surface, since by the elimination of p, q from the three equations we obtain the equation in the coordinates x, y, z. We have for the geodesic lines a differential equation of the second order between p and q; the general solution contains two arbitrary constants, and is thus capable of representing the geodesic line which can be drawn from a given point in a given direction on the surface. In the case of a quadric surface the solution involves hyperelliptic integrals of the first kind, depending on the square root of a sextic function.

Curvilinear Coordinates.

19. The expressions of the coordinates x, y, z in terms of p, q may contain a parameter r, and, if this is regarded as a given constant, these expressions will as before refer to a point on a given surface. But, if p, q, r are regarded as three independent parameters, x, y, z will be the coordinates of a point in space, determined by means of the three parameters p, q, r; these parameters are said to be the curvilinear coordinates, or (in a generalized sense of the term) simply the coordinates of the point. We arrive otherwise at the notion by taking p, q, r each as a given function of x, y, z; say we have $p=f_1(x,y,z)$, $q=f_2(x,y,z)$, $r=f_3(x,y,z)$, which equations of course lead to expressions for p, q, r each as a function of x, y, z. The first equation determines a singly infinite set of surfaces: for any given value of p we have a surface; and similarly the second and third equations determine each a singly infinite set of surfaces. If, to fix the ideas, f_1, f_2, f_3 are taken to denote each a rational and integral function of x, y, z, then two surfaces of the same set will not intersect each other, and through a given point of space there will pass one surface of each set; that is, the point will be determined as a point of intersection of three surfaces belonging to the three sets respectively; moreover, the whole of space will be divided by the three sets of surfaces into a triply infinite system of elements, each of them being a parallelopiped.

Orthotomic Surfaces; Parallel Surfaces.

20. The three sets of surfaces may be such that the three surfaces through any point of space whatever intersect each other at right angles; and they are in this case said to be orthotomic. The term curvilinear coordinates was almost appropriated by Lamé, to whom this theory is chiefly due, to the case in question; assuming that the equations $p=f_1(x,y,z)$, $q=f_2(x,y,z)$, $r=f_3(x,y,z)$ refer to a system of orthotomic surfaces, we have in the restricted sense p, q, r as the curvilinear coordinates of the point.

An interesting special case is that of confocal quadric surfaces. The general equation of a surface confocal with the ellipsoid

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1 \text{ is } \frac{x^2}{a^2+\theta}+\frac{y^2}{b^2+\theta}+\frac{z^2}{c^2+\theta}=1;$$

and, if in this equation we consider x, y, z as given, we have for θ a cubic equation with three real roots p, q, r, and thus we have through the point three real surfaces, one an ellipsoid, one a hyperboloid of one sheet, and one a hyperboloid of two sheets.

21. The theory is connected with that of curves of curvature by Dupin's theorem. Thus in any system of orthotomic surfaces each surface of any one of the three sets is intersected by the surfaces of the other two sets in its curves of curvature.

22. No one of the three sets of surfaces is altogether arbitrary: in the equation $p=f_1(x,y,z)$, p is not an arbitrary function of x, y, z, but it must satisfy a certain partial differential equation of the third order. Assuming that p has this value, we have $q=f_2(x,y,z)$ and $r=f_3(x,y,z)$ determinate functions of x,y,z such that the three sets of surfaces form an orthotomic system.

23. Starting from a given surface, it has been seen (No. 16) that the normals along the curves of curvature form two systems of torses intersecting each other, and also the given surface at right angles. But there are, intersecting the two systems of torses at right angles, not only the given surface, but a singly infinite system of surfaces. If at each point of the given surface we measure off along the normal one and the same distance at pleasure, then the locus of the points thus obtained is a surface cutting all the normals of the given surface at right angles, or, in other words, having the same normals as the given surface; and it is therefore a parallel surface to the given surface. Hence the singly infinite system of parallel surfaces and the two singly infinite systems of torses form together a set of orthotomic surfaces.

The Minimal Surface.

24. This is the surface of minimum area—more accurately, a surface such that, for any indefinitely small closed curve which can be drawn on it round any point, the area of the surface is less than it is for any other surface whatever through the closed curve. It at once follows that the surface at every point is concavo-convex; for, if at any point this was not the case, we could, by cutting the surface by a plane, describe round the point an indefinitely small closed plane curve, and the plane area within the closed curve would then be less than the area of the element of surface within the same curve. The condition leads to a partial differential equation of the second order for the determination of the minimal surface: considering z as a function of x, y, and writing as usual p, q, r, s, t for the first and second differential coefficients of z in regard to x, y respectively, the equation (as first shown by Lagrange) is $(1+q^2)r-2pqs+(1+p^2)t=0$, or as this may also be written, $\frac{d}{dy}\frac{q}{\sqrt{1+p^2+q^2}}+\frac{d}{dx}\frac{p}{\sqrt{1+p^2+q^2}}=0$. The general integral contains of course arbitrary functions, and if we imagine these so determined that the surface may pass through a given closed curve, and if, moreover, there is but one minimal surface passing through that curve, we have the solution of the problem of finding the surface of minimum area within the same curve. The surface continued beyond the closed curve is a minimal surface, but it is not of necessity or in general a surface of minimum area for an arbitrary bounding curve not wholly included within the given closed curve. It is hardly necessary to remark that the plane is a minimal surface, and that, if the given closed curve is a plane curve, the plane is the proper solution; that is, the plane area within the given closed curve is less than the area for any other surface through the same curve. The given closed curve is not of necessity a single curve: it may be, for instance, a skew polygon of four or more sides.

The partial differential equation was dealt with in a very remarkable manner by Riemann. From the second form given above it appears that we have $\frac{qdx-pdy}{\sqrt{1+p^2+q^2}}=$ a complete differential, or, putting this $=d\zeta$, we introduce into the solution a variable ζ, which combines with z in the forms $z\pm i\zeta$ ($i=\sqrt{-1}$ as usual. The boundary conditions have to be satisfied by the determination of the conjugate variables η, η' as functions of $z+i\zeta$, $z-i\zeta$, or, say, of Z, Z' respectively, and by writing S, S' to denote $x+iy$, $x-iy$ respectively. Riemann obtains finally two ordinary differential equations of the first order in S, S', η, η', Z, Z', and the results are completely worked out in some very interesting special cases.

The memoirs on various parts of the general subject are very numerous; references to many of them will be found in Salmon's *Treatise on the Analytic Geometry of Three Dimensions*, 4th ed., Dublin, 1882 (the most comprehensive work on solid geometry); for the minimal surface (which is not considered there) see Memoirs xviii. and xxvi. in Reimann's *Gesammelte mathematische Werke*, Leipsic, 1876; the former—"Ueber die Fläche vom kleinsten Inhalt bei gegebener Begrenzung," as published in *Gött. Abhandl.*, vol. xiii. (1866-67)—contains an introduction by Hattendorff giving the history of the question. (A. CA.)

SURGEONS, COLLEGE OF. See SOCIETIES.

SURGERY.

PART I.—HISTORY.

SURGERY in all countries is as old as human needs. A certain skill in the stanching of blood, the extraction of arrows, the binding up of wounds, the supporting of broken limbs by splints, and the like, together with an instinctive reliance on the healing power of the tissues, has been common to men everywhere. In both branches of the Aryan stock surgical practice (as well as medical) reached a high degree of perfection at a very early period. It is a matter of controversy whether the Greeks got their medicine (or any of it) from the Hindus (through the medium of the Egyptian priesthood), or whether the Hindus owed that high degree of medical and surgical knowledge and skill which is reflected in Charaka and Suśruta (commentators of uncertain date on the Ayur-Veda; see SANSKRIT, vol. xxi., pp. 308-9) to their contact with Western civilization after the campaigns of Alexander. The evidence in favor of the former view is ably stated by Wise in the Introduction to his *History of Medicine among the Asiatics* (London, 1868). The correspondence between the *Suśruta* and the *Hippocratic Collection* is closest in the sections relating to the ethics of medical practice; the description, also of lithotomy in the former agrees almost exactly with the account of the Alexandrian practice as given by Celsus. But there are certainly some dexterous operations described in Suśruta (such as the rhinoplastic) which were of native invention; the elaborate and lofty ethical code appears to be of pure Brahmanical origin; and the very copious materia medica (which included arsenic, mercury, zinc, and many other substances of permanent value) does not contain a single article of foreign source. There is evidence also (in Arrian, Strabo, and other writers) that the East enjoyed a proverbial reputation for medical and surgical wisdom at the time of Alexander's invasion. We may give the first place, then, to the Eastern branch of the Aryan race in a sketch of the rise of surgery, leaving as insoluble the question of the date of the Sanskrit compendiums or compilations which pass under the names of two representative persons, Charaka and Suśruta (the dates assigned to these ranging as widely as 500 years on each side of the Christian era.

Ancient Hindu practitioners.

The *Suśruta* speaks throughout of a single class of practitioners who undertook both surgical and medical cases. Nor were there any fixed degrees or orders of skill within the profession; even lithotomy, which at Alexandria was assigned to specialists, was to be undertaken by any one, the leave of the rajah having been first obtained. The only distinction recognized between medicine and surgery was in the inferior order of barbers, nail-trimmers, ear-borers, tooth-drawers, and phlebotomists, who were outside the Brahmanical caste.

Surgical instruments.

Suśruta describes more than one hundred surgical instruments, made of steel. They should have good handles and firm joints, be well polished, and sharp enough to divide a hair; they should be perfectly clean, and kept in flannel in a wooden box. They included various shapes of scalpels, bistouries, lancets, scarifiers, saws, bone-nippers, scissors, trocars, and needles. There were also blunt hooks, loops, probes including a caustic-holder), directors, sounds, scoops, and forceps (for polypi, etc.), as well as catheters, syringes, a rectal speculum, and bougies. There were fourteen varieties of bandage. The favorite form of splint was made of thin slips of bamboo bound together with string and cut to the length required. Wise says that he has frequently used "this admirable splint," particularly for fractures of the thigh, humerus, radius, and ulna, and it has been subsequently adopted in the English army under the name of the "patent rattan-cane splint."

Operations.

Fractures were diagnosed, among other signs, by crepitus. Dislocations were elaborately classified, and the differential diagnosis given; the treatment was by traction and countertraction, circumduction, and other dexterous manipulation. Wounds were divided into incised, punctured, lacerated, contused, etc. Cuts of the head and face were sewed. Skill in extracting foreign bodies was carried to a great height, the magnet being used for iron particles under certain specified circumstances. Inflammations were treated by the usual antiphlogistic regimen and appliances; venesection was practiced at several other points besides the bend of the elbow; leeches were more often resorted to than the lancet; cupping also was in general use. Poulticing, fomenting, and the like were done as at present. Amputation was done now and then, notwithstanding the want of a good control over the hæmorrhage; boiling oil was applied to the stump, with pressure by means of a cup-formed bandage, pitch being sometimes added. Tumors and enlarged lymphatic glands were cut out, and an arsenical salve applied to the raw surfaces to prevent recurrence. Abdominal dropsy and hydrocele were treated by tapping with a trocar; and varieties of hernia were understood, omental hernia being removed by operation on the scrotum. Aneurisms were known, but not treated; the use of the ligature on the continuity of an artery, as well as on the cut end of it in a flap, is the one thing that a modern surgeon will miss somewhat noticeably in the ancient surgery of the Hindus; and the reason of their backwardness in that matter was doubtless their want of familiarity with the course of the arteries and with the arterial circulation. Besides the operation already mentioned, the abdomen was opened by a short incision below the umbilicus slightly to the left of the middle line, for the purpose of removing intestinal concretions or other obstruction (laparotomy). Only a small segment of the bowel was exposed at one time; the concretion when found was removed, the intestine stitched together again, anointed with ghee and honey, and returned into the cavity. Lithotomy was practiced, without the staff. There was a plastic operation for the restoration of the nose, the skin being taken from the cheek adjoining, and the vascularity kept up by a bridge of tissue. The ophthalmic surgery included extraction of cataract. Obstetric operations were various, including cæsarean section and crushing the fœtus.

Medical treatment.

The medication and constitutional treatment in surgical cases were in keeping with the general care and elaborateness of their practice, and with the copiousness of their materia medica. Ointments and other external applications had usually a basis of ghee (or clarified butter), and con-

Training of practitioners.

tained, among other things, such metals as arsenic, zinc, copper, mercury, and sulphate of iron. For every emergency and every known form of disease there were elaborate and minute directions in the śâstras, which were taught by the physician-priests to the young aspirants. Book learning was considered of no use without experience and manual skill in operations; the different surgical operations were shown to the student upon wax spread on a board, on gourds, cucumbers, and other soft fruits; tapping and puncturing were practiced on a leathern bag filled with water or soft mud; scarifications and bleeding on the fresh hides of animals from which the hair had been removed; puncturing and lancing upon the hollow stalks of water-lilies or the vessels of dead animals; bandaging was practiced on flexible models of the human body; sutures on leather and cloth; the plastic operations on dead animals; and the application of caustics and cauteries on living animals. A knowledge of anatomy was held to be necessary, but it does not appear that it was systematically acquired by dissection. Superstitions and theurgic ideas were diligently kept up so as to impress the vulgar. The whole body of teaching, itself the slow growth of much close observation and profound thinking during the vigorous period of Aryan progress, was given out in later times as a revelation from heaven, and as resting upon an absolute authority. Pathological principles were not wanting, but they were derived from a purely arbitrary or conventional physiology (wind, bile, and phlegm); and the whole elaborate fabric of rules and directions, great though its utility must have been for many generations, was without the quickening power of reason and freedom, and became inevitably stiff and decrepit.

Chinese.

The Chinese appear to have been far behind the Hindus in their knowledge of medicine and surgery, notwithstanding that China profited at the same time as Tibet by the missionary propagation of Buddhism. Surgery in particular had hardly developed among them beyond the merest rudiments, owing to their religious respect for dead bodies and their unwillingness to draw blood or otherwise interfere with the living structure. Their anatomy and physiology have been from the earliest times unusually fanciful, and their surgical practice has consisted almost entirely of external applications. Tumors and boils were treated by scarifications or incisions. The distinctive Chinese surgical invention is acupuncture, or the insertion of fine needles, of hardened silver or gold, for an inch or more (with a twisting motion) into the seats of pain or inflammation. Wise says that "the needle is allowed to remain in that part several minutes, or in some cases of neuralgia for days, with great advantage"; rheumatism and chronic gout were among the localized pains so treated. There are 367 points specified where needles may be inserted without injuring great vessels and vital organs.

Egyptian.

Cupping-vessels made of cow-horn have been found in ancient Egyptian tombs. On monuments and the walls of temples are figures of patients bandaged, or undergoing operation at the hands of surgeons. In museum collections of Egyptian antiquities there are lancets, forceps, knives, probes, scissors, etc. Ebers interprets a passage in the papyrus discovered by him as relating to the operation of cataract. Surgical instruments for the ear are figured, and artificial teeth have been found in mummies. Mummies have also been found with well-set fractures. Herodotus describes Egypt, notwithstanding its fine climate, as being full of medical practitioners, who were all "specialists." The ophthalmic surgeons were celebrated, and practiced at the court of Cyrus.

Greek.

Hippocratic surgery.

As in the case of the Sanskrit medical writings, the earliest Greek compendiums on surgery bear witness to a long organic growth of knowledge and skill through many generations. In the Homeric picture of society the surgery is that of the battlefield, and it is of the most meagre kind. Achilles is concerned about the restoration to health of Machaon for the reason that his skill in cutting out darts and applying salves to wounds was not the least valuable service that a hero could render to the Greek host. Machaon probably represents an amateur, whose taste had led him, as it did Melampus, to converse with centaurs and to glean some of their traditional wisdom. Between that primitive state of civilization and the date of the first Greek treatises there had been a long interval of gradual progress. The surgery of the *Hippocratic Collection* (age of Pericles) bears every evidence of finish and elaboration. The two treatises on fractures and on dislocations respectively are hardly surpassed in some ways by the writings of the present mechanical age. Of the four dislocations of the shoulder the displacement downwards into the axilla is given as the only one at all common. The two most usual dislocations of the femur were backwards on to the dorsum ilii and forwards on to the obturator region. Fractures of the spinous processes of the vertebræ are described, and caution advised against trusting those who would magnify that injury into fracture of the spine itself. Tubercles (φύματα) are given as one of the causes of spinal curvature, an anticipation of Pott's diagnosis. In all matters of treatment there was the same fertility of resource as in the Hindu practice; the most noteworthy point is that shortening was by many regarded as inevitable after simple fracture of the femur. Fractures and dislocations were the most complete chapters of the Hippocratic surgery; the whole doctrine and practical art of them had arisen (like sculpture) with no help from dissection, and obviously owed its excellence to the opportunities of the palæstra. The next most elaborate chapter is that on wounds and injuries of the head, which refers them to a minute subdivision, and includes the depressed fracture and the *contrecoup*. Trephining was the measure most commonly resorted to, even where there was no compression. Numerous forms of wounds and injuries of other parts are specified. Ruptures, piles, rectal polypi, fistula in ano, and prolapsus ani were among the other conditions treated. The amputation or excision of tumors does not appear to have been undertaken so freely as in Hindu surgical practice; nor was lithotomy performed except by a specially expert person now and then. The diagnosis of empyema was known, and the treatment of it was by an incision in the intercostal space and evacuation of the pus. Among their instruments were forceps, probes, directors, syringes, rectal speculum, catheter, and various kinds of cautery.

Alexandrian period.

Between the Hippocratic era and the founding of the school of Alexandria (about 300 B.C), there is nothing of surgical progress to dwell upon. The Alexandrian epoch stands out prominently by reason of the enthusiastic cultivation of human anatomy—there are allegations also of vivisection—at the hands of Herophilus and Erasistratus. The sum and substance of this movement appears to have been precision of diagnosis (not unattended with pedantic minuteness), boldness of operative procedure, subdivision of practice into a number of specialties, but hardly a single addition to the stock of physiological or pathological ideas, or even to the traditional wisdom of the Hippocratic time. "The surgeons of the Alexandrian school were all distinguished by the nicety and complexity of their dressings and bandagings, of which they invented a great variety." Herophilus boldly used the knife even on internal organs such as the liver and spleen, which latter he regarded "as of little consequence in the animal economy." He treated retention of urine by a particular kind of catheter, which long bore his name. Lithotomy was much practiced by a few specialists, and one of them (Ammonius) is said to have used an instrument for breaking the stone in the bladder into several pieces when it was too large to remove whole. A sinister story of the time is that concerning Antiochus, son of Alexander, king of Syria, who was done to death by the lithotomists when he was ten years old, under the pretence that he had stone in the bladder, the instigator of the crime being his guardian and supplanter Diodotus.

Cato Major.

Celsus.

The treatise of Celsus *De re medica* (reign of Augustus) reflects the state of surgery in the ancient world for a period of several centuries: it is the best record of the Alexandrian practice itself, and it may be taken to stand for the Roman practice of the period following. Great jealousy of Greek medicine and surgery was expressed by many of the Romans of the republic, notably by Cato the Elder (234–149 B.C.), who himself practiced on his estate according to the native traditions. His medical observations are given in *De re rustica*, In reducing dislocations he made use of the following incantation: "Huat hanat ista pista sista damiato damnaustra." The first Greek surgeon who established himself in Rome is said to have been Archagathus, whose fondness for the knife and cautery at length led to his expulsion by the populace. It was in the person of Asclepiades, the contemporary and friend of Cicero, that the Hellenic medical practice acquired a permanent footing in Rome. This eloquent and plausible Greek confined his practice mostly to medicine, but he is credited with practicing the operation of tracheotomy. He is one of those whom Tertullian quotes as abandoning themselves to vivisections for the gratification of their curiosity: "Asclepiades capras suas quærat sine corde balantes et muscas suas abigat sine capite volantes" (*De anima*, 15). The next figure in the surgical history is Celsus, who devotes the 7th and 8th books of his *De re medica* exclusively to surgery. There is not much in these beyond the precepts of the Brahmanical śâstras and the maxims and rules of Greek surgery. Plastic operations for the restoration of the nose, lips, and ears are described at some length, as well as the treatment of hernia by taxis and operation; in the latter it was recommended to apply the actual cautery to the canal after the hernia had been returned. The celebrated description of lithotomy is that of the operation as practiced long before in India and at Alexandria. The treatment of sinuses in various regions is dwelt upon, and in the case of sinuses of the thoracic wall resection of the rib is mentioned. Trephining has the same prominent place assigned to it as in the Greek surgery. The resources of contemporary surgery may be estimated by the fact that subcutaneous urethrotomy was practiced when the urethra was blocked by a calculus. Amputation of an extremity is described in detail for the first time in surgical literature. Mention is made of a variety of ophthalmic operations, which were done by specialists after the Alexandrian fashion.

Galen.

Under the Roman empire.

Galen's practice of surgery was mostly in the early part of his career (born 131 A.D.), and there is little of special surgical interest in his writings, great as their importance is for anatomy, physiology, and the general doctrines of disease. Among the operations credited to him are resection of a portion of the sternum for caries and ligature of the temporal artery. It may be assumed that surgical practice was in a flourishing condition all through the period of the empire from the accounts preserved by Oribasius of the great surgeons Antyllus, Leonides, Rufus, and Heliodorus. Antyllus (300) is claimed by Häser as one of the greatest of the world's surgeons; he had an operation for aneurism (tying the artery above and below the sac, and evacuating its contents), for cataract, for the cure of stammering; and he treated contractures by something like tenotomy. Rufus and Heliodorus are said to have practiced torsion for the arrest of hæmorrhage: but in later periods both that and the ligature appear to have given way to the actual cautery. Häser speaks of the operation for scrotal hernia attributed to Heliodorus as "a brilliant example of the surgical skill during the empire." The same surgeon treated stricture of the urethra by internal section. Both Leonides and Antyllus removed glandular swellings of the neck (*strumæ*); the latter ligatured vessels before cutting them, and gives directions for avoiding the carotid artery and jugular vein. The well-known operation of Antyllus for aneurism has been mentioned before. Flap-amputations were practiced by Leonides and Heliodorus. But perhaps the most striking illustration of the advanced surgery of the period is the freedom with which bones were resected, including the long bones, the lower jaw, and the upper jaw.

Byzantine.

Whatever progress or decadence surgery may have experienced during the next three centuries is summed up in the authoritative treatise of Paulus of Ægina (650). Of his seven books the sixth is entirely devoted to operative surgery, and the fourth is largely occupied with surgical diseases. The importance of Paulus for surgical history during several centuries on each side of his own period will appear from the following remarks of Francis Adams in his translation and commentary (vol. ii. p. 247).

> "This book (bk. vi.) contains the most complete system of operative surgery which has come down to us from ancient times. . . . . Haly Abbas in the 9th book of his *Practica* copies almost everything from Paulus. Albucasis [Abulcasis] gives more original matter on surgery than any other Arabian author, and yet, as will be seen from our commentary, he is indebted for whole chapters to Paulus. In the *Continens* of Rhases, that precious repository of ancient opinions on medical subjects, if there be any surgical information not to be found in our author it is mostly derived from Antyllus and Archigenes. As to the other authorities, although we will occasionally have to explain their opinions upon particular subjects, no one has treated of surgery in a systematical manner; for even Avicenna, who treats so fully of everything else connected with medicine, is defective in his accounts of surgical operations; and the descriptions which he does give of them are almost all borrowed from our author. The accounts of fractures and dislocations given by Hippocrates and his commentator Galen may be pronounced almost complete; but the information which they supply upon most other surgical subjects is scanty."

It is obviously impossible in a brief space to convey any notion of the comprehensiveness of the surgery of Paulus; his sixth book, with the peculiarly valuable commentary of Adams, brings the whole surgery of the ancient world to a focus; and it should be referred to at first hand. Paulus himself is credited with the principle of local depletion as against general, with the lateral operation for stone instead of the mesial and with understanding the merits of a free external incision and a limited internal, with the diagnosis of aneurism by anastomosis, with an operation for aneurism like that of Antyllus, with amputation of the cancerous breast by crucial incision, and with the treatment of fractured patella.

Arabian.

The Arabians have hardly any greater merit in medicine than that of preserving intact the bequest of the ancient world. To surgery in particular their services are small,—first, because their religion proscribed the practice of anatomy, and secondly, because it was a characteristic of their race to accept with equanimity the sufferings that fell to them, and to decline the means of alleviation. The great names of the Arabian school, Avicenna and Averroes, are altogether unimportant for surgery. Their one distinctively surgical writer was Abulcasim (d. 1122), who is chiefly celebrated for his free use of the actual cautery and of caustics. He showed a good deal of character in declining to operate on goitre, in resorting to tracheotomy but sparingly, in refusing to meddle with cancer, and in evacuating large abscesses by degrees.

Mediæval.

For the five hundred years following the work of Paulus of Ægina there is nothing to record but the names of a few practitioners at the court and of imitators or compilers. Meanwhile in western Europe (apart from the Saracen civilization) a medical school had gradually grown up at Salerno, which in the 10th century had already become famous. From it issued the *Regimen Salernitanum*, a work used by the laity for several centuries, and the *Compendium Salernitanum*, which circulated among the profession. The serious decline of the school dates from the founding of a university at Naples in 1224. In its best period princes and nobles resorted to it for treatment from all parts of Europe. The hôtel dieu of Lyons had been founded in 560, and that of Paris a century later. The school of Montpellier was founded in 1025, and became the rallying point of Arabian and Jewish learning. A good deal of the medical and surgical practice was in the hands of the religious orders, particularly of the Benedictines. The practice of surgery by the clergy was at length forbidden by the council of Tours (1163). The surgical writings of the time were mere reproductions of the classical or Arabian authors: "unus non dicit nisi quod alter." One of the first to go back to independent observation and reflection was William of Saliceto, who belonged to the school of Bologna; his work (1275) advocates the use of the knife in many cases where the actual cautery was used by ancient prescription. A greater name in the history of mediæval surgery is that of his pupil Lanfranchi of Milan, who migrated (owing to political troubles) first to Lyons and then to Paris. He distinguished between arterial and venous hæmorrhage, and is said to have used the ligature for the former. Contemporary with him in France was Henri de Mondeville of the school of Montpellier, whose teaching is best known through that of his more famous pupil Guy de Chauliac; the *Chirurgie* of the latter bears the date of 1363, and marks the advance in precision which the revival of anatomy by Mondino had made possible. Eighteen years before Lanfranchi came to Paris a college of surgeons was founded there (1279) by Pitard, who had accompanied St. Louis to Palestine as his surgeon. The college was under the protection of St. Cosmas and St. Damianus, two practitioners of medicine who suffered martyrdom in the reign of Diocletian, and it became known as the Collége de St. Côme. From the time that Lanfranchi joined it it attracted many pupils. It maintained its independent existence for several centuries, alongside the medical faculty of the university; the corporations of surgeons in other capitals, such as those of London and Edinburgh, were modelled upon it.

Paracelsus.

Paré.

The 14th and 15th centuries are almost entirely without interest for surgical history. The dead level of tradition is broken first by two men of originality and genius, Paracelsus and Paré, and by the revival of anatomy at the hands of Vesalius and Fallopius, professors at Padua. Apart from the mystical form in which much of his teaching was cast, Paracelsus has great merits as a reformer of surgical practice. "The high value of his surgical writings," says Häser, "has been recognized at all times, even by his opponents." It is not, however, as an innovator in operative surgery but rather as a direct observer of natural processes that Paracelsus is distinguished. His description of "hospital gangrene," for example, is perfectly true to nature; his numerous observations on syphilis are also sound and sensible; and he was the first to point out the connection between cretinism of the offspring and goitre of the parents. He gives most prominence to the healing of wounds. His special surgical treatises are *Die kleine Chirurgie* (1528) and *Die grosse Wund-Arznei* (1536–37),—the latter being the best known of his works. Somewhat later in date, and of much greater concrete importance for surgery than Paracelsus, is Ambroise Paré (1517–1590). He began life as apprentice to a barber-surgeon in Paris and as a pupil at the hôtel dieu. His earliest opportunities were in military surgery during the campaign of Francis I. in Piedmont. Instead of treating gunshot wounds with hot oil, according to the practice of the day, he had the temerity to trust to a simple bandage; and from that beginning he proceeded to many other developments of rational surgery. In 1545 he published at Paris *La méthode de traicter les playes faictes par hacquebutes et aultres bastons à feu.* The same year he began to attend the lectures of Sylvius, the Paris teacher of anatomy, to whom he became prosector; and his next book was an *Anatomy* (1550). His most memorable service was to get the use of the ligature for large arteries generally adopted, a method of controlling the hæmorrhage which made amputation on a large scale possible for the first time in history. Like Paracelsus, he writes simply and to the point in the language of the people, while he is free from the encumbrance of mystical theories, which detract not a little from the merits of his fellow-reformer in Germany. It is only in his book on monsters, written towards the end of his career, that he shows himself to have been by no means free from superstition. Paré was adored by the army and greatly esteemed by successive French kings; but his innovations were opposed, as usual, by the faculty, and he had to justify the use of the ligature as well as he could by quotations from Galen and other ancients.

Sixteenth century.

Surgery in the 16th century recovered much of the dexterity and resource that had distinguished it in the best periods of antiquity, while it underwent the developments opened up to it by new forms of wounds inflicted by new weapons of warfare. The use of the staff and other instruments of the "apparatus major" was the chief improvement in lithotomy. A "radical cure" of hernia by sutures superseded the old application of the actual cautery. The earlier modes of treating stricture of the urethra were tried; plastic operations were once more done with something like the skill of Brahmanical and classical times; and ophthalmic surgery was to some extent rescued from the hands of ignorant pretenders. It is noteworthy that even in the legitimate profession dexterous special operations were kept secret; thus the use of the "apparatus major" in lithotomy was handed down as a secret in the family of Laurence Colot, a contemporary of Paré's.

Seventeenth century.

The 17th century was distinguished rather for the rapid progress of anatomy and physiology, for the Baconian and Cartesian philosophies, and the keen interest taken in complete systems of medicine, than for a high standard of surgical practice. The teaching of Paré that gunshot wounds were merely contused and not poisoned, and that simple treatment was the best for them, was enforced anew by Magati (1579–1647), Wiseman, and others. Trephining was freely resorted to, even for inveterate migraine; Philip William, prince of Orange, is said to have been trephined seventeen times. Flap-amputations, which had been practiced in the best period of Roman surgery by Leonides and Heliodorus, were reintroduced by Lowdham, an Oxford surgeon, in 1679, and probably used by Wiseman, who was the first to practice the primary major amputations. Fabriz von Hilden (1560–1634) introduced a form of tourniquet, made by placing a piece of wood under the bandage encircling the limb: out of that there grew the block-tourniquet of Morel, first used at the siege of Besançon in 1674; and this, again, was superseded by Jean Louis Petit's screw-tourniquet in 1718. Strangulated hernia, which was for long avoided as a *noli me tangere*, became a subject of operation. Lithotomy by the lateral method came to great perfection in the hands of Jacques Beaulieu. To this century also belong the first indications (not to mention the Alexandrian practice of Ammonius) of crushing the stone in the bladder. The theory and practice of transfusion of blood occupied much attention, especially among the busy spirits of the Royal Society, such as Boyle, Lower, and others. The seat of cataract in the substance of the lens was first made out by two French surgeons, Quarré and Lasnier. Perhaps the most important figure in the surgical history of the century is Richard Wiseman, the father of English surgery. Wiseman took the Royalist side in the wars of the Commonwealth, and was surgeon to James I. and Charles I., and accompanied Charles II. in his exile in France and the Low Countries. After serving for a time in the Spanish fleet, he joined the Royalist cause in England and was taken prisoner at the battle of Worcester. At the Restoration he became serjeant-surgeon to Charles II., and held the same office under James II. His *Seven Chirurgical Treatises* were first published in 1676, and went through several editions; they relate to tumors, ulcers, diseases of the anus, king's evil (scrofula), wounds, fractures, luxations, and lues venerea. Wiseman was the first to advocate primary amputation (or operation before the onset of fever) in cases of gunshot wounds and other injuries of the limbs. He introduced also the practice of treating aneurisms by compression, gave an accurate account of fungus articulorum, and improved the operative procedure for hernia.

Wiseman.

Eighteenth century.

The 18th century marks the establishment of surgery on a broader basis than the skill of individual surgeons of the court and army, and on a more scientific basis than the rule of thumb of the multitude of barber-surgeons and other inferior orders of practitioners. In Paris the Collége de St. Côme gave way to the Academy of Surgery in 1731, with Petit as director, to which was added at a later date the École Pratique de Chirurgie, with Chopart and Desault among its first professors. The Academy of Surgery set up a very high standard from the first, and exercised great exclusiveness in its publications and its honorary membership. In London and Edinburgh the development of surgery proceeded on less academical lines, and with greater scope for individual effort. Private dissecting rooms and anatomical theatres were started, of which perhaps the most notable was Dr. William Hunter's school in Great Windmill Street, London, inasmuch as it was the first perch of his more famous brother John Hunter. In Edinburgh, Alexander Monroe, first of the name, became professor of anatomy to the company of surgeons in 1719, transferring his title and services to the university the year after; as he was the first systematic teacher of medicine or surgery in Edinburgh, he is regarded as the founder of the famous medical school of that city. In both London and Edinburgh a company of barbers and surgeons had been in existence for many years before; but it was not until the association of these companies with the study of anatomy, comparative anatomy, physiology, and pathology that the surgical profession began to take rank with the older order of physicians. Hence the significance of the eulogy of a living surgeon on John Hunter: "more than any other man he helped to make us gentlemen" (*Hunterian Oration*, 1877). The state of surgery in Germany may be inferred from the fact that the teaching of it at the new university of Göttingen was for long in the hands of Haller, whose office was "professor of theoretical medicine." In the Prussian army it fell to the regimental surgeon to shave the officers. At Berlin a medico-chirurgical college was founded by surgeon-general Holtzendorff in 1714, to which was joined in 1726 a school of clinical surgery at the Charité. Military surgery was the original purpose of the school, which still exists, side by side with the surgical cliniques of the faculty, as the Friedrich Wilhelm's Institute. In Vienna, in like manner, a school for the training of army surgeons was founded in 1785,—Joseph's Academy or the Josephinum. The first systematic teaching of surgery in the United States was by Dr. Shippen at Philadelphia, where the medical college towards the end of the century was largely officered by pupils of the Edinburgh school.[1] Without attempting to enumerate the great names in surgery during the 18th century, it will be possible to introduce the more prominent of them in a brief sketch of the additions to the ideas and resources of surgery in that period. A great part of the advance was in surgical pathology, including Petit's observations on the formation of thrombi in severed vessels, Hunter's account of the reparative process, Benjamin Bell's classification of ulcers, the observations of Duhamel and others on the formation of callus and on bone-repair in general, Pott's distinction between spinal curvature from caries or abscess of the vertebræ and kyphosis from other causes, observations by various surgeons on chronic disease of the hip, knee, and other joints, and Cheselden's description of neuroma. Among the great improvements in surgical procedure we have Cheselden's operation of lithotomy (six deaths in eighty cases), Hawkins's cutting gorget for the same (1753). Hunter's operation (1785) for popliteal aneurism by tying the femoral artery in the canal of the triceps where its walls were sound ("excited the greatest wonder," Assalini), Petit's, Desault's, and Pott's treatment of fractures, Gimbernat's (Barcelona) operation for strangulated femoral hernia, Pott's bistoury for fistula, White's (Manchester) and Park's (Liverpool) excision of joints Petit's invention of the screw-tourniquet, the same surgeon's operation for lachrymal fistula, Chopart's partial amputation of the foot, Desault's bandage for fractured clavicle, Bromfield's artery-hook, and Cheselden's operation of iridectomy. Other surgeons of great versatility and general merit were Sharp of London, Gooch of Norwich, Hey of Leeds, David and Le Cat of Rouen, Sabatier, La Faye, Ledran, Louis, Morand, and Percy of Paris, Bertrandi of Turin, Troja of Naples, Palleta of Milan, Schmucker of the Prussian army, August Richter of Göttingen, Siebold of Würzburg, Olof Acrel of Stockholm, and Callisen of Copenhagen.

Nineteenth century.

Two things have given surgical knowledge and skill in the 19th century a character of scientific or positive cumulativeness and a wide diffusion through all ranks of the profession. The one is the founding of museums of anatomy and surgical pathology by the Hunters, Dupuytren, Cloquet, Blumenbach, Barclay, and a great number of more modern anatomists and surgeons; the other is the method of clinical teaching, exemplified in its highest form of constant reference to principles by Lawrence and Syme. In surgical procedure the discovery of the anæsthetic properties of ether, chloroform, methylene, etc., has been of incalculable service; while the conservative principle in operations upon diseased or injured parts and what may be called the hygienic idea (or, more narrowly, the antiseptic principle) in surgical dressings have been equally beneficial. The following are among the more important additions to the resources of the surgical art: the thin thread ligature for arteries, introduced by Jones of Jersey (1805); the revival of torsion of arteries by Amussat (1829); the practice of drainage by Chassaignac (1859); aspiration by Pelletan and recent improvers; the plaster-of-Paris bandage or other immovable application for simple fractures, club-foot, etc. (an old Eastern practice recommended in Europe about 1814 by the English consul at Bassorah); the re-breaking of badly set fractures; galvano-caustics and écraseurs; the general introduction of resection of joints (Fergusson, Syme, and others); tenotomy by Delpech and Stromeyer (1831); operation for squint by Dieffenbach (1842); successful ligature of the external iliac for aneurism of the femoral by Abernethy (1806); ligature of the subclavian in the third portion by Astley Cooper (1806), and in its first portion by Colles; crushing of stone in the bladder by

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[1] [That is the Medical Department of the University of Pennsylvania, established 1765.—Am. Ed.]

Gruithuisen of Munich (1819) and Civiale of Paris (1826); cure of ovarian dropsy by removing the cyst (since greatly perfected); discovery of the ophthalmoscope, and many improvements in ophthalmic surgery by Von Gräfe and others; application of the laryngoscope in operations on the larynx by Czermak (1860) and others; together with additions to the resources of aural surgery and dentistry. The great names in the surgery of the first half of the century besides those mentioned are: Scarpa of Italy (1747–1832); Boyer (1757–1833), Larrey (1766–1842),—to whom Napoleon left a legacy of a hundred thousand francs, with the eulogy: "C'est l'homme le plus vertueux que j'aie connu,"—Roux (1780–1854), Lisfranc (1790–1847), Velpeau (1795–1868), Malgaigne (1806–1865), Nélaton (1807–1873),—all of the French school; of the British school, John Bell, Charles Bell, Allan Burns, Liston, Wardrop, Astley Cooper, Cline, Travers, Brodie, Stanley, and Guthrie; in the United States, Mott, Gross, and others; in Germany, Kern and Schuh of Vienna, Von Walther and Textor of Würzburg, Chelius, Hesselbach, and the two Langenbecks. In surgical pathology the discoveries and doctrines of the 19th century are greater in scientific value than those of any antecedent period; and it would be unprofitable to attempt any enumeration of them, or of their authors, in a brief space.

The authorities mostly used have been—Wise, *History of Medicine among the Asiatics*, 2 vols., London, 1868; *Paulus Ægineta*, translated with commentary on the knowledge of the Greeks, Romans, and Arabians, in medicine and surgery, by Francis Adams, 3 vols., London, 1844–47; Häser, *Gesch. d. Medicin*, 3d ed., vols. i. and ii., 1875–81. (C. C.)

Part II.—Practice of Surgery.

A great change has taken place in the practice of surgery since the publication (1860) of the article SURGERY in vol. xx. of the 8th edition of the present work. This change is due in great part to the fact that the germ theory of disease has been accepted by the majority of surgical teachers and practitioners. Scientific men have demonstrated that the causation of many diseased conditions is closely connected with the presence in the diseased organ, tissue, or individual of living organisms, which have to a certain extent been classified, and are supposed to be forms of plant life. In one sense it is perhaps unfortunate that the article on surgery has to be written at the present time, because, while there are few who now hold that these organisms are inert, there are some who do not grant that they are the cause of disease; and there are many differences of opinion as to the best methods of applying this scientific knowledge to practical use. In other words, although much of the surgical practice of the present day is founded on a scientific basis, the practical details are still matter of dispute.

Improvements in wound treatment.

It is impossible in the present sketch to go with any fulness into the details of the experimental research by which the truth of the germ theory was proved; but some allusion must be made to the salient points which have a bearing on the work of the surgeon. It has long been known that subcutaneous injuries follow, as a rule, a very different course from open wounds; and the past history of surgery gives evidence that surgeons not only were aware of this great difference but endeavored, by the use of various dressings, empirically to prevent the evils which were matters of common observation during the healing of open wounds. Various means were also adopted to prevent the entrance of air, *e.g.*, in the opening of abscesses by the "valvular method" of Abernethy, and by the subcutaneous division of tendons in the common deformity termed "club-foot." Balsams, turpentine, and various forms of spirit were the basis of many varieties of dressing. These different dressings were frequently cumbersome, difficult of application, and did not attain the object aimed at, while at the same time they retained the discharges, and gave rise to other evils which prevented rapid and painless healing. In the beginning of the 19th century these complicated dressings began to lose favor, and practical surgeons went to the opposite extreme and applied a simple dressing, the main object of which was to allow a free escape of discharge. Others applied no dressing at all, laying the stump of a limb after amputation on a piece of dry lint, avoiding thereby any unnecessary movement of the parts. Others left the wound open for some hours after an operation, preventing in this way any accumulation, and brought its edges and surfaces together after all oozing of blood had ceased and after the effusion, the result of injury to the tissues by the instruments used in the operation, had to a great extent subsided. As a result of these various improvements many wounds healed in a thoroughly satisfactory manner. But in other cases inflammation often occurred, accompanied by pain and suppuration or the formation of pus, and various feverish conditions, due to and in some way connected with the unhealthy state of the wound, were observed. These constitutional sequelæ frequently proved fatal and the general impression of surgeons was either that the constitution of the patient rendered him liable to these conditions, or that some poison had entered into the wound, and, passing from it into the veins or lymphatic vessels that had been cut across, reached the general circulation, contaminating the blood and poisoning the patient. The close clinical association between suppuration (or the formation of pus) in wounds and many of those fatal cases encouraged the belief that the pus cells from the wound entered the circulation (whence the word "pyæmia"). It was also frequently observed that a septic condition of the wound was associated with the constitutional fever, and it was supposed that the septic matter passed into the blood (whence the term "septicæmia"). It was further observed that the crowding together of patients with open wounds increased the liability to these constitutional disasters, and every endeavor was made by surgeons to separate their patients and to improve the ventilation of the larger hospitals. In building hospitals the pavilion and other systems, with windows on both sides and cross ventilation in the wards, were adopted in order to give the patients as much fresh air as was attainable. Hospital buildings were spread over as large an area as possible; the blocks were restricted in height, and if practicable were never higher than two stories. The term "hospitalism" was coined by Sir J. Y. Simpson, who collected statistics comparing hospital and private practice, by which he endeavored to show that private patients were not so liable to those constitutional sequelæ.

Lister's germ theory, and treatment of wounds.

This was very much the condition of affairs when Lister in 1860, from a study of the experimental researches of Pasteur into the causes of putrefaction, stated that the evils observed in open wounds were due to the admission into them of organisms which exist in the air, in water, on instruments, on sponges, and on the hands of the surgeon. These organisms, finding a suitable nidus for their growth and development in the discharges and surrounding tissues, germinate in them and alter their chemical constitution, forming various poisonous compounds, which, if absorbed into the blood, give rise to pyæmia and septicæmia. Having accepted the germ theory of putrefaction, he applied himself to discover the best way of preventing these organisms from reaching the wound from the moment that it was made until it was healed. He had to deal with a plant and he desired to interfere with its growth. This was possible in one of two ways,—either (1) by directly destroying or paralyzing the plant itself before it entered the wound or after it had entered, or (2) by an interference with the soil in which it grew, for example, by facilitating the removal of the discharges and preventing their accumulation in the wound cavity, and by doing everything to prevent depression of the wounded tissues, because healthy tissues are the best of all germicides. Several substances were then known possessing properties antagonistic to sepsis or putrefaction, and hence called "antiseptic." Acting on a suggestion of Lemaire's, Lister chose for his experiments carbolic acid, which he used at first in a crude and impure form. He had many practical difficulties to contend with,—the impurity of the substance, its irritating properties, the difficulty of finding the exact strength in which to use it: on the one hand, he feared to use it too strong, lest it should irritate the tissues to which it was applied and thus prevent healing; on the other hand, he feared to use it too weak, lest its true antiseptic qualities should be insufficient for the main object in view. It is unnecessary to dwell on the details of his tentative experiments. As dressings for wounds he used various chemical substances, which, being mixed with carbolic acid in certain proportions, were intended to give off a quantity of carbolic acid in the form of vapor, so that the wound might be constantly surrounded by an antiseptic vapor which would destroy any organisms approaching it and at the same time not interfere with its healing. At first, although he prevented pyæmia in a marked degree, he, to a certain extent, irritated his wounds and prevented rapid healing. He began his experiments in Glasgow and continued them after his removal to the chair of clinical surgery in Edinburgh. After many disappointments, he gradually perfected his method of performing operations and dressing wounds, which will be best understood by an illustration.

Amputation at ankle joint.

A patient is suffering, let us say, from a diseased condition of the foot necessitating amputation at the ankle joint. The part to be operated on is enveloped in a towel which has been soaked with a 5 per cent. solution of carbolic acid. The towel is applied two hours before the operation, with the object of destroying the (putrefactive) organisms present in the skin. The patient is placed on the operating table, and brought under the influence of chloroform; the limb is elevated to empty it of blood, and a tourniquet is applied round the limb below the knee. The instruments to be used during the operation have been previously purified by lying for half an hour in a flat porcelain dish containing carbolic acid (1 to 20). The sponges are lying in a similar carbolic lotion. Towels soaked in the same solution are laid over the table and blankets near the part operated upon. The hands of the operator, as well as those of his assistants, are thoroughly purified by washing them in the same lotion, free use being made of a nail brush for this purpose. The operation is performed under a cloud of carbolized watery vapor (1 in 30) from a steam-spray producer. The visible bleeding points are first ligatured; the tourniquet is removed; and then any vessels that have escaped notice are ligatured. The wound is stitched, a drainage-tube made of red rubber being introduced at one corner to prevent accumulation of discharge; a strip of protective (oiled silk coated with carbolized dextrin) is washed in carbolic lotion and applied over the wound. A double ply of carbolic gauze[1] is soaked in the lotion and placed over the protective, overlapping it freely. A dressing consisting of eight layers of dry gauze is placed over all, covering the stump and passing up the leg for about 6 inches. Over that a piece of thin Mackintosh cloth is placed, and the whole arrangement is fixed with a gauze bandage. The Mackintosh cloth prevents the carbolic acid from escaping and at the same time causes the discharge from the wound to spread through the gauze. The wound itself is protected by the protective from the vapor given off by the carbolic gauze, whilst the surrounding parts, being constantly exposed to its activity, are protected from the intrusion of septic contamination; and these conditions are maintained until sound healing has taken place. Whenever the discharge reaches the edge of the Mackintosh the case requires to be dressed, and a new supply of gauze applied round the stump. The gauze that is used should be freshly made and kept in a tin box to prevent evaporation of the volatile carbolic acid. This precaution is most needful in warm weather. Whenever the wound is exposed the stump is enveloped in a vapor (1 in 30) of carbolic acid by means of the steam-spray producer. At first a syringe was used to keep the surface constantly wet with lotion, then a hand-spray, such as Richardson's ether-spray producer. More recently a steam-spray producer has been introduced into practice. These dressings are repeated at intervals until the wound is healed, the drainage-tube being gradually shortened and ultimately removed altogether.

In the case of an accidental wound to which the surgeon is called a short time after its occurrence, carbolic lotion (1 to 20) must be injected into the cavity of the wound to destroy any organisms which may have fallen into it. The dressings already described are then applied. In operating on a case in which putrefaction has occurred, every endeavor must be made to destroy the causes of putrefaction which are already present. The substance most frequently used for this purpose is chloride of zinc solution, 40 grains to 1 oz. of water. This powerful antiseptic was extensively used some years ago by Mr. De Morgan, Middlesex Hospital, London. When the wound has been thus purified from its septic condition, the after-treatment must follow strictly the plan already recommended for a recent wound to avoid secondary contamination at subsequent dressings.

Progress since Lister.

The object Lister had in view from the beginning of his experiments was to place the open wound in a condition as regards the entrance of organisms as closely analogous as possible to a truly subcutaneous wound, such as a contusion or a simple fracture, in which the unbroken skin acts as a protection to the wounded tissues beneath. The introduction of this practice by Lister effected a complete change in operative surgery. Although the principle on which he founded it was at first denied by many, it is now very generally acknowledged to be correct. In Germany more especially his views were speedily accepted. In France and England their adoption was slower. In Scotland, perhaps in consequence of the fact that many saw him at work and worked under him, acquiring perhaps some little part of his persevering enthusiasm, he soon had many believers. Since about 1875 surgeons have been trying to improve and simplify the method; chemists have been at pains to supply carbolic acid in a pure form and to discover new antiseptics, the great object being to get a non-irritating substance which shall at the same time be a powerful germicide. Iodoform, eucalyptus, salicylic acid, boracic acid, corrosive sublimate, have been and are being used, and the question as to their relative superiority is not yet settled. Carbolic acid has the disadvantage of irritating the tissues. This is partly counterbalanced by its anæsthetic properties. Absorption of the carbolic acid has occasionally taken place, giving rise to symptoms of poisoning. But this danger has been greatly lessened by the introduction of pure acid. Of the antiseptics named carbolic acid, eucalyptus, and iodoform are volatile; the rest are non-volatile. At first Lister for some years irrigated a wound with carbolic lotion during the operation, and at the dressings when it was exposed. The introduction of the spray displaced the irrigation method. At the present time the irrigation method is again gaining favor. All these different procedures, however, as regards both the antiseptic used and the best method of its application in oily and watery solutions and in dressings, are entirely subsidiary to the great principle involved—namely, that putrefaction in a wound is an evil which can be prevented, and that, if it is prevented, local irritation, in so far as it is due to putrefaction, is obviated and septicæmia and pyæmia do not occur. Alongside of this great improvement the immense advantage of free drainage is now universally acknowledged. Surgeons now understand the dangers which lie on every side, and this knowledge causes them to take greater care in the purification and in securing the greater cleanliness of wounds, and some hold that much of the good result follows from these precautions apart from the principle of the system.

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[1] The gauze dressing consists of thin gauze which has been soaked in a mixture of carbolic acid (1 part), resin (5 parts), and paraffin (7 parts). The object of the paraffin is to prevent the gauze sticking to the skin. The resin retains the carbolic acid and prevents evaporation at the ordinary temperature; at the temperature of the body, however, a certain quantity of the carbolic acid is constantly being given off, and in this way the part operated on is enveloped in a vapor of carbolic acid. This antiseptic vapor persists as long as there is any carbolic acid in the gauze. A gauze dressing is not reliable for more than a week; by that time the carbolic acid in the gauze is dissipated and the dressing requires to be renewed.

Putrefactive organisms.

Putrefaction has been clearly shown by Pasteur, Tyndall, and others to be due to the activity of certain lowly forms of organized matter. Scientific men have therefore had their attention more particularly directed to these lower forms of plant life. A careful study has been made of their life history, and several diseased conditions are now known to be due to the deposit and growth of organisms of a specific form in the blood and in the tissues. This is not the place to discuss points still *sub judice;* but there can be no doubt, *e.g.*, that the *Bacillus anthracis* is the cause of splenic fever and of its local manifestation, malignant pustule, and that erysipelas is due to the presence of a micrococcus. There are many other diseases spoken of as zymotic or fermentative, upon which observers are now at work, and hardly a month passes without the publication of new observations (compare SCHIZOMYCETES). It can certainly be said that the relation between those organisms and various specific diseases is the question which at present most occupies the attention both of pathologists and of practitioners of medicine and surgery. It is now known that there are many varieties of organisms (in Crookshank's *Bacteriology* sixty are described), some of which are hurtful to the human economy, though others are apparently harmless. Those of the former class give rise to an alteration in the tissue in which they grow; and during their growth they alter its composition and cause it to break up into various compounds, some of which, when absorbed into the blood-stream, poison the individual. Some, on the other hand, are either in themselves innocuous or are killed when they enter the blood, which is a fluid tissue and acts as a germicide; hence the tissues in a healthy condition are spoken of as "germicidal." Some apparently grow only on dead tissue, or in tissue the vitality[1] of which has been lowered.

Fermentations.

The alteration in the tissue is strictly analogous to a fermentation—such, for example, as the change which takes place in a solution of grape sugar in which the yeast plant has been planted. The solution breaks up into alcohol and carbonic acid; along with this change there is an increase in the quantity of the yeast. The most common fermentation is the alteration termed "putrefactive" or "septic." The cause of this change is in all probability a special organism named *Bacterium termo.* It lives on any dead matter containing nitrogen when exposed to heat and moisture; dryness and cold are antagonistic to its growth. Its results are so evident and of such common observation that the term "antiseptic" was used long before the primary cause of the condition was understood. Antiseptics originally were substances which interfered with sepsis. The term has now, however, a wider meaning, and includes any substance opposed to fermentation. "Antifermentative" or "antitheric" would be a better term. An antitheric substance is one which interferes with fermentation by destroying or paralyzing the organism which is the primary cause of the condition. The word "antiseptic," on the other hand, should be reserved to denote any substance which is opposed to putrefaction or sepsis,—one form of fermentation. Many of the most dangerous fermentations have nothing in common with putrefaction; the products which result are odorless; the appearances which arise bear no similarity to the changes which occur when putrefactive fermentation is present. Plant the *Bacterium lactis* in milk, and souring, or the lactic acid fermentation, takes place; plant the *Bacterium termo* in milk, and putrefactive fermentation occurs. The fermentations of smallpox, vaccinia, syphilis, scarlet fever, typhoid, relapsing fever, typhus, erysipelas, and cholera may be taken as examples of fermentations of the non-putrefactive class. Apparently in them the organism enters the blood-stream, there develops and forms its products, which, acting directly or indirectly on the heat-centre gives rise to a specific fever. This fever continues until the soil is worn out, and the organism, finding no longer a nidus for its development, dies out, and recovery takes place. Death of course results if the individual has not sufficient strength to withstand the attack. There is a general law regarding all living things which holds true of these lowly organisms as of the highest: remove its food and the organism dies, or at any rate ceases to develop. It may, however, lie quiescent, again appearing when a new nidus is provided for it. These considerations explain the reason why, after one attack, the individual is protected for a longer or shorter period. They also explain why many diseases are becoming through course of time less virulent than they once were: the soil is becoming exhausted in relation to the special requirements of the organism, and the organism is therefore incapable of flourishing, as it formerly did. Plant the organism in a virgin soil—take, for example, as was unwittingly done, the organism of measles to Fiji—and a disease which in Great Britain is comparatively harmless becomes a most deadly scourge.

Infective and non-infective organisms.

An attempt has been made to divide organisms into two great divisions—the infective and the non-infective. The first class can grow in living tissue; the second cannot. The first form their products in living matter; the second can only grow in dead or lowly vitalized matter. The infective organism can migrate from the original point of entrance by the vascular and lymphatic streams to distant parts of the body, and may there form secondary foci of infection. As regards the non-infective the manufactory of the poison is principally restricted to the near neighborhood of the original point of entrance, generally a wound. It cannot migrate into the living tissues around if they remain healthy. Both kinds of organisms form ptomaines (πτῶμα, a carcase), the products of the fermentation which result from the breaking up of the tissue or discharge in which the organisms grow. They may enter the blood-stream and poison the patient. Their entry into the blood must be differentiated from the entry of the organism itself into the stream. Clinically, the two conditions, although often met with in one individual, are in many cases distinctly separable. This physiological division of organisms into infective and non-infective is at present only tentative, and much work must be done before a strictly physiological classification can be attempted; at present the main line of inquiry must be principally morphological. Even in this direction a difficulty meets the observer, because organisms change their shape according to the media in which they are cultivated.

In the present article only a general view of the present aspects of surgical practice can be given.

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[1] John Hunter defines "vitality" as the power which resists putrefaction.

Special stress will be laid upon the principles which guide the surgeon in his daily work. For full particulars with reference to any special points the reader is referred to Holmes's *System of Surgery*, Erichsen's *Science and Art of Surgery*, and Gross's *System of Surgery*.

Surgical affections may be divided into two great classes,—those which are the result (1) of injury and (2) of disease.

I. INJURIES.

Shock.

Before proceeding to the consideration of the different injuries it will be necessary to say a few words about the general condition termed *shock* or *collapse*, which supervenes after a severe injury. Care must be taken not to confound this state with faintness or syncope from loss of blood. Undoubtedly in many cases both conditions are present. Syncope from loss of blood is considered below. Syncope from mental emotion differs from shock in degree only. In shock the patient is pale, and bathed in cold clammy perspiration; his sensibility is blunted; his pulse is small and feeble; he is unable to make any active exertion, but lies in bed indifferent to external circumstances, and can only be roused with difficulty; he frequently complains of a feeling of cold; and he may have a distinct shivering or rigor. These symptoms may continue for some hours; the first evidence of improvement is that he shifts his position in bed and complains of the pain of the injury which has caused the condition. The pulse becomes stronger, and he then passes from the state of shock into the condition of reaction. If the improvement continues recovery will take place, but if it is only transient the patient will sink back again into a drowsy condition, which, if it persists, will end in death. In severe cases there may be no reaction; the patient then gradually becomes weaker and weaker, his pulse feebler and feebler, till death ensues. Shock is due to an impression conveyed to the central nervous system by an afferent nerve of common or special sensation. This impression produces a change in the medulla oblongata, by which the nerve-centres are so affected that a partial paralysis or paresis of the voluntary and involuntary muscular fibres in the body takes place. In consequence of the change in the voluntary muscles the patient is unable to lift his arm or move his leg; the respiratory functions are performed wearily, and the muscle of the heart contracts feebly; the muscular fibres in the walls of the bloodvessels lose their tonicity and the bloodvessels dilate; the blood collects in the large venous trunks, more especially of the abdomen; the vessels of the skin are emptied of blood, giving rise to the marked pallor. Two of the great causes that keep up the normal circulation of the blood through the body are in partial abeyance; the heart has not sufficient energy to contract, and there is not a sufficient quantity of blood passing into it from the bloodvessels. The heart beats feebly (1) because its nervous energy is lowered, and (2) because it has not a sufficient quantity of blood to act upon. An understanding of these facts gives the general indications for treatment,—(1) external stimulation over the heart by mustard poultices or turpentine stupes; (2) elevation of the limbs, to cause the blood to gravitate towards the heart; (3) manual pressure on the abdominal cavity from below upwards, to encourage the flow of blow from the dilated abdominal veins into the heart. These different measures may be supplemented by the administration of stimulants by the mouth, or, if the patient cannot swallow, by subcutaneous injection of a diffusible stimulant, such as ether or ammonia.

Syncope.

In syncope or faintness from mental emotion the weakened heart cannot drive a sufficient quantity of blood to the brain; the patient feels dizzy and faint and falls down insensible. The condition is a transitory one, and the recumbent posture, assisted if need be by elevation of the limbs, causes the blood to gravitate to the heart, which is thereby stimulated to contraction; a sufficient quantity of blood is then driven onwards to the brain and the insensibility passes off. If the patient is in the sitting posture when he feels faint, the head should be depressed between the knees, which will cause the blood to rush to the brain, and the faintness will pass off.

Hæmorrhage.

With few exceptions the soft parts are freely supplied with bloodvessels, and as a preliminary to a consideration of the different forms of injuries it will be well to say a few words about hæmorrhage or bleeding. If a bloodvessel is torn or cut across, the blood within it escapes, either externally on to the clothes or floor, or, in the case of a subcutaneous injury, into the tissues, giving rise to *ecchymosis*. Cessation of the bleeding may take place in consequence of an arrest of the hæmorrhage either by nature's effort or by the adoption of artificial means by the surgeon. The loss of blood may be so great that the heart's propelling power is weakened, and in this way the natural arrest is assisted. But there is always a danger that with the arrest of the hæmorrhage the heart's action may recover its power and the bleeding recommence. In arresting hæmorrhage temporarily the chief thing is to press directly on the bleeding part. The pressure to be effectual need not be severe, but must be accurately applied. If the bleeding point cannot be reached, the pressure should be applied to the main artery between the bleeding point and the heart. In small bloodvessels pressure will be sufficient to arrest hæmorrhage permanently. In large vessels it is usual to pass a ligature round the vessel and tie it with a reef knot. Apply the ligature also, if possible, at the bleeding point, tying both ends of the cut vessel. If this cannot be done, the main artery of the limb must be exposed by dissection at the most accessible point between the wound and the heart, and there ligatured. Hæmorrhage has been classified in three varieties: (1) primary, occurring at the time of the injury; (2) reactionary, or within twelve hours of the accident, during the stage of reaction; (3) secondary, occurring at a later period, and caused by unhealthy processes attacking the wound and giving rise to ulceration of the coats of the bloodvessels. In treating these different varieties the principles already laid down hold good. In cases of severe hæmorrhage the patient suffers from syncope owing to loss of blood. Syncope from loss of blood is to be treated on the same principles as those already laid down for shock. But in addition it may be necessary in cases of severe hæmorrhage, in which much blood has been lost, to introduce into the circulation fluid which will give the heart something to act upon. Blood drawn directly from the arm of a healthy person, and introduced through an opening in the vein of the arm, has frequently been made use of. The tendency of the blood to coagulate when brought in contact with foreign matter has led to the adoption of ingenious instruments to avoid this danger. Some surgeons have used defibrinated blood, and others milk. The opinion is at present gaining ground that a nutrient fluid is unnecessary, and that all that is required is to introduce an aseptic neutral fluid at the temperature of the body which has no tendency to cause coagulation of the blood with which it mixes. A saline solution, composed of .75 per cent of common salt in distilled water, fulfils all these requirements; 4 to 6 oz. are generally sufficient. Recent experiments have been made by which blood drawn from the arm of the giver is mixed with a solution of phosphate of soda. This admixture prevents the blood from coagulating, and it can be introduced into the blood-stream with safety.

Contusions.

In a recent contusion careful pressure should be applied, with cotton wadding fixed in position with a bandage. The aim is to prevent ecchymosis and to hasten the absorption of the effused blood after it has escaped into the tissues. Accurate pressure fulfils these ends more perfectly than the commoner application of cold.

Wound treatment.

The procedure for the treatment of an open wound is: (1) arrest of hæmorrhage; (2) removal of any foreign bodies in the wound; (3) careful apposition of its edges and surfaces,—the edges being best brought in contact by the use of horse-hair stitches, the surfaces by carefully applied pressure; (4) free drainage of the wound to prevent accumulation either of blood or of serous effusion, which may be done—(*a*) by leaving the dependent corner open, or (*b*) by introducing a drainage-tube, a skein of catgut, or a skein of horsehair; (5) avoidance of putrefaction by the use of antiseptic precautions; (6) perfect rest of the part by appropriate means during the cure. These methods of treatment require to be modified for wounds in special situations and for those in which there is much contusion and laceration. In punctured wounds free drainage is of primary importance.

Poisoned wounds.

When a special poison has entered the wound at the time of its infliction or at some subsequent date the following dangers have to be combated: (1) an intense inflammation in the wound itself and surrounding parts; (2) inflammation of the lymphatic vessels leading from it; (3) inflammation of the lymphatic glands; (4) blood-poisoning of the general circulation. One of the commonest poisons is that connected with wound putrefaction; of others some are the result of diseased action in the lower animals, *e.g.*, hydrophobia, whilst some are special diseases in man. These diseased conditions are at the present time being carefully studied, and the observations all tend to one conclusion, that they are due to specific organisms which have found entrance into the diseased animal or man, and, finding there a suitable nidus for their growth and development, have set up a specific disease. If the surgeon is accidentally wounded in operating on the living subject, or the pathologist in making a post-mortem examination, the poison may pass into the wound and give rise to one or more of the symptoms already indicated. There can be no doubt that these special poisons,[1] which are spoken of as pathogenic or infective, are in some way associated with low forms of plant life, and that in this they resemble the poison of putrefaction. If the operator is in good health the poison will generally have little effect; if he is in bad health the effect may be very severe. We do not yet know in what cases bad results are to be expected. The great point in every doubtful case is to purify the wound thoroughly with some powerful antiseptic, so as to destroy the poison at the point of inoculation. If the poison escapes the germicidal action of the antiseptic used and enters the system, the patient should be stimulated, as the poison exercises a depressing action. For hydrophobia no cure is at present known. Experiments are, however, now (1887) being made by Pasteur which will throw some light on this dreadful disease.

Burns.

Burns are dangerous accidents in young children and in old people when the areas affected are large, and when they are situated over the cavities of the body. The patient may die of shock soon after the accident, of deep-seated inflammation coming on during the stage of reaction, or of hectic, which in all probability is a form of chronic pyæmia associated with profuse discharge from the wounded surface. To prevent death from any of these causes stimulating treatment is necessary. It has long been known that it is important to keep the air from the wounded surface, and antiseptic dressings must be used to prevent the access of organisms to it. When the skin is destroyed to any great extent contraction is apt to take place, followed by deformity. Care must be taken during the process of cure to prevent this, by keeping the limb in an extended position during the treatment of burns on the flexor surface. To hasten cicatrization after a burn in which the skin has been destroyed grafts of epidermic tissue may be planted on the granulating surface according to the method of Reverdin. These grafts, each the size of a pin's head, become fixed and from them cicatrization spreads over the surface. After cicatrization the tendency to contraction is not nearly so great. Epidermis grafting must not be confounded with skin grafting, in which the grafts are of the whole thickness of the skin.

Fracture.

A bone may be broken at the part where it is struck, or it may break in consequence of a strain applied to it. In the former case the fracture is generally transverse and in the latter more or less oblique in direction. The fully developed bone is broken fairly across; the soft bones of young people may simply be bent—"*green stick*" or "*willow*" *fracture*. Fractures are either simple or compound. A simple fracture is analogous to the contusion or subcutaneous laceration in the soft parts; a compound fracture is analogous to the open wound in the soft parts. The wound of the soft parts in the compound fracture may be caused either by the same force which has caused the fracture, as in the case of a cart wheel going over a limb, first wounding the soft parts and then fracturing the bone, or by the sharp point of the fractured bone coming through the skin. In either case there is a communication between the external air and the injured bone. As some years elapse before the epiphyseal extremities of the bone become united by osseous deposit to the shaft, external violence may cause a separation of the epiphysis from the shaft. This variety of fracture is termed a *diastasis*. When a bone is broken there is generally distortion and preternatural mobility, inability to use the limb, and pain on pressure over the fractured part. In the majority of fractures there is also crepitus,—the feeling elicited when two osseous surfaces are rubbed together. When a bone is bent, or when a diastasis has occurred, there is no crepitus. It is also absent in impacted fractures, in which the broken extremities are driven into one another. In order to get firm osseous union in a case of fracture the great points to attend to are accurate apposition of the fragments and complete rest of the broken bone. Accurate apposition is termed "setting the fracture"; this is best done by the extension of the limb and coaptation of the broken surfaces. Complete rest is attained by the use of appropriate splints. As a rule it is of great importance to command the joint above and below the seat of fracture. In cases of fracture near a joint, in which very commonly a splintering of the bone into the joint has taken place, more especially in those cases in which numerous tendons in their tendinous sheaths have been stretched, if the surgeon forgets that there may be effusion into the joint and the tendinous sheaths, and that this effusion may form fibrous tissue leading to stiffness of the joint and stiffening of the tendons, the result, more especially in old people, will be a permanently stiff joint or permanently stiffened tendons. Care must be taken in such instances by gentle passive movement during the process of cure to keep the joint and tendons free from the fibrous formation. To take a common example,—in fracture of the radius close to the wrist joint, it is necessary to apply appropriate splints to keep the bone at rest, and to arrange them so that the patient can move his fingers and thumb to prevent stiffness, and the splints must be taken off occasionally in order to move the wrist joint gently. If, however, the splints extend to the points of the fingers and are kept on for some weeks without removal, the consequence is a normal radius and a useless hand. Instances occasionally occur in which non-union results, either from want of formative power on the part of the individual or in consequence of improper treatment by the surgeon. For the treatment of this condition the reader is referred to one of the systematic works mentioned above. For fractures of the cranium see below, p. 724.

Treatment of compound fractures.

There is no form of injury in which the truth of the principles first advocated by Lister has been more prominently brought forward than in compound fractures. When such an accident occurs from direct violence the soft parts are generally much crushed and the bone is frequently comminuted. When a bone is broken from indirect violence the fracture is frequently oblique and the sharp point of the bone projects through the skin. In such a case the injury is, as a rule, not so severe. Formerly compound fractures were the dread of the surgeon: septic inflammation occurring in the wound reached the open medullary cavity of the bone, and the open bloodvessels of the bone gave easy access to the causes and products of the inflammation into the general blood-stream, giving rise to pyæmia. It is not asserted, however, that this accident always occurred. In a case of compound fracture the wound should be at once covered with a towel thoroughly soaked in a five per cent. solution of pure carbolic acid. And, if some time elapses before the arrival of a surgeon, more of the solution must be poured upon the towel, which should be kept thoroughly soaked. After the fracture is set it will probably be necessary to inject the solution into the interstices of the wound, over which an efficient antiseptic dressing must be applied. When the injury is so severe that it is impossible to preserve the limb, amputation is the only resource. It is often a difficult thing to say when the surgeon should amputate. The question will frequently be settled by a consideration of the general circumstances and surroundings of the patient, and no definite rules can be laid down. Speaking in general terms, an artificial substitute may take the place of the lower limb, but no artificial substitute can ever efficiently take the place of the upper limb; and therefore surgeons will run some risk in attempting to save an upper limb which they will not do in treating an injury of a lower limb.

Joint injury.

There are three principal types of joint injury: (1) sprain or strain, in which the ligamentous and tendinous structures around the joint are stretched and even lacerated; (2) contusion, in which the cartilaginous surfaces of the opposing bones in the joint are driven forcibly together; (3) dislocation, in which the articular surfaces are separated from one another; in this last injury the ligamentous capsule of the joint must be torn to allow the accident to occur. Joint strength may be classified anatomically under three heads: (1) ligamentous, due to the ligaments binding the bones together; (2) osseous, due to the shape of the bones forming the joint; (3) muscular, due to the muscles surrounding the joint. Ligamentous strength predisposes to sprains, osseous to contusions, and muscular to dislocations. A joint is frequently saved from injury in consequence of the relative weakness of a bone near it. The ankle joint is saved by the weakness of the fibula, the wrist joint by the weakness of the radius, the sterno-clavicular joint by the weakness of the clavicle; the fracture of the bone preserves the joint from injury. The tonicity of the muscular structures around a joint often prevents a dislocation, the patient being prepared for the violence to which his joint is subjected. The osseous strength of a joint will depend very much on the position of the limb at the time of the accident.

When a joint is sprained or contused there is effusion into it and into the structures around it. In such cases accurately applied pressure will prevent effusion, and along with gentle passive exercise and rubbing will prevent subsequent stiffness. When a joint is dislocated it is of importance to restore the bones to their normal position as soon as possible after the accident. Within the last few years, in several dislocations, the treatment by extension of the limb and forcible pressure of the bones back into their normal position has been given up, and a method of treatment at one time in use in the French schools has been revived by Dr. Bigelow of Boston, Mass., who has pointed out that with less force and therefore less injury a dislocated joint may be reduced by manipulation. The great principle at the root of this treatment is to manipulate the limb so as to cause the dislocated bone to pass back into its normal position by the same path by which it left it. In compound dislocations the same precautions must be attended to as in compound fractures.

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[1] For their classification, as yet very imperfect, consult Ziegler's *Pathological Anatomy* (trans. by Macalister, London, 1883-84).

II. Process of Repair.

Forms of local death.

After an injury certain changes take place, which, if kept within bounds, terminate in repair, in other words, in a restoration of the injured part to a condition as nearly as possible normal. When the injury is severe the restoration may fall far short of the normal. The recovery may take place with very little pain or discomfort even in severe injuries. Frequently, however, as the result either of improper treatment on the part of the surgeon or of feebleness on the part of the person injured, local uneasiness and a general feverish condition arise, which interfere with the healing. When these evil results follow, a local death of tissue in a greater or less degree is observed. Three forms of local death have been described: (1) suppuration or the formation of pus; (2) ulceration, or the formation of an ulcer; (3) mortification, or the formation of a slough. These three processes run imperceptibly into one another. They are not distinctly separable from one another, and they very frequently occur together. It is to be noted that the process of repair and the local death which interferes with a painless repair differ only in degree. As a general rule, in the truly subcutaneous wound of tissue, be it the soft parts or bone, the changes that take place ending in its repair are simple and uncomplicated; it is in the open wounds of the soft parts and in compound fractures of bone that complications arise.

Repair of an incised wound.

In order to understand this process, it will be best to take a simple injury, such as a clean cut. As the result of the passage of even the sharpest knife through the tissues a microscopic laceration along the line of the incision must occur. The skin, subcutaneous fat, fascia, and muscle are divided. These parts being vascular, bleeding takes place from the cut vessels. Let us suppose that the bleeding has ceased, and that the surfaces and edges of the wound are not brought into contact. The retractile power of the tissues, when they are divided, necessarily produces a trench-shaped gap. If the sides of this gap are watched a weeping of a straw-colored fluid will be observed, which, when examined under the microscope, is seen to have corpuscles floating in it. The fluid is the liquor sanguinis of the blood, and the corpuscles are the blood corpuscles. In the blood as it circulates throughout the vessels in the body, the yellow or red blood corpuscles are greatly in excess of the white. In this fluid the white blood corpuscles are very numerous. Careful observation, with the aid of a sufficiently powerful microscope, will show the formation of fine fibrils of a solid substance, which gradually extend over the field; this fibrillation takes its start from the white blood corpuscles. The effusion has coagulated. A soft solid —fibrin—is formed, which gradually contracts, and a clear fluid escapes; this is the blood serum. To return to the wound,—in consequence of the injury the smaller bloodvessels dilate, their walls are thinned, and a stasis or stoppage of the flow of blood within these vessels takes place. The stasis is caused by the injury to the vessel walls, rendering the blood corpuscles more adhesive. The circulation is going on in the vessels beyond the area of stasis. The blood in a state of stasis acts as an obstruction, and consequently there is an increased pressure on the inner surface of the thin walls. As a result the fluid part of the blood or liquor sanguinis and the corpuscular elements of the blood escape into the tissues and on to the surface of the wound. On this surface and in the tissue next the surface a clotting takes place, and fibrin is formed. The surface of the wound becomes glazed, and as the fibrin contracts the blood serum oozes out upon the wound surface and escapes. The glazed surface then becomes vascular; new bloodvessels are formed in it; and through these a circulation is set up continuous with the circulation in the bloodvessels around. If the surfaces of the gap are now brought into gentle contact, the bloodvessels on the two surfaces will unite. At first the uniting tissue is very succulent and vascular, and further changes must occur before the uniting medium is consolidated. This is effected by the formation of fibrous tissue in the deeper parts of the uniting medium and by the formation of epithelial tissue in the more superficial parts where the skin is divided. Along with these changes the uniting medium becomes less vascular, and a linear scar is the result.

This is the case of an incised wound in which the surfaces are not brought at once into contact. If, however, this is done, the same changes take place, and in a small wound no untoward results need follow. But in a wound of some size there is danger in bringing the edges of the wound into contact. In consequence of the difference in the retractile power of the different tissues that are divided, it may be impossible to bring the deeper parts into accurate contact. The patient will complain of local pain, accompanied by a throbbing sensation, showing that an accumulation of serum has taken place. If a stitch is removed, the serum will escape and the local uneasiness disappear. If, however, no relief is given, the retained serum, pressing upon the surrounding tissues and acting as a foreign body, will cause effusion of more serum. The white blood corpuscles will pass from the vessels in large numbers, will die, and practically a cemetery of white blood corpuscles will be formed; if a stitch is then removed a creamy fluid escapes. This fluid is termed "pus." Once the tension is relieved, the local uneasiness disappears; but the wound cannot then heal by primary union. The walls of the cavity must again become glazed; vascularization must take place; and, as the walls of the cavity gradually come together by contraction, fibrous tissue is formed. This is *union by second intention.*

Abscess and pus formation.

The collection of white blood corpuscles floating in the effusion and eventually forming pus is termed an *abscess.* Pus may also form amongst the tissues after a blow or other injury. As the result of a blow a certain area of tissue becomes congested, and effusion takes place into the tissues outside the vessels; the effusion coagulates and a hard brawny mass is formed. This mass softens towards the centre; and if nothing is done the softened area gradually increases in size, the skin becomes thinned over it, the thinned skin loses its vitality, and a small slough is formed. When the slough gives way, the pus escapes. Such shortly is the history of an acute abscess under the skin, and the explanation generally given is that a local necrosis or death of tissue takes place at that part of the inflammatory swelling farthest from the normal circulation. When the dying process is very acute death of the tissue occurs *en masse,* as in the core of a boil or in the slough in a carbuncle. Sometimes, however, no such evident mass of dead tissue is to be observed, and all that escapes when the skin gives way is the creamy pus. In the latter case the tissue has broken down in a molecular form; in the former case it has broken down *en masse.* After the escape of the core or slough along with a certain amount of pus, a cavity is left, the walls of which become lined with lymph. The lymph becomes vascular, and receives the name of granulation tissue. The cavity heals by second intention. Pus may accumulate in a normal cavity, such as a joint or bursa. It may also be met with in the cranial, thoracic, and abdominal cavities. In all these situations, if the diagnosis is clear, the principle of treatment is free evacuation of the pus, and in joints and in the peritoneal and pleural sacs washing out the cavity at the time of opening, free drainage, and careful antiseptic treatment during the subsidence of the inflammatory process. The tension is relieved by letting out the pus. If the after-drainage of the cavity is thorough the formation of pus ceases, and the serous discharge from the inner side of the abscess wall gradually subsides; and as the cavity contracts the discharge becomes less and less, until at last the drainage tube can be removed and the external wound allowed to heal. The large collections of pus which form in connection with disease of the vertebræ in the cervical, dorsal, and lumbar regions are also now treated by free evacuation of the pus, with careful antiseptic measures. In all cases care should be taken to make the opening as dependent as possible in order that the drainage may be thoroughly efficient. If tension occurs after opening by the blocking of the tube, or by its imperfect position, or by its being too short, there will be a renewed formation of pus.

Ulceration.

When a considerable portion of tissue dies in consequence of an injury, the death taking place by gradual breaking down or disintegration, the process is termed *ulceration,* and the result is an ulcer. As long as the original cause which formed the ulcer is at work, the gap in the tissues becomes larger and larger. Suppose that the ulcerative process is going on and the ulcer is spreading. The ulcer is then painful and the parts around are inflamed. Remove the cause by appropriate treatment and the necrotic process ceases, the shreds of tissue are cast off, the ulcer gradually cleans, the inflammation subsides, the pain disappears: the ulcer becomes a healing ulcer. The surface of the gap becomes glazed, and those changes take place in it which have already been described as occurring in an open wound. The gap gradually contracts in size. Round the edges cicatrization occurs, leaving a scar or cicatrix. Within the last few years the process of cicatrization has been hastened by planting on the granulation tissue small grafts of epidermic tissue in the manner already described (p. 716). There can be little doubt that the growth of an ulcer, as well as the disintegrating process which precedes its formation, is closely associated with the multiplication of low forms of plant life in the decaying tissue. By destroying these organisms with some powerful antiseptic the destructive process may be checked. Since these organisms live on decaying matter, they are termed "saprophytic." The healthy tissues are antagonistic to their growth, and any treatment which renders the tissues around the gap healthy will interfere with their further development. The entrance of those organisms into a wound made by the surgeon, if they find in it a suitable soil for their development, is undoubtedly also a fertile cause of suppuration in wounds. But it must be distinctly remembered that any means which are adopted to keep the injured tissues in a healthy condition interferes with the growth of these saprophytes as directly as if the surgeon used some antiseptic substance which destroyed them. What relation obtains between a local necrotic process, such as the formation of a boil with its central slough, situated necessarily in the first instance under the skin, or the equally necrotic process, the formation of pus in a subcutaneous abscess, and these low forms of plant life? There can be no doubt that by the injection into the tissues of a powerful irritant these necrotic changes can be induced without the intervention of organisms. Professor Ogston and Mr. Watson Cheyne have also shown that micrococci are present in the great majority of acute subcutaneous necrotic inflammations, as they are commonly met with in the human body. Here the question at present rests. The opinion of the present writer is that in all probability they are the cause of the necrotic process. It is not asserted that they are the cause of the primary inflammation, which need not go on to necrosis; but the probability is that they find in the inflamed area a nidus for their growth and development. It is not known how they cause it, whether by direct action upon the tissues or by irritating products formed during their growth. The organisms described by Ogston and Cheyne have a life history and require conditions for their existence and development different from those demanded by the saprophytic organisms already described. To reach the subcutaneous area of inflammation they must pass by the blood-stream, and must be able to exist in the living blood. They are probably associated with the infective class of organisms. In some suppurations at the present moment, such as acute suppurative periostitis, the formation of pus under the periosteum connected with bone, a suppuration within the medullary cavity of a bone called osteomyelitis, and in acute ulcerative endocarditis, the organisms met with are undoubtedly infective. We do not know exactly how they enter the blood-stream, but we know that they can live in it, and that the occurrence of these diseased conditions is undoubtedly a local effect closely connected with blood-poisoning.

Mortification or gangrene.

A portion of the body may die in consequence either of an intense inflammation or of a cutting-off of the blood-supply. Besides these two distinct varieties there is a great intermediate group of cases in which both causes may be at work. A comparatively slight injury affecting a portion of the body imperfectly supplied with blood may give rise to an inflammatory condition which in a healthy part would be easily checked, but which in consequence of imperfect nutrition may end in mortification. Whilst the pressure of a tight boot in an old person with atheromatous vessels can give rise to mortification, the same pressure in a healthy person would give rise only to an evanescent redness. Frost-bite is a localized death of a portion of the body which has been exposed to prolonged cold. It may attack the fingers or toes. The death may occur directly without any intermediate reactionary inflammation, or it may follow an excessive reaction. The rule of treatment in all cases of gangrene in which there is a tendency to death is to keep the part warm by layers of wadding, but to avoid all methods which hurry the returning circulation; because any such increase would be followed by excessive reaction, which in its turn in a part already weakened would be followed by secondary death. When the part is dead, envelop it in antiseptic wadding to prevent putrefaction; wait until the line of demarcation between the living tissues and the dead part is evident, and then, if the case permits, amputate at a higher level. In spreading gangrene in which sepsis is present, and in which no line of demarcation forms, the best chance for the patient—at best a poor one—is to amputate high up in sound tissues. In these cases the blood is generally poisoned, and if the patient recovers from the primary shock of the operation a return of the decaying process may attack the stump, and carry him off.

III. DISEASES.

1. *Diseases of Bloodvessels.*

Aneurism.

An aneurism, in so far as we have to deal with it at present, may be defined as a sac communicating with the lumen of an artery. The sac-wall may be formed of one or more of the arterial coats which have become dilated. The tissues around, being condensed and being more or less adherent to the sac-wall, strengthen and support it. The dilatation of the arterial coats is generally due to a local weakness, the result of disease. The diseased condition is almost always a chronic form of inflammation, to which the name *atheroma* is given. In some instances the local weakness may be due to an injury bruising or lacerating the vessel and injuring its internal coat. When an artery is wounded and when the wound in the skin and superficial structures heals, the blood may escape into the tissues. In this case it displaces the tissues and by its pressure causes them to condense and form the sac-wall. The coats of the vessels, more especially when they are diseased, may be torn from a severe strain, and the blood will then escape into the condensed tissues forming the sac-wall. When one or more of the vessel coats form the sac there results what is called a *true aneurism*; in those instances in which the sac-wall is formed by the condensed tissues around we have a *primary false aneurism*; when a true aneurism bursts and the blood escapes into the tissues around it, as sometimes occurs in deep-seated aneurisms, giving rise to secondary localized accumulation, the term *secondary false aneurism* is used. In both varieties of false aneurism the swelling is more diffuse and the pulsation as a rule is less marked than in the true aneurism.

The blood in an aneurism is at first in a fluid state, and at each beat of the heart a certain amount passes into the sac, causing its expansion. In all aneurisms there is a tendency to coagulation of the blood, and a blood-clot is deposited in a laminar form on the inner surface of the aneurismal sac. In some instances this laminar coagulation by constant additions gradually fills the aneurismal cavity. The pulsation in the sac then ceases; contraction of the sac and its contents gradually takes place; the aneurism is cured. On the other hand, if the blood within the sac remains fluid, the aneurism will gradually increase in size; the tissues over the aneurism and the sac-wall will become thinned, and at last give way; and death occurs from hæmorrhage.

Treatment of true aneurism.

In the treatment of true aneurism the great principle is to encourage coagulation in the aneurismal sac. This can be done by lessening the force of the circulation generally or locally. The general force of the circulation can be lessened by low diet, rest in bed, avoidance of all causes of vascular excitement, and by the administration of large doses of iodide of potassium. The force of the circulation can be decreased locally and temporarily by the application of a ligature to the artery between the aneurism and the heart or by the application of pressure upon the main vessel at a convenient point between the aneurism and the heart. The general treatment is available in all cases. The local treatment by operation or by compression is only available in those instances in which the aneurism is so situated that the bloodvessel can be compressed or ligatured, as in aneurisms of the head and neck or of the extremities. In certain aneurisms in the lower part of the neck and upper part of the thorax, in which a ligature cannot be applied between the aneurism and the heart, the blood-flow through the aneurismal sac has been diminished by the application of a ligature to one or more of the main vessels on the distal side of the aneurism. The blood-supply to the parts beyond the aneurism being thus cut off, the immediate effect is increased pressure on the aneurismal sac; but, since the parts accommodate themselves to altered circumstances, as the collateral bloodvessels increase in size, becoming the main vessels of supply to the parts beyond, the original channel becomes of secondary importance, the result being a diminution in the size of the main vessel and diminished blood in the sac, encouraging coagulation and contraction of the aneurismal sac. Practically the same effect has sometimes been obtained in a permanent way, as in cases of rapidly increasing aneurism of the subclavian artery in the root of the neck by amputation of the upper extremity at the shoulder-joint. And within the last few years, in popliteal aneurism, the same thing has been done temporarily by the application of an elastic bandage to the limb from the foot upwards to the popliteal space, emptying the bloodvessels below the knee, and in this way cutting off the blood-supply temporarily. The application of the elastic bandage is continued up the thigh, care being taken not to make firm pressure with the bandage as it passes over the aneurism behind the knee-joint, so that the sac may not be emptied of blood. If the sac were emptied, the object in view would be defeated, because there would be no blood in the sac to coagulate. The continuation of the bandage in the thigh above the aneurism is practically a compressing agent applied to the artery on the proximal side of the aneurism. The rationale of this treatment of popliteal aneurism, due to Dr. Walter Reid of the British navy, may, if this explanation is correct, be said to owe its success to the fact that in it we combine the two great principles which check the blood-pressure locally, *i.e.*, a cutting off of the blood-supply beyond the aneurismal sac and compression on the main vessel on the proximal side. It is to be noted that all these different means of checking the blood-pressure within the aneurismal sac are temporary in their action. The temporary arrest by compression, the equally temporary arrest by the application of a ligature, in the latter case the collateral anastomosing circulation taking the place of that of the main trunk which has been ligatured, start the process of coagulation within the sac, and, the process being once started, complete consolidation gradually takes place. Although these methods of treatment are principally of value in true aneurism, they are also to a certain extent useful in secondary false aneurism. In primary false aneurisms, on the other hand, we have to deal with a wounded vessel in which the blood, instead of being poured out externally, is poured into the tissues, and is practically a (chronic) bleeding point; the principle of treatment is to open the sac, turn out the clots, and ligature the artery above and below the bleeding point.

Diseases of veins.

The veins are liable to inflammation (*phlebitis*). When this occurs the blood in the vein is liable to coagulation, forming a clot or thrombus, which, if displaced from its original position, either makes its way as an embolus towards the heart and is there arrested, or passes through the cavities of the heart into the lungs, there sticking and giving rise to lung symptoms. If the thrombus is formed in the hæmorrhoidal plexus, it passes as an embolus by the portal system into the liver. If it is formed in the left side of the heart, it may pass into the large vessels at the root of the neck and reach the brain, giving rise to symptoms of brain disease. The thrombus may be formed apart from inflammation of the vein wall in consequence of diseased states of the blood, as in gout and rheumatism, or it may form in consequence of stagnation of the blood-current due to slowing of the circulation in various wasting diseases. When a thrombus forms, absolute rest in the recumbent posture is to be strictly enjoined; the great danger is embolism or the displacement of the clot from its original position. Hot fomentations in the early stages and belladonna ointment when the condition becomes sub-acute are the best local applications. The desire is to promote absorption of the clot. The veins in the lower extremity and in the hæmorrhoidal and spermatic plexus are liable to dilatation. The condition is termed *varix*. The veins dilate with tortuosity; the valves become incompetent; and the condition is apt to spread. In the lower extremity the primary cause may be an injury or some obstruction at a higher point. General laxity of the tissues predisposes to the condition; occupations which necessitate much standing and alternation of heat and cold also act as predisposing causes. The treatment consists in giving the dilated vessel support by means of an elastic bandage or stocking. When the condition is local and gives discomfort, the vessel may be ligatured at various points so as to cause its obliteration. This operation should not be undertaken rashly, and should only be performed if the case is an aggravated one, since it is by no means devoid of risk. In the hæmorrhoidal plexus the disease is termed *internal hæmorrhoids* or *piles*; many operations are performed for this condition, but in the great majority of cases the careful use of purgatives and the administration of cold water injections into the rectum will relieve the condition. The dilated veins often ulcerate and give rise to bleeding piles; here an operation is often called for, because the persistent loss of even small quantities of blood is apt to result in chronic anæmia. The enlargement of the spermatic plexus is termed *varicocele*, and almost always occurs on the left side. The use of a suspensory bandage and cold bathing should first be tried; if the disease persists, it is often associated with mental depression, and an operation —ligature at several points of the dilated vessel—should be performed. The disease may be associated with atrophy of the testicle on the same side, and this liability aggravates the mental condition and encourages the surgeon to operate. Inflammation of the lymphatic vessels in the lower limbs is often associated with inflammation of the veins in the female after delivery, giving rise to the various forms of *white leg*. Acute inflammation of the lymphatic vessels and glands is also associated with poisoned wounds, and has already been alluded to in connection with injuries. The use of hot fomentations and careful elastic pressure with rest are prescribed for treatment.

2. *Diseases of Bone.*

Bone diseases.

Attention has already been directed to one form of injury to a bone, viz., fracture. A word may now be said about inflammation of a bone and its results. As a typical instance we will take a long bone, consisting of a shaft and two extremities. The walls of the shaft consist of dense bone, the extremities of cancellated tissue. The shaft of the bone is hollow, and filled with medullary tissue. In the fully developed bone the extremities alone are tipped with cartilage; in the extremities of the bones of a growing person there are also layers, termed the *epiphyseal cartilages*. The bone is surrounded by a fibrous membrane termed the *periosteum*. This membrane is richly supplied with bloodvessels, which ramify through it and pass, along with lymphatic vessels and nerves, from it into the Haversian canals in the dense bone forming the shaft. The deeper layers of the periosteum consist of osteoblastic cells, which also line the Haversian canals. In the undeveloped condition these cell elements take an active part in the growth of the bone as regards its breadth, the epiphyseal cartilages taking an active part in its growth as regards its length. The medullary tissue in the cavity of the bone is supplied by the nutrient artery; the cancellated tissue forming the extremities receives its blood-supply partly from the nutrient artery and partly from vessels passing indirectly from the periosteum. When a bone is injured—as happens, for example, in a severe bruise—the bloodvessels in the periosteum and in the Haversian canals become congested, effusion of liquor sanguinis and migration of the white blood corpuscles take place, and a severe gnawing pain is felt at the seat of the bruise. The pain is severe because the effusion cannot escape. It collects under the periosteum and in the Haversian canals. The cell elements in these situations are irritated, and cell proliferation takes place. The periosteum becomes thickened, and if the tension continues suppuration may occur between the periosteum and the bone. The periosteum is raised from the bone; the bloodvessels passing into the Haversian canals are obliterated or torn across; and the outer layers of the hard dense bone, their sources of nutriment being cut off, die. The extent of the necrosed tissue will depend upon the extent of the suppurating area; if the suppurating area includes the nutrient artery within its range, nutriment being then cut off from the medullary tissue from which in part the deeper layers of the shaft of the bone are supplied with blood, death of the whole thickness of the shaft of the bone may occur. As already stated, the most acute forms of suppurative periostitis and suppurative osteomyelitis are infective diseases, the suppuration in them being due to the presence of a micrococcus. If after an injury the primary inflammation is relieved by fomentations, leeching, or incisions, suppuration may be prevented; or even if, after suppuration has occurred, free incisions are made to allow the pus to escape, the periosteum may assume its normal position, and the area of necrosis be limited or necrosis be prevented altogether. After a portion of the shaft of the bone dies, the necrosed area is gradually absorbed; but, if the area is of considerable size, and more particularly if sepsis occurs, the dead part is gradually separated from the living, and after a time it becomes loose, and as a rule has to be removed by operation. If the inflammation, acute in the first instance, becomes sub-acute, or if it is sub-acute from the first, then, instead of suppuration, the effusion under the periosteum coagulates, whereupon lymph is formed, the proliferating osteoblastic cells in the lymph take up their normal function, and new bone is made. This mass of new bone is termed a *node*. In the Haversian canals the osteoblasts there forming bone will render the bone tissue more dense and ivory-like in consistence, to which the term *sclerosis* is applied. In some cases the osteoblastic cells in the Haversian canals, instead of forming bone, feed upon the original bony tissue which constitutes the walls of the canals. The Haversian canals becoming enlarged, the result is a lessening of the amount of inorganic matter in the area affected, and a cancellation of the hard bone takes place. This condition is called *rarefying ostitis*. The rarefaction of the dense bone may persist, or the process may stop, the osteoblasts again forming bone and the rarefied area becoming sclerosed. In the cancellated tissue in the extremities of the long bones, and in that which forms the mass of the short bones, such as the vertebræ, the tarsal and the carpal bones, the inorganic matter compared with the hard bone is relatively in smaller amount than the organic matter filling the cancellæ. Here as a result of injury the thin lamellæ of bone may be cut off from their blood-supply, and death take place. If the process is acute, an area of cancellated tissue will die, and be separated from the surrounding living tissue as in the hard bone. In consequence, however, of the quantity of organic matter, death may take place in a molecular form, more nearly allied to the process of ulceration in the soft parts. This condition is known as *caries*. If the inflammatory process in cancellated tissue is sub-acute, instead of a molecular death, sclerosis of the cancellated tissue occurs. When the cancellated tissue is the seat of inflammation, in consequence of its close connection and intimate anatomical relations with the articular cartilages, they in their turn become implicated, and we have then to deal with disease of the joint. In all cases in which incisions are made to relieve tension under the periosteum, or in which portions of bone are removed to relieve tension in the shaft or in the medullary cavity of a bone, or in which incisions are made to check the progress of inflammatory action in the cancellated tissue, strict antiseptic precautions must be taken to prevent sepsis occurring in the wound.

3. *Diseases of Joints.*

Structure of joint.

A joint is a complicated organ, and its integrity depends upon a healthy condition of the bones which form it, of the articular cartilages which cover the ends of the bones, and of the synovial membrane which supplies the synovial fluid that lubricates the joint. These different structures are closely associated anatomically and physiologically, and disease beginning in any one of them will assuredly, unless checked, gradually extend to the others. The cartilage covering the ends of the bones receives its blood-supply mainly from the bone, and is also to a certain extent supplied at its edges by the synovial membrane. The cartilage being in itself non-vascular, disease does not commence in it; the majority of joint diseases commence either in the synovial membrane or in the bone; as a general rule they begin with some slight injury of the joint. These injuries consist of strains or twists (of the joint) on the one hand and jarring or contusion on the other. In the latter case the elastic cartilage lessens the force of the contusion.

Sprain.

When a joint is strained, the ligaments binding the bones together are stretched and the synovial membrane becomes inflamed. Consequently effusion takes place into the joint, which becomes swollen and painful on pressure. Any movement of it is painful, and all the muscles around it are rigid. In a healthy person appropriate treatment—rest, hot fomentations, and gentle elastic pressure—will cause the fluid within the joint to be gradually absorbed, after which the joint can be restored to its normal condition. When the inflammation becomes sub-acute the pain disappears, and unless the joint is kept quiet by appropriate splints the condition is very apt to become chronic; that is, the joint becomes swollen and the movements are restricted. This condition is most persistent, and prolonged rest, along with counter-irritation by blistering or by the application of tincture of iodine, is necessary before the effusion subsides. The joint may remain weak for the rest of the patient's life. Fibrous adhesions may form and prevent free movement. A joint in such a condition is always liable on the slightest injury to have a return of the effusion in an acute or sub-acute form. These are the chief consequences of a strain in a healthy person. In a weakly person the primary strain may entail a very different result. The synovial membrane may undergo gelatinous or pulpy degeneration, and, although it is improbable that this condition is associated with the tubercular diathesis in all cases, there can be no doubt that in very many the degeneration of the synovial membrane is tubercular in character. The tubercle bacillus has been found in the thickened membrane. A joint in this condition swells; the enlargement, although it may be due in part to effusion into the cavity of the joint, is mainly caused by the thickening of the synovial membrane, which has a peculiar doughy semi-elastic feeling. The movements of the joint are restricted, though little pain is complained of. If it is an upper limb the patient will not use it, if a lower limb he will walk with a distinct limp. The disease is a chronic one, and the joint may remain in this condition for months. Rest, elastic pressure, and blistering may check the progress of the disease, but as a rule, sooner or later, and very often as the result of some slight injury, a change takes place. On the one hand, the effusion within the joint, instead of being serous, becomes sero-purulent, and even purulent, owing to the formation of pus within it. If the joint is an important one, inflammatory fever is set up; the joint becomes intensely painful on the slightest movement, and unless incisions are made to allow the pus to escape it passes gradually into a state of complete disorganization. The cartilage softens and breaks down, so that gradually the cancellated bone underneath is exposed. A similar change takes place in the opposing cartilage. It is destroyed in its turn and the ligaments binding the bones together are softened and lose their elasticity, so that the joint can be moved in abnormal directions. A grating sensation can be felt when the cancellated bony surfaces are rubbed together. Along with these changes within the joint, foci of inflammation form in the soft tissues around it. These inflammatory areas suppurate; the abscesses burst into the joint; the skin over them gives way; and communication is established between the external air and the cavity of the joint. Through this channel the causes of putrefaction reach the cavity, and complete disorganization of the part accompanied by sepsis occurs. Should the joint be an important one, a condition termed *hectic* is set up. If the discharge is allowed to continue, a gradual wasting takes place, which sooner or later ends in the death of the individual, unless the surgeon either relieves the tension by free incisions, or excises the joint, or amputates the limb. After disorganization has occurred, if the inflammatory process ceases, anchylosis of the joint may result. But, if the joint is freely drained and kept at rest, the inflammation will subside, and the granulation tissue on the two opposing surfaces will unite and a fibrous formation take place. The process may stop there, or the fibrous tissue may be gradually transformed into bone. Osseous union has taken place between the bones forming the joint. In many cases this is what the surgeon aims at, and it is of great importance to keep it constantly in view and to place the joint in such a position that, if anchylosis does occur, the limb may be as useful as possible. This result is only attained after prolonged treatment, and, if the patient's strength is unequal to it, it will be necessary to excise the affected joint or to amputate the limb. Suppuration sometimes occurs within a joint without any previous pulpy degeneration of the synovial membrane, either as the result of a wound or from septic inflammation secondary to pyæmia, or in consequence of a very acute simple synovitis resulting from excessive tension within the joint. When the synovial membrane is affected with pulpy degeneration the vitality of the cartilage at its edges, where it joins the synovial membrane, may be interfered with; the thickened synovial membrane, by encroaching on the articular cartilage, gradually by pressure alters the nutrition of the cartilage so that it disintegrates and breaks down, and when it is destroyed disorganization of the joint ensues, as already described. Should the disease assume this form, if care is taken, and if the joint is kept quiet, suppuration within it need not necessarily take place. The inflammation may assume a sub-acute type and fibrous anchylosis occur.

Contusion.

When a joint has been severely contused, separation of the cartilage from the bone occurs; effusion then takes place between the cartilage and the bone; the cartilage is cut off from its nutrient supply; and, unless the joint is kept at complete rest, unless the effusion is absorbed, the cartilage will sooner or later become necrosed. The necrosed cartilage will give way; the bone beneath will be exposed; and, if the irritation is kept up, effusion, at first serous but soon becoming purulent in consequence of the tension within the joint, will take place. Changes follow in the opposing cartilage, which has been itself bruised by the primary jar, and perhaps even separated from the bone beneath. It will in its turn necrose, and the bone will be exposed, suppuration taking place within the joint. The synovial membrane will become diseased, the ligaments softened, and the evil sequence of events already described will ensue. A joint affected in this way is easily recognized from one in which the synovial membrane is primarily affected by the absence of swelling and by the intense pain. In the early stages complete rest should be obtained by affixing a weight to the affected limb. This, by setting up between the opposed and injured cartilaginous surfaces a condition of negative pressure, will tend to check the disease. But if this plan of treatment does not soon cause a subsidence of the pain, actual cautery must at once be resorted to. Contusion in which the cancellated bone is injured at some distance from the cartilage is most commonly met with in young people, in whom the extremities of the bones are not fully developed. In them the epiphyseal cartilages are richly supplied with blood for the performance of their physiological function, the formation of bone, and a comparatively slight injury may cause inflammation to be set up in the bone immediately in contact with the epiphyseal cartilage. As in the synovial membrane when it is affected with pulpy degeneration, this disease may be occasionally non-tubercular in character; but in the majority of cases, more especially when the primary injury is very slight, the disease assumes the tubercular type and tubercle is deposited. In such cases the symptoms are often very insidious; the young patient complains of some slight uneasiness, or the first thing to be noticed is a limp in walking when a lower limb is affected. In the case of an upper limb the patient will avoid moving the affected joint. As there is no external swelling, the disease may be overlooked in its early stages; but, if it is suspected, and if the affected limb is kept at rest, the inflammation will subside and recovery ensue. On the other hand, if the patient is allowed to use the limb, even in an imperfect way, the tubercular area may extend and the articular cartilage become affected. The articular cartilage does not in that case receive its proper nourishment: it disintegrates, breaks down, and the disease attacks the joint. Into this last tubercular matter escapes and suppuration occurs, resulting sooner or later in disorganization of the joint.

Anchylosis.

In recent years a useful limb has often been saved by excision of the affected joint. In the early stages the disease may subside under appropriate local treatment, such as counter-irritation, rest, pressure, assisted by constitutional treatment, such as tonics, fresh air, and careful dieting. By these means an operation may be avoided, and in applying such treatment it must be remembered that, while the disease itself may subside, the joint as an organ may be irretrievably damaged: it may become anchylosed. If anchylosis occurs in a flexed position of the hip or knee joints, the limb will be useless for progression; and an operation will be necessary in order to straighten it. In the ankle joint, if anchylosis occurs with the foot in an extended position, the patient will not be able to put his heel to the ground, and an operation will be necessary to bring the foot at right angles to the leg. Do not interfere with an anchylosed joint in the lower limb if it is in good position. If the shoulder joint becomes anchylosed after disease, the sterno-clavicular and acromio-clavicular joints take up to a great extent the function of the anchylosed shoulder. In the elbow, in whatever position the joint becomes anchylosed, the arm loses much of its usefulness and excision of the joint is performed in order to get a movable elbow. In the wrist it may be necessary to operate for anchylosis; but as a rule, if the fingers are mobile, the anchylosed wrist does not interfere to any great extent with the usefulness of the hand.

4. *Venereal Diseases.*

Relations of venereal diseases.

Three distinct affections are included under this term—gonorrhœa, chancroid, and syphilis. At one time these were regarded as different forms of the same disease; and, though gonorrhœa is now generally held to be quite distinct from the other two, there are not wanting eminent authorities, including Mr. Jonathan Hutchinson, who are inclined to look upon chancroid and syphilis as essentially one and the same disease. The present writer believes that gonorrhœa, chancroid, and syphilis are three distinct diseases, due to separate causes, which have nothing in common except their habitat. The cause in each case is a specific virus, probably a micro-organism. In the case of gonorrhœa the virus attacks mucous membranes, especially that of the urethra; in chancroid mucous membranes and the skin are affected; in syphilis the whole system comes under the influence of the poison. Gonorrhœa and chancroid correspond to the process of septic intoxication. The organisms on implantation set up a local disturbance, and the products of this fermentative process pass into the system and give rise to constitutional effects; but the organisms themselves do not pass into the system generally. In syphilis, on the other hand, there is a true infective process; the organisms pass into the general circulation and live and multiply wherever they find a suitable nidus. The joint affection commonly called "gonorrheal rheumatism," which sometimes follows gonorrhœa, is in all probability an infective condition. If this is true, then in these rare cases gonorrhœa is infective. The chancroid poison may pass into the lymphatics and cause inflammation of the lymphatic glands in the groin giving rise to *chancroidal bubo*. These clinical facts are undoubtedly opposed to any generalization such as that laid down above, and it is right to note them; but the general comparison between gonorrhœa and chancroid as non-infective and syphilis as distinctly infective in its character holds good in the great majority of cases. A further study of these quasi-infective varieties of gonorrhœa and chancroid must undoubtedly throw light upon the physiological classification of pathogenic organisms. These three affections are generally acquired as the result of impure sexual intercourse; but there are other methods of contagion, as, for example, when the accoucheur is poisoned whilst delivering a syphilitic woman, the surgeon when operating on a syphilitic patient. An individual may be attacked by any one or any two of the three, or by all of them at once, as the result of one and the same connection; but they do not show themselves at the same time; in other words, they have different stages of incubation. In gonorrhœa the disease appears very rapidly, so also in chancroid, the first symptoms commencing as a rule three or four days after inoculation. It is very different, however, with syphilis. Here the period of incubation is one rather of weeks, the average length being twenty-eight days, though it may vary from one week to eight. The length of the period of incubation, therefore, is the great primary diagnostic in the case of syphilis.

Syphilis is an infective fever, and its life history may be best considered by comparing it with vaccinia.

Syphilis.

A child is vaccinated on the arm with vaccine lymph. For the first two or three days nothing is observed; but on the fourth day redness appears, and by the eighth day a characteristic vaccine vesicle is formed, which bursts and frees a discharge, which dries and forms a scab. If on the eighth day the clear lymph in the vesicle is introduced at another point in the child's skin, no characteristic local effect follows. The system is protected by the previous inoculation; this protection will last for some years, and in certain cases for the rest of the patient's life. We have here, then, exposure to a poison, its introduction locally, a period of incubation, a characteristic local appearance at the seat of inoculation, a change in the constitution of the individual, and protection from another attack for a variable period. So with syphilis. The syphilitic poison is introduced at the seat of an accidental abrasion either on the genital organs or on any part of the surface of the body. The poison lies quiescent for a variable period. The average period is four weeks. A characteristic cartilaginous hardness appears at the seat of inoculation. If this is irritated in any way, an ulceration takes place; but ulceration is an accident, not an essential. From the primary seat the system generally is infected. The virus is multiplied locally and, passing along the lymphatic vessels, attacks the nearest chain of lymphatic glands. If the original sore is in the genital organs, the glands in the groin are first attacked; if in the hand, the gland above the inner condyle of the humerus; if on the lip, the gland in front of the angle of the jaw. The affected glands are indurated and painless; they may become inflamed, just as the primary lesion may ulcerate; but the inflammation is an accident, not an essential. From the primary glands the mischief will affect the whole glandular system. The body generally is so altered that various skin eruptions, often symmetrical, break out. Any irritation of the mucous membrane is followed by superficial ulcerations, and in the later stages of the disease skin eruptions, pustular and tubercular in type, appear, and in weakly people in severe cases, or in cases that have not been properly treated by the surgeon, syphilitic deposits termed *gummata* are formed. These, if irritated, break down and give rise to deep-seated ulcerations. Gummata may attack the different organs in the body; the muscles, liver, and brain are the favorite sites. Their presence interferes with the functions of the organs, and, if the organ affected is one functionally important in the economy, may cause death. The individual is as a general rule protected against a second attack, although there have been rare cases recorded in which individuals have been attacked a second time.

Treatment of syphilis.

Syphilis is treated by many surgeons by giving careful attention to the general health, to diet and regimen and tonics, by placing the patient in the most favorable hygienic circumstances, in the belief that it runs a natural course and has a tendency to natural cure. Special symptoms are treated as they arise. Other surgeons administer small doses of mercury, in the form of gray powder, iodide of mercury, or corrosive sublimate. If the physiological effects of mercury are observed—tenderness of the gums and a metallic taste in the mouth—this treatment is desisted from and iodide of potassium is administered, mercury being given again when its physiological symptoms have disappeared. Oleate of mercury or mercurial ointment, or mercury with lanoline, is applied to the primary lesion and rubbed in over the enlarged glands. This is continued for six months or a year. In the later stages of the complaint iodide of potassium is the main remedy used. There are, therefore, two distinct methods of treating syphilis,—the non-mercurial and the mercurial. Both methods have been extensively tried by the present writer, and he believes that the mercurial is infinitely preferable to the non-mercurial method. Recent investigations point to the value of corrosive sublimate as a germicide, and in all probability the good results which follow saturation of the system with mercury are to be explained in this way. It is said by the non-mercurialists that the administration of mercury masks the symptoms. There can be no doubt that the symptoms often appear after the mercury is stopped, but in a modified form, and there is no evidence that the mercurial treatment prolongs the disease. Syphilis has a tendency to natural cure, like all the continued fevers, and along with the administration of mercury careful hygienic treatment must receive particular attention, and often in weakly unhealthy people a long sea voyage is of great value. Any means which causes a free action of the skin, as, for instance, by periodic visits to thermal baths, is of great assistance in eliminating the poison.

Syphilis as commonly met with nowadays is not of so severe a type as it formerly was. One reason often given for this is that mercury was formerly always pushed until its full physiological effects were observed, and that the lowering of the patient's constitution by this severe treatment aggravated the primary complaint. There may be some truth in this explanation; but the principal reason in all probability is that the syphilitic organism does not now find so suitable a nidus or soil for its growth and development as it once did. Syphilis in the United Kingdom at the present moment is in the stage of an epidemic in its decline. This may be looked on as a startling statement; but it is true of syphilis as of all infective diseases. A time must come when the soil is practically worn out, when it becomes so poor that the organism grows only in a stunted form, producing a mild disease, till in time it ceases to grow altogether. It is not asserted that it will necessarily die out, because after lying fallow for a time the soil may recover its power and the disease be revived in a more virulent form, analogous to the luxuriant crop which follows after a period of fallow. Syphilis can be conveyed by the discharge from any syphilitic lesion occurring within two years after the commencement of the complaint. It cannot be conveyed by the normal secretions of the syphilitic person except in the case of the semen, which, impregnating the ovum in the female, causes the fœtus to be syphilitic. Syphilization of the fœtus is followed by syphilization of the mother. The blood of a syphilitic person is infectious for two years after the commencement of the attack. Pure vaccine lymph cannot convey syphilis; if, however, it is mixed with blood it may convey it. No person who has had syphilis should marry until he has been entirely free from the complaint for two, or better still for three, years. If a person marries before this time pregnancy greatly increases the risk to the mother. If there is any suspicion of syphilis the mother should take mercury during the period of pregnancy. It is interesting to note how time has a modifying influence in a case of repeated pregnancies occurring in a syphilitic woman. At first there may be miscarriage in the early stage of pregnancy; after a time abortions in the later stage; there may then be a still-born child; then one born alive but syphilitic; then a child born apparently healthy but soon becoming syphilitic; and ultimately a healthy child is born and remains healthy, showing no evidence of syphilitic disease. The disease has worn itself out. The relation of apparently healthy people born of syphilitic parents to syphilis acquired during the course of their life may explain those remarkable cases of escape from syphilitic infection which constantly come under the observation of the surgeon.

5. *Tumors.*[1]

Cause of tumors.

As the result of a local irritation an acute inflammatory swelling may appear. If the irritant is of a severe type the result may be local death. An abscess may form; and, after the pus has escaped or has been evacuated, and after the original cause of the irritation has subsided, the swelling may disappear and the parts be restored to a condition nearly allied to the normal. If the irritant, however, is slight and its action prolonged, a chronic inflammatory swelling of the part may result. Although in many cases with appropriate treatment the induration disappears, in other cases it persists during the life of the individual. The indurated mass in its microscopic characters closely resembles the original anatomical characteristics of the part affected. When, for example, an organ like a gland is the seat of a chronic irritation a general increase in its size takes place. A hypertrophy or overgrowth has occurred, but as a rule the hypertrophied gland is only altered in size; it retains its general shape and functional activity. Occasionally the hypertrophic area is localized, and to a great extent separable from the original gland by a more or less distinct capsule. In the mammary gland, for example, a local hypertrophy may occur, the microscopic characters of which resemble imperfect gland tissue. Between this condition and an adenoid or glandular tumor of the mamma no distinct line of demarcation can be drawn, and the probability is that the adenomatous tumor of the mamma is caused by local irritation. It may be the immediate outcome of a misdirected or excessive functional activity. The great practical difference, however, between it and true hypertrophy is this, that it can only be removed by operation. The adenomatous tumor closely resembles in some of its microscopic characters one of the varieties of epithelioma, of which an increase in the columnar epithelium lining the acini in the gland is the main characteristic. This tumor is not a simple tumor like the true adenoma; it does not grow slowly; it is not encapsulated; the cellular elements in it not only invade the surrounding tissues but tend to pass into the lymphatic vessels and reach the lymphatic glands in the arm-pit, where they grow and form secondary tumors similar in microscopic characters to the original growth. From these secondary foci a further invasion may take place, and the cell elements may reach the blood-stream and be caught in the capillaries, forming there new growths, till the patient dies from the general implication of the whole system. This form of tumor has been termed a *malignant adenoma*. While it has originally the microscopic characters of a simple adenoma, if we look to its life history we have in it an excellent example of a malignant tumor. Microscopically it is a stepping-stone between the simple and the malignant type of tumor; clinically it is characteristically malignant. The mammary gland is composed of glandular tissue and fibrous tissue. A hyperplasia of the fibrous tissue may occur in consequence of an excessive irritation of the glandular tissue, or apparently a primary increase in the fibrous tissue may occur locally, giving rise to a simple fibrous tumor of the mamma, of which fully developed fibrous tissue is the microscopic characteristic. This overgrowth may become encapsulated and give rise to no symptoms except those referable to its gradual increase in size, and after the gland in which it lies has fulfilled its life history it may stop growing, degenerate, and decay. In the uterus, *e.g.*, those fibrous tumors which occur after the time of child-bearing is past, after the uterus has fulfilled its destiny, cease to give any further trouble and are only inconvenient in consequence of their size. Fibrous tissue in the early stages of its development is largely composed of cell elements, and there are tumors, *e.g.*, in connection with the mamma, which have their prototype in the undeveloped or cellular stage of fibrous tissue. These tumors also are essentially malignant. They grow rapidly, and are richly supplied with thin-walled bloodvessels; the elements of the tumor pass directly into the blood-stream, and reach the capillaries, where they are arrested and where secondary growths like the original growth in their anatomical characteristics are formed, causing the death of the patient.

Various forms of tumor.

In what has just been said it will be seen that there is no distinct line of demarcation between the inflammatory swelling and the hypertrophy, between the hypertrophy and the tumor proper, between the simple and the malignant tumor. The local irritation can be traced in the case of the inflammatory swelling and the hypertrophy, and it is highly probable that both the simple and the malignant tumor are also due to local irritation. It must, however, be acknowledged that it cannot always be traced. If the malignant tumor is not due to local irritation, but to a general dyscrasia or peculiarity of the patient, the surgeon has slight grounds for recommending its removal. If, however, he believes that all tumors are evidences of local irritation, he is fully justified in recommending their early and complete removal—in the case of the malignant tumors before they have time to spread by the lymphatic or blood-stream to distant parts, in the case of simple tumors before they have assumed characteristics of malignancy, as these tumors sometimes do. The mammary gland has been taken as an example of an organ in which tumors frequently occur. The reason for this frequency, if we believe in local irritation as a cause of tumor-growth, is not far to seek: from the time of puberty to the time when it terminates its functional activity this gland is in a constant state of vascular unrest and functional change. Both forms of tumor are met with in all the organs and tissues of the body. Simple tumors are generally composed of fully developed tissue, similar to the tissue in which they lie, the simple fatty tumor occurring in connection with fatty tissue, the simple fibrous tumor in connection with fibrous tissue, the osseous tumor in connection with bone. The malignant tumor, on the other hand, is generally formed of undeveloped tissue which has not yet fulfilled its destiny, which is not only misplaced in situation but in time. The cartilaginous tumor has its prototype in cartilage, for that which covers the ends of the long bones and enters into the formation of a joint is a fully developed tissue. The true prototype of the cartilaginous tumor is not, however, fully developed cartilage, but one or other of those forms of cartilage which, as regards their developmental position, are intermediate between fibrous tissue and bone, and therefore the cartilaginous tumor has frequently a life history more closely allied to the malignant than to the simple type of tumor formation.

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[1] Compare PATHOLOGY, vol. xviii. p. 377 *sq.*

No attempt can here be made to classify the different forms of tumor. The surgeon at the bedside meets with tumors as living parasitic formations. He studies their life history; he observes their birth, their growth, their peculiarities, and their tendencies; he naturally attempts to classify them from a study of their physiological or clinical aspects. The pathologist, on the other hand, examines the tumor after it is removed; he studies it as it appears to the naked eye and under the microscope; and he attempts to classify tumors from an anatomical standpoint. Within recent years the pathologist's classification, associated with a recognition of the developmental division of the human embryo into different layers, has become the favorite; but it is hoped that, as science advances, the increase of clinical knowledge, assisted by microscopic and embryological research, will make a physiological classification a reality.

IV. OPERATIVE SURGERY.

Range of surgical operations.

Conservative surgery.

Modern surgical procedure.

Within recent years the main advance in surgery has been from the scientific side, due to increased precision in physiological knowledge and a careful study of the relation of organisms to various diseased conditions. And with this progress operative skill, in many directions previously unthought of, has kept pace. Cranial operative surgery has advanced as the motor areas on the surface of the brain have been localized with greater precision. The experimental physiologist has done his part; the clinical observer is now doing his. Cranial surgery necessitates special notice. In the thoracic cavity also diseased conditions are now relieved by surgical operations. The greatest advance of all, however, is in connection with the abdominal cavity. Under this head the work of the last thirty years requires special notice. The peritoneum was at one time considered a closed book to the operator; now all is changed, and abdominal surgery has become one of the most important branches of operative work. Joints in a state of inflammation are also now freely opened and tension is relieved. With the relief of tension the inflammatory process subsides and the joint recovers. The excision of diseased joints has also become part of the everyday work of the surgeon. Cancerous affections—using the term in a clinical sense —of the tongue, rectum, and larynx are now treated by excision of these organs. But it is still a question in what cases the operation prolongs life, and what cases are specially suited for operation. While greater latitude has been given to surgical interference with the different cavities of the body, operations upon the limbs have been restricted in consequence of the acceptance of Lister's views with regard to wound treatment. Many limbs upon which formerly amputation was performed, as, for example, in the case of compound fractures, are now saved. The term "conservative surgery," which formerly had reference to the excision of a diseased joint instead of amputation of the affected limb, has now a wider meaning, and covers not only the different excisions which have taken the place of amputation but also those cases in which a limb is saved by careful antiseptic management after severe injury. At one time, perhaps, in the early stages of antiseptic wound treatment the brilliancy of the results obtained by these means, and the immunity which resulted from the prevention of blood-poisoning, encouraged surgeons to save a limb which, when the wound was healed, was not really useful. An upper limb saved, however inefficient, is better than any artificial substitute, and every endeavor in the direction of conservation should be made. Conservation in the case of a lower limb, on the other hand, may be carried too far. Unless the saved limb can support the weight of the body, it is far better to perform amputation, because a satisfactory artificial substitute can be found to take the place of the lower extremity. In performing amputation on a lower limb every endeavor should be made to obtain a stump which will bear, in part at any rate, the weight of the patient's body. Since the introduction of anæsthetics rapidity in performing an amputation is not essential. Flaps can be carefully made; time can be taken to shape them; and they can be so arranged that the resulting cicatrix will not be opposite the sawn extremity of the bone. In order to obtain such flaps the surgeon is justified in sacrificing to some extent the length of the limb, if by so doing he can leave a mobile and painless stump on which an artificial limb can be comfortably fitted. But this does not hold good to the same extent for an upper limb. The pressure on the extremity is not so great, and the longer the stump the more easily can an artificial substitute be fitted on. As a result also of Lister's teaching operative procedure for the cure of various deformities, such as knock-knee, rickets, and club-foot, in which the bones affected are freely attacked, has done much to relieve unsightly deformity and increase the usefulness of the individual. In all operations absorbable catgut ligatures for the cut vessels have since about 1861 taken the place of silk, which had to come away by ulceration,—a destructive process antagonistic to rapid healing. Greater care is taken to save blood by emptying the part to be operated on before beginning the operation. Greater care is also taken to tie all bleeding points, so as to prevent reactionary hæmorrhage and the escape of blood between the surfaces of the wound, whereby healing is retarded. Free drainage by india-rubber and glass tubing, by absorbable tubes made of decalcified bone, by skeins of catgut acting by capillarity—all the outcome of an understanding of the local irritation and constitutional fever caused by tension—have done more than anything else to enable the surgeon to attain his triple object,—painlessness, rapidity, and safety in the healing of a wound. Lastly, the clear understanding of the term "antiseptic" in its fullest meaning, the knowledge of the power which the unirritated and healthy tissues have as germicidal agents, and the introduction of various antiseptic or rather antitheric substances, some of which destroy, some of which paralyze, those lowly organisms whose power for evil in an unhealthy tissue or an injured part is so great, contribute towards the same great end. By these means operations are to a great extent relieved of their dangers, and by anæsthesia, which prevents pain and suffering, they are robbed of their terrors. (J. C.)

1. *Cranial.*

The necessity for setting apart a distinct section of this article to deal separately with the region of the head does not depend upon any specialization in the principles of treatment peculiar to that region. The general laws of surgical procedure hold good here as elsewhere throughout the body; but they have to be exemplified in relation to a region so separated from others in its architectural and functional peculiarities as to call for special record and delineation. The surgeon has to deal with a most intricate series of considerations—anatomical, physiological, and psychic—in devising suitable treatment for abnormal conditions in this region; the inter-relation of cranial tissues and organs, their capital importance in the physical economy, and the position of some of them as the substrata of mental activities render any surgical interference a matter of great delicacy and grave anxiety. So much is this the case that it has been left for the most daring and the most modern surgeons to prove that this is a region to which

Function of the cranium.

Protective mechanism.

ordinary surgical rules may properly apply; and hence what must be here recorded is largely matter of quite recent history and to a large extent at variance with the doctrine of former epochs. The function of the cranium as a protective agent for the brain and the organs of special sense is strikingly shown by its architectural design. The proper discharge of this function is of paramount importance from the economic value of the cranial contents; and the demands upon it are the more exacting from the extreme delicacy of physical structure and the unstable physiological equilibrium present in the brain. Clothed externally by the densely resisting textures of the scalp, further protected by a layer of heat-deflecting hair, the cranium itself consists of a firmly welded bony casket of ovoid form, maintained in its balanced position upon the upright spinal column by a series of ligamentous and muscular bands. There is thus protection against the sun's rays and a general mobility that provides for the avoidance of impending blows. But the cranium has chiefly to receive and annul transmitted physical vibrations, the result either of blows upon the head or of those jars and oscillations, incidental to bodily movements, which would interfere greatly with the functions of the brain did they actually reach it. The function of the cranium in this respect has been fully described by Hilton,[1] who shows that special bony ridges are present in the skull which arrest vibrations and divert them into channels where their action is no longer deleterious. Three series of such buttresses descend from the vault to the base of the skull, where they converge in the region of the sella turcica at a point termed by Felizet "the centre of resistance," and where the terminations of the ridges come into immediate contact with the cartilage of the foramen lacerum medium or the lake of cerebro-spinal fluid which surrounds the anterior and posterior clinoid processes. The transmitted vibrations are thus annulled by transference to a liquid or a soft solid medium, and lose all further power. In addition to the special mechanism which mitigates the effect of considerable shocks and renders slight ones ordinarily imperceptible, there is a general elasticity of the skull which enables it to withstand great violence without material injury and so enhances its protective power. This elasticity is not uniformly present, but is much more developed in the bell-like vault than in the region of the base. The osseous texture also is much more brittle in the latter locality. When, therefore, such severe shocks are communicated to the skull as overcome its elasticity and its power of resistance, the fracture which ensues is found as a rule to involve the base much more seriously than the vault.

Effects of violence.

These physical qualities are of great importance as giving an index of the relative resisting powers of different parts of the skull, and as affording data that may assist in determining the position of a fracture from a study of the forces which caused it. Of such forces those that are closely circumscribed in their area of application produce strictly local effects, whilst diffuse blows produce their most marked effects at a distance from their point of application. The former fact needs no illustration; the latter has been made the subject of numerous researches in relation to the usual course of cranial fractures. From the results of these investigations three different etiological laws have been educed—(1) Saucerotte's law of *contrecoup;* (2) Aran's law of radiation; and, in special relation to fractures of the base of the skull, (3) Von Wahl's law of parallel cleavage. In its special sphere each of these laws probably holds true; but the sphere of each is a limited one and is dependent upon the local peculiarities of the skull already described.

Theory of contrecoup.

The theory of contrecoup is that a force produces its maximum effect at the opposite pole of the skull to the point of its application. That this law can have no general bearing is shown by the numerous cases in which the fracture bears no such relation to the force which causes it. In relation to a limited area of the vault, however, it appears to hold true; for isolated fractures of the base resulting from blows upon the vault are on record, but as these are the only fractures which this theory would explain, and as they are very rare, its range of action is very greatly curtailed.

Law of radiation.

Law of parallel cleavage.

Aran's law of radiation is that, starting from the point where the blow is received, a fissure traverses the walls of the skull in the direction of the base and spreads itself in that fossa of the base of the skull which corresponds to the part of the vault that is struck. Thus a diffuse blow on the frontal bone causes injury to the anterior fossa of the base, and blows upon the parietals or occipital bone cause similar injury to the middle or posterior fossa respectively. This law holds true of the great majority of fractures of the skull and will assist in localizing the course of a fracture when the part of the skull first struck can be recognized. But numerous cases of fractured base are on record in which no fissure can be traced leading from the point first struck; and from a study of these Von Wahl has concluded that fractures of the base, whether connected with fissured vault or isolated, are always parallel to the direction of the force which caused them. Thus blows upon the frontal and occipital regions cause longitudinal fissures of the base, in the temporal region oblique fissures, and in the mastoid region transverse fissures. An index of the probable direction of a fracture is thus obtained by observing the exact point of incidence of the blow which caused it, whether other evidences of localized injury to the cranial contents be forthcoming or not.

Symptoms of fracture.

Question of trephining.

The diagnosis of the presence of a fracture is often a matter of great difficulty, especially where the soft parts are still intact, and by their contused and swollen condition mask the true nature of the case. Apart from obvious external signs of injury, the following symptoms should lead to the suspicion of a fracture: bleeding from the mouth, nose, or ears; local ecchymoses or lacerations, as that of the membrana tympani; circumscribed hæmorrhages, as under the scalp or visceral conjunctiva; interference with the functions of the brain or special sense-organs, as aphasia, motor spasms or paralyses, blindness, deafness, an altered condition of the respiration or the pupils, slight unconsciousness or profound stupor. The immediate risks to life are from shock and compression, the latter due to depressed bony fragments or effused blood. The treatment of shock has already been alluded to (p. 715 above); that of compression consists in the early relief of pressure by trephining, with elevation of the depressed fragments and removal of the blood-clots, if the symptoms are advancing. These symptoms are increasing stupor, stertorous respiration (Cheyne-Stokes breathing), relaxation of sphincters,—the condition passing on to complete coma. In cases where pressure symptoms are not urgent (especially in young patients with elastic skulls) and in cases where no such symptoms are present, expectant treatment should be employed,—complete rest, local cooling applications, constantly applied, the exclusion of all stimuli to the special sense-organs or to the attention, and a careful watch for further symptoms. Should symptoms of compression appear and advance, or should slight symptoms already present become aggravated, immediate operative interference for the relief of pressure as above indicated must be resorted to, and in operating in this region it must be remembered that strict antiseptic precautions are essential, for in no region of the body—not excluding even the peritoneal cavity—are the effects of septic infection more disastrous and at the same time so hopeless of remedy.

Topographical areas of brain.

Localisation of function.

Relation of convolutions to surface of head.

Having thus alluded to the physiology and surgery of the cranial envelope, it remains to consider the corresponding aspects of the cranial contents. The older theory of Flourens and Hertwig, that all parts of the brain are equally concerned in producing its aggregate activities, has been displaced by the more recent theory of the localization of function. This theory is supported by the results of recent physiological and pathological investigations, the former carried on for the most part by Hitzig, Fritsch, and Ferrier, the latter by Broca and Meynert. The practical outcome of these researches—viz., an adaptation to the human brain of results obtained in that of the higher mammals, controlled by pathological observations on the human brain itself—is that the surface of the brain can be mapped out into a series of topographical areas, each of which occupies a definite relationship to some well-defined function—motor, sensory, or psychic—of the human economy. Of the areas connected with psychic activity little is at present known; they are generally believed to occupy the frontal lobes of the brain. In the parietal region grouped around the fissure of Rolando are the cortical areas connected with motor functions in the extremities, and around the horizontal limb of the fissure of Sylvius are arranged those concerned in general and special sensation. The results of these researches confirm the views of Hughlings-Jackson, who has conclusively demonstrated the cortical origin of those epileptiform seizures in which the motor phenomena are limited to particular groups of muscles. At the same time these results open a new field of anatomical and surgical inquiry, with the object of defining what relation the cerebral convolutions bear to external cranial landmarks, and of showing that circumscribed cortical disease or injury is capable of detection and relief. For practical purposes in the present state of our knowledge of cerebral physiology, the first part of the question limits itself to an exact delineation of the position of the fissures of Rolando and Sylvius in relation to well-known cranial landmarks. In regard to the position of the former several researches have been made, and its upper extremity has been localized at a point 2 inches behind the coronal suture in the mesial line by Broca, Turner, and Féré. For the purpose of its exact determination in the living subject, where the line of the coronal suture cannot always be detected, measurements have been made and formulæ for its localization devised by Giacomini, Lucas-Championnière, Hare, and Reid (see the literature cited below). The commencement of the fissure of Sylvius is situated 1¼ inches behind the external angular process of the frontal bone.

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[1] [John Hilton (1807-78), anatomist, surgeon at Guy's Hospital, President of the Royal College, wrote on Pain and Rest.—Am. Ed.]

Trephining for cortical disease.

As an outcome of these additions to our knowledge of accurate facts, a new branch of surgical procedure is now firmly established and already sufficiently supported by successful results, viz., trephining for the relief of cortical disease. Encouraging cases have occurred in the hands of Hughes Bennett and Godlee, Fraser and Chiene, and Victor Horsley. The last named presented to the British Medical Association meeting in 1886 three patients relieved by this operation from cortical lesions. As a result of wide experience in operating upon apes and upon human beings, Mr. Horsley accentuates the importance of employing the following precautions in operative interference: (1) thorough cleansing and disinfection of the scalp; (2) the use of chloroform as an anæsthetic, morphia having been previously given to reduce cerebral congestion and to obviate excessive hæmorrhage during the operation; (3) strict antiseptic precautions; (4) a semilunar incision through the soft parts; (5) the use of large trephines; (6) Macewen's method of replacing the bone in small fragments carefully purified. The occurrence of hernia cerebri signifies a failure in the antiseptic precautions, and a primary union of the integuments is a matter of the most extreme importance. In removing the tumor or scar-tissue the knife is preferable to the thermo-cautery.[1] (A. W. H.)

2. *Thoracic.*

Purulent collections in the pericardium and pleural sacs may be treated as ordinary abscesses by incision. In the case of the pleural cavity the pus may be evacuated through an opening made in the axillary line at the seventh costal interspace; but it is quite possible to empty it thoroughly at the fifth. A drainage-tube is inserted, protected by a broad flange, that it may not slip into the cavity, and strict asepsis should be secured. Should sepsis occur, the wound should be washed out, and a counter-opening made if necessary. As the lung, however, frequently will not expand, and a large cavity is therefore left to heal by granulation, with little chance of it ever getting filled up, surgeons have excised portions of the ribs in order to bring about a collapse of the chest wall and thus insure obliteration of the cavity. The second, third, fourth, fifth, and sixth ribs have been partially removed, together with a portion of the clavicle. It is better in young people to remove the periosteum also. Some surgeons cut away the thickened pleura as well. The possibility of opening into the pleural sacs and pericardium for the removal of tumors has been demonstrated by König and Küster, who have reported cases where growths in connection with the sternum and ribs were successfully removed. Special care was taken that as little air as possible should gain access to the pleural cavities. Attempts have also been made to tap and wash out vomicæ in the lung, but as yet operative interference in such instances is not fully established.

3. *Abdominal.*

Peritoneal wound treatment.

Modern surgery has made its greatest advance and has achieved its most signal triumphs in connection with operations performed in those cavities of the body which are lined by a synovial or serous membrane. The older surgeons did not dare to systematically attack the joints and the cranial, thoracic, and abdominal cavities; but the surgeon of to-day performs the most daring operations here with confidence, and is rewarded with a success which at first sight appears almost marvellous. The timid extraperitoneal manipulations of former days made use of in the treatment of hernia and kidney disease and in the formation of artificial anus, have now given way to systematic intraperitoneal modes of treatment, whereby we aim at the radical cure of hernia and bring disease affecting any of the abdominal viscera directly under our control. We have to consider the conditions under which wound treatment of the peritoneum is placed, and in what respect this portion of the human framework reacts upon injuries as compared with the general behavior. It is generally acknowledged that rest in the surgical sense, the factor necessary for healthy wound closure, is obtained by a condition of asepsis and fixation. Moreover, it is generally granted that tension as a condition of unrest is dangerous not so much in itself as in the character of the material that gives rise to tension; hence the extravasated serum and blood in a case of simple fracture give rise to comparatively little disturbance. The presence of ascites need not lead to fever. But once let sepsis gain entrance and the fermenting exudate is resented by the organism; violent attempts to throw it off are made; and forms of blood-poisoning more or less severe and variable ensue. In a severe injury of the extremities, say a compound fracture, the effused serum and blood-clot are not readily removed by the damaged lymphatic system, and, when that does act, sepsis having already occurred, the absorption of the putrid fluid does much harm. Fortunately the open character of the wound may allow the fœtid discharge to escape. In any case, the surgeon insures a good result when he makes use of splints, drainage, and antiseptics. He brings about local fixation, removes the excessive exudation, and so relieves the lymphatics and prevents sepsis. In the case of a penetrating abdominal wound, where the healthy peritoneum is injured, we have somewhat different conditions, mainly varying in degree. It must ever be borne in mind that here we open into a huge lymph-sac. The peritoneum consists of a sheet of vascular and lymphatic network, covered with epithelium and provided with stomata. It is easily injured, and then rapid effusion ensues. Like most vascular structures, however, it heals quickly with favorable surroundings, and, the source of irritation having been removed, it speedily returns to the normal. In comparison with the large absorbing surface the injured portion is but small, and the effusion thrown out at the seat of injury may readily enough be absorbed by the remainder of the healthy sac. So long as the rate of absorption equals that of effusion tension cannot exist. If, however, the nature of the fluid be of importance, it is evident that nowhere in the body is this more marked than in the case of the peritoneum, and here above all other parts must we preserve strict asepsis. This may be gained in various ways: (1) By drainage, in which case the surgeon carefully draws off from the pouch of Douglas any excess of fluid thrown out as the result of injury, until such time as the peritoneum itself has recovered its full absorbing power and the excessive secretion has ceased. (2) Where by careful sponging the operator so far relieves the peritoneum and then, closing the wound to prevent entrance of further sepsis, leaves the rest to nature. For, if we do permit a moderate septic inoculation, it is evident that the rapid change of fluid may prove inimical to the development of septic ferments and the contact of healthy tissue will finally render impossible the existence of organisms. The presence, however, of any accumulation of putrid effusion is at once resented by the peritoneum and an attempt by local peritonitis may shut off the collection, or even previous to any local reaction septic absorption may prove fatal, or again severe general peritonitis may kill the patient. (3) From the above we at once see how applicable the antiseptic system must be to the abdomen, and the most signal success has crowned attention to matters of detail in this respect. By means of antiseptics we can securely close the abdomen, resting assured that the peritoneum is perfectly capable of carrying off effusions due to our interference. Where we dread that oozing may complicate matters, the drainage-tube can in addition be employed, but the necessity for its use becomes less marked as the operator acquires experience. Abdominal surgery requires from beginning to end the utmost care, and it is well that specialists reached a high standard of success before the adoption of the antiseptic system, since various points have been formulated, all of which, however, are of minor importance compared with the one great end in view,

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[1] *Literature of Cranial Surgery.*—Percivall Pott, *Injuries of the Head;* Sir Astley P. Cooper, *Lect. on Surgery* (Tyrell), vol. i.; Sir B. Brodie, *Med. Chir. Trans.*, vol. xiv.; Hilton, *Lectures on the Cranium;* Felizet, *Recherches anat. et exper. sur les fract. du crâne*, 1873; Aran, *Arch. Gén. de Méd.*, 4th ser., vol. vi. p. 180; Saucerotte, *Mélanges de Chirurgie*, part i. p. 233, Paris, 1801; Von Wahl, "Fracturen der Schädelbasis," in *Volkmann's Series*, No. 228; Flourens, *Les propriétés et les fonctions du Système Nerveux*, Paris, 1824; Hitzig and Fritsch, in Reichert and Du Bois Reymond's *Archiv*, 1870; Hitzig, "Ueber den heutigen Stand der Frage von der Localisation," in *Volkmann's Series*, No. 112; Ferrier, *Functions of the Brain*, 1876, and *West Riding Reports*, vol. iii., 1873; Hughlings-Jackson, *Lond. Hosp. Rep.*, 1864, and *Clin. and Phys. Researches*, 1873; Broca, *Sur la topographie crâniocérébrale*, 1876; Turner, "Relations of Convolutions to Skull and Scalp," in *Jour. Anat. and Phys.*, 1873; Giacomini, *Topografia della Scissura di Rolando*, 1878; Lucas-Championnière, *La trépanation guidée par les localisations cérébrales*, 1878; Hare, *Jour. Anat. and Phys.*, January, 1884; Reid, *Lancet*, vol. ii., 1884, p. 539; Hughes Bennett and Godlee, *Brit. Med. Journ.*, May, 1885; Victor Horsley, *Brit. Med. Journ.*, vol. ii., 1886, p. 670 [also *Amer. Jour. Med. Sciences*, April, 1887, p. 342].

—that of asepsis from first to last. The utmost care should be taken to ascertain the general bodily condition of the patient, to see that the kidneys are healthy, and to select an anæsthetic suitable to the requirements of the case. The temperature of the room, the clothing during operation, rapid dexterous manipulation, and preventives against hæmorrhage require the utmost attention. The patient should be prepared by having had low diet and gentle purgatives for a few days prior to surgical interference, so that rest of the intestinal tract may readily be assured. As a material for ligature fine silk Chinese twist, of various sizes, may be employed. It must be carefully disinfected by boiling, and is readily preserved pure in a five per cent. solution of carbolic acid. The ends should always be cut short. It possesses certain advantages over catgut.

In reviewing the field of abdominal surgery we must study shortly the methods and results gained by ovariotomy, removal of the uterine appendages (ovaries, Battey; tubes, Tait), hysterectomy, myotomy, removal of fibroid tumors of the uterus, intraperitoneal operations on the kidney, liver, spleen, intestinal tract, including stomach, pylorus, duodenum, small and large intestine. Finally, attention should be given to the extraperitoneal operations for sarcoma and disease of the kidney and intestine.

Ovariotomy.

From 1701, the date when Houston of Carluke, Lanarkshire, carried out his successful partial extirpation, progress was arrested for some time, although the Hunters (1780) indicated the practicability of the operation. In 1809 Ephraim M'Dowell[2] of Kentucky, inspired by the lectures of John Bell, his teacher in Edinburgh, performed ovariotomy, and continuing to operate with success established the possibility of surgical interference, and was followed in the United States by many others. The cases brought forward by Lizars of Edinburgh were not sufficiently encouraging; the operation met with great opposition; and it was not until Clay, Spencer Wells, Baker Brown, and Keith began work that the procedure was placed on a firm basis and regarded as justifiable. Improved methods were introduced, and surgeons vied with one another in obtaining good results, until by the introduction of the antiseptic system of treating wounds this operation, formerly regarded as one of the most grave and anxious in the domain of surgery, has come to be attended with a lower mortality than any other of a major character. We may now briefly outline the mode employed in operating. The room should be well heated, be free from draughts, have a good light, and above all a pure atmosphere. The patient is secured to a firm table and well protected with blankets. Anæsthesia having been obtained, the state of the bladder being known, and the urine drawn off if thought necessary, the surgeon purifies the integument with carbolic acid five per cent. solution, attending specially to the region of the umbilicus and pubes, which latter should be shaved. A large perforated waterproof sheet may be spread over and secured to the body, through which the more prominent part of the tumid abdomen protruding presents a localized field for manipulation; this also protects adjoining parts and obviates unnecessary exposure. An incision 2 or 3 inches in length in the linea alba and midway between the umbilicus and the symphysis pubis carries the surgeon down to the interval between the recti; bleeding points are seized with pressure forceps; and by a further use of the knife the subperitoneal fat is exposed, the peritoneum divided, and its free edges seized with forceps. The operator next introduces his finger and with the scissors enlarges the wound downwards or upwards on the left side of the umbilicus if necessary. The entire hand is then introduced between the parietal peritoneum and the tumor and swept around so as to ascertain the condition of affairs, and even to separate gently slight adhesions. A few sponges are next packed round the exposed tumor surface, which serve to keep the intestines and omentum out of the way and to retain any tumor content which may escape during tapping. With a large trocar, aided perhaps by an exhausting jar, the contents are drawn off, and, as the tumor collapses, its folds may be caught by forceps and the whole sac gradually pulled outside the abdomen. The pedicle is clamped by strong forceps; the tumor is cut off; the stump of the pedicle is carefully ligatured, the clamping forceps removed, the peritoneum carefully sponged out, more especially the pouch of Douglas, the ligature cut short, and the pedicle dropped into the cavity of the abdomen. At this stage the forceps and sponges are counted, a definite number being always employed, and, their tale being perfect, the surgeon proceeds to close the wound. For this purpose his needle traverses the entire thickness of the parietes from peritoneum to skin; the stitches should be about one-third of an inch apart, and closer apposition is gained by secondary sutures, which go through the integument alone. A dressing is now applied, and for the next few days the patient gets little else than occasional spoonfuls of hot water and milk, unless brandy be necessary, until she passes wind, after which time the usual diet is gradually resumed. It is necessary that the most precise precautions be taken against septic infection. The sponges are steeped in a five per cent. solution of carbolic acid, then dipped in boiling water, and squeezed dry immediately before use. Should the contents of the cyst be too viscid to run through the trocar, the contents of the sac must be pulled out with the hand. Adhesions to various organs must be dealt with by careful separation and ligature. Rents in the peritoneum should be stitched up with fine catgut, and some operators also stitch over the stump of the pedicle, or bury it in a bared portion of the adjacent broad ligament, so that it may not contract adhesions. While the great majority of surgeons are at one as regards the use of antiseptic precautions, they do not agree as to the use of the spray. Many dispense with it altogether. Some employ it in the room prior to the operation. A few surgeons also, without availing themselves of the antiseptic system appear to obtain as good, if not better, results than their fellows. It may also be noted that the antiseptic in use by different operators varies, and that, while the pedicle is usually ligatured, Keith attaches great importance to the clamp and cautery introduced by Baker Brown. The drainage-tube is not now so frequently employed as formerly. The statistical results show an increasing success in the case of every surgeon. Spencer Wells tells us that in his first five years one patient in three died, in his second and third five years one in four, in his fourth five years one in five, in 1876–77 one in ten, since the introduction of antiseptics (complete Listerism), 1878–84, 10.9 per cent.,—the last series showing a marked absence of septic fatality. Keith in 1884 reported a mortality of 9.11; formerly, when using the spray, he once had a successful consecutive series of 80. Koeberle up to 1878 had performed 300 operations, of which 231 had a favorable result. Of 300 patients operated on by Schroeder up to 1882 258 recovered; in the last hundred cases there were only 7 deaths. Other figures are—Knowsley Thornton, 423 cases, 40 deaths; Tait, 405 cases, 33 deaths, and in 1885 (including parovarian cysts) 139 cases, no deaths; Olshausen (1885), 293 cases, 27 deaths (in the last hundred only 4 deaths).[1]

Removal of uterine appendages.

Removal of the uterine appendages, the ovaries and Fallopian tubes, is performed for three distinct conditions—(1) for disease, when the tubes are the seat of inflammatory changes and distended, or when the ovaries are the seat of cystic and cirrhotic changes; (2) for fibroid tumors, in which case by operating we hasten the menopause and bring about involution; (3) in cases where dysmenorrhœa is wearing out and rendering useless the life of the patient, and where less severe treatment is ineffectual. Oophorectomy, by which we mean removal of the ovaries only, was introduced by Battey of Georgia in 1872. It is now replaced by the more extensive procedure of Lawson Tait, sapingo-oophorectomy. The operation is sometimes followed by loss of sexual feeling and has been said to unsex the patient, hence strong objections have been urged against it. The patient and friends should clearly understand the object and results likely to be gained. According to Angus Macdonald, "as soon as we are certain that the ovaries or tubes are distinctly diseased and are not likely to yield to our ordinary methods of treatment . . . . . we are bound to at least inform our patient of the possibility of relieving her by operation. The operation presents greater difficulties and is associated with a higher mortality than ovariotomy." The greatest care must be taken in making the initial incision for fear of wounding the bowel. The organs are not uncommonly deeply placed and have contracted adhesions. Every trace of ovarian tissue should be removed along with the tubes and the ligatures must be carried close up to the uterus. The stitches should be placed closer, since the tendency to hernia is greater.

Hysterectomy.

In cases of fibroid tumor—myoma—the surgeon must be largely guided by the condition of the patient and the new growth as to whether removal of the uterine appendages is sufficient. If it is not and the patient is in such danger that the next period threatens life, he had better proceed to hysterectomy or entire removal of the uterus and appendages. When we consider the circumstances under which this operation is performed, the weakly anæmic state of the patient, the size of the tumor, and the rapidity with which procedure should be conducted, we must regard hysterectomy as one of the gravest in the domain of surgery. There is, moreover, a special danger which does not obtain in ovariotomy,—the risk of septic poisoning. Since we cut into the canal of the uterus, it is obvious that we open into a septic cavity, and it is impossible merely to ligature and drop the pedicle, since by doing so we should court failure. The surgeon, having made a way into the peritoneum, seizes and ligatures adhesions, projects the tumor through the wound, clamps the pedicle (cervix uteri), removes the tumor and uterus, and closes the wound, leaving the clamped pedicle protruding. It is advisable to scoop out the septic central canal of the pedicle and carefully to pare away surplus tissue, and as dressing to have a plentiful supply of some potent non-irritating antiseptic in contact with the stump. If we take care that the septic focus is removed without coming in contact with its surroundings, if we keep the stump aseptic and dry, there will be little fear of septic fluid trickling down the side of the pedicle and causing sepsis, peritonitis, or blood-poisoning. Attempts have been made, by careful disinfection of the stump, paring its centre, careful ligature, and stitching its raw surfaces together, to treat the pedicle by dropping it into the abdomen as in ovariotomy, but as yet with no marked success. The results of hysterectomy in the hands of Keith (33 cases, 3 deaths, in 1885) stand unrivalled. Similar principles guide the performance of cæsarean section and Porro's operation.

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[1] [The size of ovarian cysts may be very great. Spencer Wells has successfully removed one which, with its contents, weighed 125 lbs.; Keith, one weighing 120 lbs.; and Kelly, of Philadelphia, one of 116 lbs. See *Amer. Journal Obstet. and Dis. of Women and Children*, vol. xviii., Aug., 1885.—AM. ED.]

[2] [This Virginian (1771-1830) settled at Danville and was very successful in lithotomy.—AM. ED.]

Removal of gall-bladder;

spleen;

kidney;

Affections of the liver and gall-bladder have also been treated by laparotomy. In the latter case an incision is made over the swelling, and the gall-bladder, having been exposed, may be removed or explored, gall-stones cleared out, the walls stitched to the sides of the abdominal wound, and a drainage tube inserted as occasion requires. The spleen has also been attacked. In removal of the entire organ special care must be taken that none of the larger veins give way during manipulation. Most careful ligation and subdivision of the pedicle is requisite. In recent years the surgery of the kidney has made gigantic strides. There are three modes of reaching the organ, each of proportionate value according to the nature of the case. (1) From the lumbar region. In this way we may open abscesses, remove calculi, and even extirpate if the kidney be not enlarged. Increased room may be obtained by removing the twelfth rib. By this method we gain sufficient and dependent drainage and we need not open the peritoneum. (2) As in ordinary laparotomy, making an incision in the middle line. This admits of our examining both organs and to a large extent determining the condition of each. We get free access and can more readily treat the pedicle of vessels and the ureter. We open into the peritoneal cavity and again divide the peritoneum; but our incisions are readily closed and we no longer dread interfering with this huge lymph-sac. For tumors of the kidney this method is clearly indicated. (3) Langenbuch has proposed making an incision along the outer border of the rectus, which is said to present advantages in certain cases.

portions of intestinal tract.

Since the advance of ovariotomy the possibility of removal of portions of the intestinal tract with a subsequent suture of the divided ends has been repeatedly demonstrated, and thus resections for disease of the pylorus and bowel have been successfully performed. In cases of gun-shot wound, laparotomy, arrest of hæmorrhage, careful cleansing of the peritoneum, and suture of the wounded gut is now the established practice. W. T. Bull, of New York, reports a recovery in a case where seven wounds in the gut were sutured. All laparotomies are founded on the type of ovariotomy; success depends on the fact that two opposed serous surfaces rapidly unite, and this fact must ever be borne in mind when we tear or injure the bowel and its coverings, or unite them. Sepsis is the main disaster likely to attend our interference, but with the means at our disposal, washing out the peritoneum if necessary, we should be able to obviate this.

In regard to operations on the abdominal organs in which we do not interfere with the peritoneum it is sufficient to note that from the lumbar region we can reach the colon, where it is uncovered by serous membrane, the kidney, and retroperitoneal tumors.[1] (F. M. C.)

4. *Deformities.*

(1) For club-foot, see vol. vi. p. 41.

Knock-knee, etc.

(2) During the last few years, in consequence of the safety with which bones may be divided, other deformities such as knock-knee or *genu valgum* and bow-leg or *genu varum*, have been remedied by operation. Drs. Macewen of Glasgow, Ogston of Aberdeen, Schede of Hamburg, and the present writer have been working at this subject and have devised, more especially in knock-knee, various methods of remedying the deformity. Operations are only justifiable when the deformity has become chronic. During the advancing stage, when the deformity is getting worse, when the bones are still cartilaginous and plastic, the evil can be remedied by mechanical means. This statement may be best illustrated by a short consideration of the development of the lower limbs and the changes which normally take place. At birth all children are more or less bandy-legged. The child lies on its nurse's knee with the soles of the feet facing one another; the tibiæ and femora are curved outwards; and, if the limbs are extended, although the ankles are in contact, there is a distinct space between the knee joints. During the first year of life a gradual change takes place. The knee joints approach one another; the femora slope downwards and inwards towards the knee joints; the tibiæ becomes straight; and the sole of the foot faces almost directly downwards. While these changes are occurring, the bones, which at first consist principally of cartilage, are gradually becoming ossified, and in a normal child by the time it begins to walk the lower limbs are prepared, both by their general direction and by the rigidity of the bones which form them, to support the weight of the body. If, however, the child attempts either as the result of imitation or from encouragement to walk before the normal bandy condition has passed off, the result will necessarily be either an arrest in the development of the limbs or an increase of the bandy condition. If the child is weakly, either rachitic or suffering from any ailment which prevents the due ossification of the bones, or is improperly fed, the bandy condition may remain persistent. As a rule, however, in children that are precocious as regards walking, if proper care is taken the bandy condition will disappear, without any special treatment. In a healthy child who does not attempt to walk until the limbs are prepared to support the weight of the body, no further abnormal change takes place. But in a weakly child in whom the development already described has occurred, in whom the limbs as regards their general direction are prepared for the support of the body, but in whom the bones forming the limbs are not sufficiently ossified, as in the rachitic child, the shafts of the femora above the knee and the shafts of the tibiæ below the knee bend forwards; at the same time a change takes place at the knee joint,—the condition called *knock-knee.* In the normal limbs, the tibiæ being vertical and parallel, and the distance between the upper extremities of the femora being greater than that between their lower extremities, the femora necessarily slope inwards towards the middle line, and there is therefore in every properly developed person an angle at the knee joint. If at this stage the bones are sufficiently rigid to bear the weight of the patient, no further change takes place; but, if the limbs give way and are not sufficiently strong, the normal angle at the knee joint increases and the internal lateral ligament of the knee joint becomes stretched,—the result being knock-knee. The condition may be arrested in its earliest stage by an improvement in the general health of the child; but, if no such improvement takes place, and if the child is allowed to walk, then definite changes occur in the bones which form the knee joint. These changes are the direct outcome of a general law, namely, that diminished pressure results in increased growth, increased pressure in diminished growth. The best example of the former principle is the rapid growth that takes place in a child that is confined to bed during a prolonged illness. The distorted, stunted, shortened, and fashionable foot of the Chinese lady is an example of the latter. In the knee joint there is diminished pressure between the internal condyle of the femur and the inner condyle surface of the tibia; there is increased pressure between the external condyle of the femur and the outer condyle surface of the tibia. The result is an increased growth of the internal and a diminished growth of the external condyles; the knock-kneed condition is intensified, and will go on as long as the primary cause is at work, getting worse and worse, and will only cease when the bones become fully developed. As long as the disease is getting worse, the application of a rigid splint to the outer side of the limb fixed at the foot and at the upper part of the thigh, and the arrangement of an elastic bandage so as to draw the limb towards the splint, the person being kept in the horizontal posture, will cause a diminution in the pressure on the external condyles followed by their increased growth, and by an increased pressure on the internal condyles followed by a diminished growth. This effect may be obtained by applying a weight to the limb; and by mechanical means founded on this general law cases of

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[1] The literature of abdominal surgery is very extensive. The most complete lists will be found in Olshausen's "Die Krankheiten der Ovarien," in *Die deutsche Chirurgie*, 1866, and in Hart and Barbour's *Manual of Gynæcology*.

knock-knee that are getting worse can be improved. At first there is an arrest in the abnormality, which is soon followed by improvement. The different methods that have been recommended for division of the bones are only necessary in those cases in which they have become permanently distorted.

Spinal curvature.

(3) Lateral curvature of the spine is a deformity which occurs during the developing period of life before the bodies of the vertebræ are fully ossified. In young people who are growing rapidly, and whose muscular system is weak, any bad habit, as for example, that of standing and throwing the weight of the body constantly on one leg, gives rise to a drooping of the pelvis on one side; or, if, when writing at a desk, they are allowed to sit in a twisted position, a lateral curvature of the spine takes place. By constant indulgence in these bad habits the cartilaginous spinal column gets set in an abnormal direction. In the concavity of the curve there is increased pressure and necessarily diminished growth, in the convexity of the curve diminished pressure with increased growth. The patient's friends will probably notice first the right scapula being pushed backwards by the underlying ribs, which from their close attachment to the dorsal vertebræ participate in a rotatory movement occurring in the vertebræ themselves, and, unless means are taken to alter the abnormal distribution of pressure, the condition will become worse and worse, until complete ossification checks the progress of the deformity. The commonest curvature is one in which there is a dorsal convexity towards the right, with the right shoulder higher than the left. Compensatory curves in the opposite direction form in the lumbar and cervical regions. Along with the lateral curvation a rotation of the bodies of the vertebræ towards the convexity of the curve takes place; their spinous processes necessarily turn towards the concavity of the curve. Since the line of the spinous processes of the vertebræ can be easily traced through the skin, their deviation may mislead the superficial observer as to the true direction in which curvature has taken place. As the lateral curvation occurs the articular facets along the line of the concavity are pressed together, the line of these facets being posterior to the bodies of the vertebræ and their intervening elastic intervertebral disks. The result of this is that the vertebral column as a whole cannot fly away towards the convexity. The anterior parts of the bodies, being farthest away from the fixed point, are least restrained from movement, and they pass away to a greater extent than the posterior parts. The result is a rotation of each vertebra in the direction indicated. To counteract this deformity in the earliest stages, the patient (generally a girl) should be encouraged to walk about with a book on her head, to retain which in position she must necessarily keep perfectly erect. Muscular exercises, to strengthen the muscles of the back, ought to be enjoined and superintended by the surgeon. During the intervals of rest she should lie upon her back on a firm board, and should carefully avoid taking any exercise which gives rise to weariness of the muscles; for, whenever the muscles become wearied, she will attempt to take up a position which throws the strain off them on to her ligamentous and bony structures. One of the best exercises is to lay the patient on her face, fix her feet, and encourage her to raise herself by using the muscles of the back. When the deformity becomes more marked the use of the trapeze should be prescribed. Hanging with her arms upon the trapeze, the weight of the lower limbs and pelvis will tend to straighten the spine as a whole, necessarily diminishing the increased pressure upon the cartilaginous bodies of the vertebræ towards the concavity, and increasing the pressure between the sides of the bodies towards the convexity. The tendency to rotation must be counteracted in another way. The pelvis being fixed, elastic bands attached to fixed points, one in front of the patient towards her left side, another behind her towards her right side, are to be grasped by her right and left hands respectively, the right arm passing in front of her body, the left arm behind it. When the patient stretches both hands simultaneously there will be an untwisting of the spine in a direction opposite to the abnormal rotation. In this description, the common curvature—namely, of the dorsal region towards the right—has been taken as a typical example to illustrate the treatment. When the dorsal curve is in the opposite direction, the untwisting of the curve must necessarily be in the opposite direction also. During the intervals of active treatment the patient must wear a rigid support, which in itself has no direct curative action, but will materially assist the treatment by preventing the good result obtained by the muscular exercises from being nullified. (J. C.)

SURINAM. See GUIANA, DUTCH, vol. xi. p. 223.

SURRENDER is a mode of alienation of real estate. It is defined by Lord Coke to be "the yielding up of an estate for life or years to him that hath an immediate estate in reversion or remainder" (Coke upon Littleton, 337b). It is precisely the converse of release, which is a conveyance by the reversioner or remainderman to the tenant of the particular estate. A surrender is the usual means of effecting the alienation of copyholds. The surrender is made to the lord, who grants admittance to the purchaser, an entry of the surrender and admittance being made upon the court rolls. Formerly a devise of copyholds could only have been made by surrender to the use of the testator's will, followed by admittance of the devisee. The Wills Act of 1837 now allows the devise of copyholds without surrender, though admittance of the devisee is still necessary. A surrender must since 8 and 9 Vict. c. 106 be by deed, except in the case of copyholds and of surrender by operation of law. Surrender of the latter kind generally takes place by merger, that is, the combination of the greater and less estate by descent or other means without the act of the party. It has been dealt with by recent legislation (see REMAINDER). In Scotch law surrender in the case of a lease is represented by renunciation. The nearest approach to surrender of a copyhold is resignation *in remanentiam* (to the lord) or resignation *in favorem* (to a purchaser). These modes of conveyance are now practically superseded by the simpler forms introduced by the Conveyancing Act, 1874.

Plate X.

SURREY, a metropolitan county of England, is bounded north by the Thames, which separates it from Berks and Middlesex, east by Kent, south by Sussex, and west by Hampshire. Owing to the fact that it includes a portion of London, it ranks fourth among the counties of England in point of population, but in point of size it is only the thirtieth, the total area being 485,129 acres, or 758 square miles.

The geological structure of Surrey is reflected in its varied and picturesque scenery, the charms of which are enhanced by the large proportion of ground still remaining uncultivated. The extent of common land is also very great, a circumstance which, from its proximity to London, must be considered as specially fortunate. The northern portion of the county, in the London basin, belongs to the Eocene formation; the lower ground is occupied chiefly by the London clay of the Lower Eocene group, stretching (with interruptions) from London to Farnham; this is fringed on its southern edge by the plastic clays or Woolwich beds of the same group, which also appear in isolated patches at Headley near Leatherhead; and the Thanet sands of the same group crop out under the London clay between Beddington, Banstead, and Leatherhead. The northwestern portion of the county, covered chiefly by heath and Scotch fir, belongs to the Middle Eocene group, or Bagshot sands: the Fox Hills and the bleak Chobham Ridges are formed of the upper series of the group, which rests upon the middle beds occupying the greater part of Bagshot Heath and Bisley and Pirbright Commons, while eastwards the commons of Chobham, Woking, and Esher belong to the lower division of the group. To the south of the Eocene formations the smooth rounded outlines of the chalk hills extend through the centre of the county from Farnham to Westerham (Kent). From Farnham to Guildford they form a narrow ridge called the Hog's Back, about half a mile in breadth with a high northern dip, the greatest elevation reached in this section being 505 feet. East of Guildford the northern dip

decreases, and the outcrop widens, throwing out picturesque summits, frequently partly wooded, and commanding widely variegated views, the highest elevation being Botley Hill near Titsey, 866 feet. The Upper Greensand or gray chalk marl, locally known as firestone, crops out underneath the Chalk along the southern escarpment of the Downs, and the Gault, a dark blue marl, rests beneath the Upper Greensand in the bottom of the long narrow valley which separates the chalk Downs from the well-marked Lower Greensand hills. Leith Hill of this formation, reaches a height of 967 feet, and from its isolated position commands one of the finest views in the south of England, the next highest summits being Hindhead Hill (894 feet) and Holmbury Hill (857 feet). The southern part of the county belongs to the Wealden formation of freshwater origin: the lower strata or Hastings beds occupy a small portion at the southeastern corner, but the greater part consists of a blue or brown shaly clay, amid which are deposited river shells, plants of tropical origin, and reptilian remains.

The whole of the county north of the Downs is in the basin of the Thames. Besides a number of smaller streams, its chief affluents from Surrey are the Wey at Weybridge, the Mole at East Moulsey, and the Wandle at Wandsworth. The Eden, a tributary of the Medway, takes its rise in the southeast corner of Surrey.

According to the agricultural returns for 1886, of the total area of the county 299,034 acres were under cultivation, 77,553 being under corn crops, 44,998 under green crops, 26,741 rotation grasses, 138,117 permanent pasture, 2547 hops, and 9078 fallow. There are considerable varieties of soil, ranging from plastic clay to calcareous earth and bare rocky heath. The plastic clay is well adapted for wheat, the most largely grown of the corn crops, occupying 29,694 acres in 1886, while barley, oats, and pease, which grow well on the loamy soils in different parts of the county, occupied respectively 15,439, 24,705, and 4587 acres, beans occupying 1872 and rye 1256. Of green crops there were 6432 acres under potatoes, 15,975 under turnips and swedes, 9995 mangolds, 860 carrots, 2660 cabbage, kohl-rabi, and rape, and 9076 vetches and other green crops. A considerable proportion of the area under green crops is occupied by the market gardens on the alluvial soil along the banks of the Thames, especially in the vicinity of London. The total area of nursery grounds in 1886 was 1466, and of market gardens 2953 acres. In early times the market gardeners were Flemings, who introduced the culture of asparagus at Battersea and of carrots at Chertsey, for which this district is still famous. The area under orchards in 1886 was 2144 acres. Rhododendrons and azaleas are largely grown in the northwestern district of the county. In the neighborhood of Mitcham various medicinal plants are extensively cultivated for the London herb-sellers and druggists, such as lavender, mint, camomile, anise, rosemary, liquorice, hyssop, etc. The calcareous soil in the neighborhood of Farnham is well adapted for hops, but this crop in Surrey is of minor importance. There is a considerable area under wood (42,974 acres in 1881). Oak, chestnut, walnut, ash, and elm are extensively planted; alder and willow plantations are common; and the Scotch fir propagates naturally from seed on the commons in the northwest of the county. The extent of pasture land is not great, with the exception of the Downs, which are chiefly occupied as sheep-runs. Dairy-farming is a more important industry than cattle-feeding, large quantities of milk being sent to London. The number of horses in 1886 was 9930, of which 3273 were unbroken horses and mares kept solely for breeding; of cattle 49,986, of which 24,869 were cows and heifers in milk or in calf and 8699 other cattle two years old and above; of sheep 87,658; and of pigs 25,172.

According to the latest (1873) landowners *Return* for England, Surrey was divided among 17,293 proprietors possessing 398,746 acres at an annual value of £2,285,814 [$11,109,056.04], in addition to which there were 40,037 acres of common lands. Of the proprietors 12,712, or nearly two-thirds, possessed less than one acre each, the total which they owned being 2861 acres. The average annual rental per acre of the land all over was about £5 14s. 9d [$27.88]. The following proprietors held over 5000 acres each: earl of Lovelace, 9958; crown, 7496; earl of Onslow, 6563; Sir W. R. Clayton, 6505; G. W. G. Leveson-Gower, 6368.

Manufactures.—The more important manufactures are chiefly confined to London and its immediate neighborhood (see LONDON, vol. xiv. pp. 841-2). There are paper-mills at Wandsworth, and along the valley of the Wandle there are snuff, drug, and copper mills. Calico bleaching and printing are carried on to a small extent in the same valley, and there are also a few silk mills and tanneries. Ropes, snuff, and drugs are likewise manufactured along the banks of the Mole. Woollen goods and hosiery are made at Godalming, and gunpowder is largely manufactured at Chilworth.

Communication.—In addition to the navigation by barges, steamers ply on the Thames as far as Hampton. The Basingstoke Canal from Basingstoke to the Wey at Weybridge crosses the northwest corner of the county, and the Surrey and Sussex Canal passes southwards from the Wey near Guildford to the Arun. Surrey is more completely supplied by railways than any other county in England, the London, Chatham, and Dover, the South-Eastern, the London, Brighton, and South Coast, and the London and South-Western Railways intersecting it by their main lines as well as by various branches.

Administration and Population.—Surrey contains 14 hundreds; the borough of Southwark (pop. 221,946), which has no municipal government, but for certain purposes is connected with the city of London; and the municipal boroughs of Godalming (2505), Guildford (10,858), Kingston-upon-Thames (20,648), and Reigate (18,662). A considerable portion (22,472 acres, with a population in 1881 of 980,522) is within the metropolitan district of London, in addition to which there are the following urban sanitary districts—Aldershot (20,155), Croydon (78,953), Dorking (6328), East Moulsey (3289), Epsom (6916), Farnham (4488), Ham Common (1349), Hampton Wick (2164), New Malden (2538), Richmond (19,066), Surbiton (9406), Teddington (6599), and Wimbledon (15,950). The county has one court of quarter sessions, and is divided into twelve petty and special sessional divisions. The central criminal court has jurisdiction over certain parishes in this county. The borough of Guildford has a separate court of quarter sessions and commission of the peace; the boroughs of Reigate and Kingston-upon-Thames have commissions of the peace; the borough of Southwark is included in the petty sessional division of Newington; and the borough of Godalming, in which the mayor and ex-mayor are magistrates, forms part of the petty sessional division of Guildford, the county justices having concurrent jurisdiction. The county contains 152 civil parishes, with parts of two others. It is shared among the dioceses of Canterbury, Rochester, and Winchester. Until 1885 the county for parliamentary purposes was divided into East, Mid, and West Surrey; it is now rearranged in six divisions, viz., Kingston, Mid (Epsom), North-East (Wimbledon), North-West (Chertsey), South-East (Reigate), and South-West (Guildford). The portion of Surrey formerly included in the borough of Greenwich was in 1885 included in the borough of Deptford (Kent); the borough of Guildford was disfranchised; one member was given to Croydon; and instead of the two metropolitan boroughs of Lambeth and Southwark the following fifteen constituencies (each returning one member) were created: Battersea and Clapham, constituting two divisions; Camberwell, embracing the divisions of North Camberwell, Dulwich, and Peckham; Lambeth, embracing the divisions of Brixton, Kennington, Lambeth North, and Norwood; Southwark, containing the divisions of Bermondsey, Rotherhithe, and Southwark West; Wandsworth; and Newington, with the divisions of Walworth and West Newington.

Since the beginning of the 19th century the population has increased nearly 600 per cent. From 268,233 in 1801 it had increased by 1821 to 399,417, by 1851 to 683,082, by 1871 to 1,091,635, and by 1881 to 1,436,899, of whom 683,228 were males and 753,671 females. The number of persons to an acre is 2.96 and of acres to a person 0.34. Within the last decade the increase has been 35.1 per cent.,—much greater than the increase in the general town population of England and Wales, which was 19.63 per cent., the increase in the whole population being only 14.34. Nearly two-thirds (980,522) of the population belong to the metropolitan district of London, but the suburbs of London extend practically throughout the greater part of the county, its increase in population being chiefly due to the building of residences for those who have business or professional interests in London.

History and Antiquities.—Notwithstanding its proximity to London, Surrey has been associated with few great events in English history. Roman remains have been discovered at Albury, Kingston, Titsey, Woodcote, and a few other places, but none are of much importance. On several of the hills there are remains of camps of either Roman or British origin. The Roman Stane Street from London to Chichester in Sussex passed by Kingston, Chessington, Leatherhead, Dorking (where its remains are specially well marked), Leith Hill, and Ockley. During the Saxon period Surrey was included in the dominions of the South Saxons, and afterwards of Wessex. Its name Surrey or "south kingdom" has apparently reference to its position south of London or south of the Thames. Kingston in Surrey was in 838 the seat of a witanagemot convened by Egbert; and after the capture of Winchester by the Danes it was from 901 to 978 the place where the Anglo-Saxon kings were crowned. Surrey was an earldom of Godwine; and after the conquest was bestowed on William de Warren, who had married Gundrada, supposed to have been a daughter of the Conqueror. From the time that the great charter was on 15th June, 1215, signed by King John at Runnymede near Egham the historical annals of the county are a blank, until the period of the Civil War, when a skirmish took place, 7th June, 1648, at Kingston.

The only ecclesiastical ruins worthy of special mention are the picturesque walls of Newark Priory, founded for Augustinians in the time of Richard Cœur de Lion; and the Early English crypt and part of the refectory of Waverley Abbey, the earliest house of the Cistercians in England, founded in 1128 by William Gifford, bishop of Winchester. The *Annales Waverlienses*, published by Gale in his *Scriptores* and afterwards in the Record series of *Chronicles*, are supposed to have suggested to Sir Walter Scott the name of his first novel. The church architecture is of a very varied kind, and has no peculiarly special features. Among the more interesting churches are Albury, the tower of which is of Saxon or very early Norman date; Beddington, a fine example of the Perpendicular, and containing monuments of the Carew family; Chaldon, remarkable for its fresco wall-paintings of the 12th century, discovered during restoration in 1870; Compton, which, though mentioned in Domesday, possesses little of its original architecture, but is worthy of notice for its two-storied chancel, and its carved wooden balustrade surmounting the pointed Transition Norman arch which separates the nave from the chancel; St. Mary's, Guildford, containing examples of Norman, Early English, Decorated, and Perpendicular, but is of interest chiefly for the grotesque carving on the corbels of the aisles and the colored medallions on the roof of the north chapel; Leigh, Perpendicular, possessing some very fine brasses of the 15th century; Lingfield, Perpendicular, containing ancient tombs and brasses of the Cobhams; Ockham, chiefly Decorated, with a lofty embattled tower, containing the mausoleum of Lord Chancellor King (d. 1734), with full-length statue of the chancellor by Rysbroeck; Reigate, chiefly Perpendicular, but with Transition Norman pillars in the nave; Stoke d'Abernon, Early English, with the earliest extant English brass, that of Sir John d'Abernon, 1277; and Woking, Decorated, with Early English chancel. Of old castles the only examples are Farnham, occupied as a palace by the bishops of Winchester, originally built by Henry of Blois, and restored by Henry III.; and Guildford, with a strong quadrangular Norman keep. Ancient domestic architecture is, however, well represented, the examples including Beddington Hall, now a female orphan asylum; the ancient mansion of the Carews, rebuilt in the reign of Queen Anne, but still retaining the hall of the Elizabethan building; Crowhurst Place, built in the time of Henry VII., the ancient seat of the Gaynesfords, and frequently visited by Henry VIII.; portions of Croydon Palace, an ancient seat of the archbishops of Canterbury; the gate tower of Esher Place, built by William of Waynflete, bishop of Winchester, and repaired by Cardinal Wolsey; Archbishop Abbot's hospital, Guildford, in the Tudor style; the fine old Elizabethan house of Losely near Guildford; Cowley House, Chertsey, originally of the time of James I., inhabited by the poet Cowley from the Restoration till his death; Smallfield Place, now a farmhouse, at one time the seat of Sir Edward Bysshe, garter king-at-arms; and Sutton Place, dating from the time of Henry VIII., possessing curious mouldings and ornaments in terra-cotta. Among the eminent persons specially connected with Surrey may be mentioned George Abbot, archbishop of Canterbury, the son of a cloth-worker in Guildford; Arthur Onslow, born at Merrow in 1691, who became member for Guildford and speaker of the House of Commons; Sir William Temple, who had his residence at Moor Park, where he died in 1699; Sir Nicolas Carew, beheaded for conspiracy in 1539, and other members of the family, who had their ancestral seat at Beddington; John Evelyn, the diarist, who was born at Wotton in 1620; Malthus, the political economist, who was born at the Rookery, near the same place, in 1766; William Cobbett, who was born near Farnham in 1766; Horne Tooke, who was born at Westminster, wrote his well-known book at Purley, and died at Wimbledon in 1812; the historian Gibbon, who was born at Putney in 1737, which was also the birthplace of Cromwell, the minister of Henry VIII.

See Topley's *Geology of the Weald* and Whitaker's *Geology of London Basin*, forming part of the *Memoirs of Geological Survey of United Kingdom*; *Surrey Archæological Collections*; Aubrey, *Natural History and Antiquities of Surrey*, 5 vols., 1718-19; Manning and Bray, *Hist. and Antiq. of Surrey*, 1809-14; Brayley, *Topograph. Hist. of Surrey*, 5 vols., 1841-46; Lysons, *Environs of London*, 5 vols., 1800-11; Baxter, *Domesday Book of Surrey*, 1876. (T. F. H.)

SURREY, Henry Howard, Earl of (1516?-1547), one of the leaders in the poetic movement under Henry VIII. that heralded the great outburst of the Elizabethan period. Of his personal life outside his poetry only the barest outline is known, and till comparatively of late even that outline was not free from confusion. Three different men—the grandfather of the poet, his father, and the poet himself—bore the title within a period of ten or eleven years; and at one time the poet was confounded with his grandfather, and supposed to have been present at the battle of Flodden (1513). He was not born till at least two years after that event. It was his grandfather who distinguished himself at Flodden under the title of the earl of Surrey, and was created duke of Norfolk as a reward for his services, surrendering the title of Surrey to his son, the poet's father, for his lifetime. Although the poet has always been most familiarly known as the earl of Surrey, he really held the title only by courtesy, succeeding to it on that footing in 1524, when his father became duke of Norfolk. In one of his poems he speaks of having passed "his childish years" at Windsor "with a king's son." This was Henry VIII.'s natural son, Henry Fitzroy, duke of Richmond, who was affianced to Surrey's sister, Mary, but died before he was out of his teens. It is sometimes said that the two were educated together at Windsor; but the sweet companionship to which the poem refers, when the two youth "hoved" in the large green courts "with eyes cast up into the maiden's tower," belongs to the last year of Fitzroy's short life. Whether or not Surrey was educated from literal childhood with a king's son, he was certainly educated with the care for literary culture which about that time became common in the households of English noblemen; and, as the fashion was, he was sent, after passing through Cambridge, to complete his education in Italy. The tradition that he made the tour of Europe as a knight-errant, upholding against all comers the superiority of his mistress Geraldine, has no extrinsic evidence in its favor. If Geraldine was, as is commonly supposed, Elizabeth Fitzgerald, a daughter of the earl of Kildare, she was but a child of seven or eight years when Surrey set out on his travels. The legend about his knight-errantry is probably only a sign of the extent to which his chivalrous personality and poetry fascinated the imagination of his own and the next generation. The eminence of the Howards at Henry's court was evidenced in many ways: in the festivities at the king's marriage with Anne of Cleves, Surrey was the leader of one of the sides at the tournament, and two years later his cousin, Catherine Howard, became the king's fifth wife. Surrey took an active part in the insignificant wars of Henry's later years, accompanied the expedition, led by his father, which ravaged the south of Scotland in 1542, and held a command in the French expedition of 1544. When the king's death was known to be near, the duke of Norfolk was suspected of aiming at the throne, and Surrey's own haughty and ostentatious manners countenanced the suspicion. A month before the king's death both were arrested and lodged in the Tower, and on the 13th January, 1547, Surrey was brought to trial for high treason. The main charge against him was that he had "falsely, maliciously, and treacherously set up and borne the arms of Edward the Confessor." His plea that the arms belonged to his ancestors was probably not accepted as an extenuation of the offence. A common jury found him guilty, and he was executed on Tower Hill on 19th January.

His poems, which had been one of the occupations of his crowded life, first appeared in print in *Tottel's Miscellany* in 1557. On the title-page of this memorable publication Surrey's name stood first, but this was probably in deference to his rank; Wyatt was the first in point of time of Henry's "courtly makers" (see WYATT). Surrey, indeed, expressly acknowledges Wyatt, who was several years his senior, as his master in poetry. Seeing, however, that their poems were first published in the same volume, many years after the death of both, their names can never be disassociated, and it must always be hard to say which was the leader in the various new and beautiful forms of verse which *Tottel's Miscellany* introduced into English poetry. Surrey's only unquestionable distinction as a metrician lies outside the *Miscellany:* his translation of the second and fourth books of the *Æneid* into blank verse—the first attempt at blank verse in English—was published separately by Tottel in the same year. But his sonnets (in various schemes of verse), his elegy on the death of Wyatt (in elegiac staves shut in by a final couplet), his pastoral poem (a lover's complaint put into the mouth of a shepherd), and his lyrics in livelier measures are all extremely interesting experiments, and served as models for more than one generation of courtly singers and sonneteers. In form as well as in substance Surrey and his compeers were largely indebted to Italian predecessors; most of his poems are in fact translations or adaptations of Italian originals. The tone of the love sentiment was new in English poetry, very different in its earnestness, passion, and fantastic extravagance from the lightness, gayety, and humor of the Chaucerian school. In this respect *Tottel's Miscellany* helped to educate the English muse for the triumphs of the tragic drama. Surrey's own contributions are distinguished by their copious and impetuous eloquence and sweetness.

SURROGATE[1] is a deputy of a bishop or an ecclesiastical judge, acting in the absence of his principal, and strictly bound by the authority of the latter. At present the chief duty of a surrogate is the granting of marriage licenses. Quite recently judgments of the arches court of Canterbury have been delivered by a surrogate. The office is unknown in Scotland, but is of some importance in the United States. In the State of New York the surrogate's court is a court of record, with jurisdiction over the administration of the personal estate of a deceased person and certain other matters. In New Jersey the surrogate is an official of the orphans' court, grants unopposed probates, etc.

SURVEYING.[2]

SURVEYING is the art of determining the relative positions of prominent points and other objects on the surface of the ground and making a graphical delineation of the included area. The general principles on which it is conducted are in all instances the same: certain measures are made on the ground and corresponding measures are protracted on paper, on a scale which is fixed at whatever fraction of the natural scale may be most appropriate in each instance. The method of operation varies with the magnitude and importance of the survey, which may embrace a vast empire or be restricted to a small plot of land. All surveys rest primarily on linear measures for direct determinations of distance; but these are usually largely supplemented by angular measures, to enable distances to be deduced by the principles of geometry which cannot be conveniently measured over the surface of the ground where it is hilly or broken. The nature of a survey depends on the proportion which the linear and the angular measures bear to each other; it may be purely linear or even purely angular but is generally a combination of both methods. Thus in India there are numerous instances of large tracts having been surveyed by the purely linear method, in the course of the revenue surveys which were initiated by the native Governments. The operations were conducted by men who had no knowledge of geometry or of any other measuring instrument than the rod or chain, and whose principal object was the determination of fairly accurate areas; their methods sufficed for this purpose and were accepted and perpetuated for many years by the European officers to whom the revenue assessments became intrusted after the subversion of the native rule. In India, too, there are extensive tracts of country which have been surveyed by the purely angular method, either because the ground did not permit of the chain being employed with advantage, as in the Himalayan mountains and hill tracts generally, or because the chain was considered politically objectionable, as in native states where it would have been regarded with suspicion.

Surveys of any great extent of country were formerly constructed on a basis of points whose positions were fixed astronomically, and in some countries this method of operation is still of necessity adopted. But points whose relative positions have been fixed by a triangulation of moderate accuracy present a more satisfactory and reliable basis; for astronomical observations are liable, not only to the well-known intrinsic errors which are caused by uncertainties in the catalogued places of the moon and stars, but to external errors arising from deflections of the plumb line under the influence of local attractions, and these of themselves materially exceed the errors which would be generated in a fairly executed triangulation of a not excessive length, say not exceeding 500 miles. The French Jesuits who made a survey of China for the emperor about 1730 appear to have been the first deliberately to discard the astronomical and adopt the trigonometrical basis. In India the change was made in 1800, when what is known as the Great Trigonometrical Survey was initiated by Major Lambton—with the support of Colonel Wellesley, afterwards Duke of Wellington—as a means of connecting the several surveys of routes and districts which had already been made in various parts of the country, and as a basis for future topography. This necessitated the inception of the survey as an undertaking calculated to satisfy the requirements of geodesy as well as geography, because the latitudes and longitudes of the points of the triangulation had to be determined for future reference,—as in the case of the discarded astronomical stations, though in a different manner,—by processes of calculation combining the results of the triangulation with the elements of the earth's figure. The latter were not then known with much accuracy, for so far geodetic operations had been mainly carried on in Europe, and additional operations nearer the equator were much wanted; the survey was conducted with a view to supply this want. Thus a high order of accuracy was aimed at from the very first. In course of time the operations were extended over the entire length and breadth of Hindustan and beyond, to the farthest limits of British sway; they cover a larger area than any other national survey as yet completed, and are very elaborate and precise. Thus, as triangulation constitutes the most appropriate basis for survey operations generally, a short account will be given of (1) the methods of the Great Trigonometrical Survey of India. This will be followed by accounts of

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[1] ["In American law. A term used in some States to denote the judge to whom jurisdiction of the probate of wills, the grant of administration and of guardianship is confided. In some States he is called surrogate, in others, judge of probate, register, judge of the orphans' court, etc. He is ordinarily a county officer, with a local jurisdiction limited to his county." (*Bouvier's Law Dictionary*.)—AM. ED.]

[2] [For a history of the United States Geological Survey see Vol. XXIX.—AM. ED.]

(2) traversing as a basis for survey, (3) levelling, (4) survey of interior detail, (5) representation of ground, (6) geographical reconnaissance, (7) nautical surveying, (8) mapping, (9) map printing, (10) instruments.

I. GREAT TRIGONOMETRICAL SURVEY OF INDIA.

General outlines.

1. *General Outlines.* — Primarily a network was thrown over the southern peninsula. The triangles on the central meridian were measured with extra care and checked by base-lines at distances of about 2° apart in latitude in order to form a geodetic arc, with the addition of astronomically determined latitudes at certain of the stations. The base-lines were measured with chains and the principal angles with a 3-foot theodolite, which, however, was badly damaged almost at the outset by an accident to the azimuthal circle. The signals were cairns of stones or poles. The chains were somewhat rude and their units of length had not been determined originally, and could not be afterwards ascertained. The results were good of their kind and sufficient for geographical purposes; but the central meridional arc —the "great arc"—was eventually deemed inadequate for geodetic requirements. A superior instrumental equipment was introduced, with an improved *modus operandi*, under the direction of Colonel Everest in 1832. The network system of triangulation was superseded by meridional and longitudinal chains taking the form of gridirons, and resting on base-lines at the angles of the gridirons, as represented in Fig. 1. For convenience of reduction and nomenclature the triangulation west of meridian 92° E. has been divided into five sections,—the lowest a trigon, the other four quadrilaterals distinguished by cardinal points which have reference to an observatory in Central India, the adopted origin of latitudes. In the northeast quadrilateral, which was first measured, the meridional chains are about one degree apart; this distance was latterly much increased, and eventually certain chains—as on the Malabar coast and on meridian 84° in the southeast quadrilateral — were dispensed with, because good secondary triangulation for topography had been accomplished before they could be commenced.

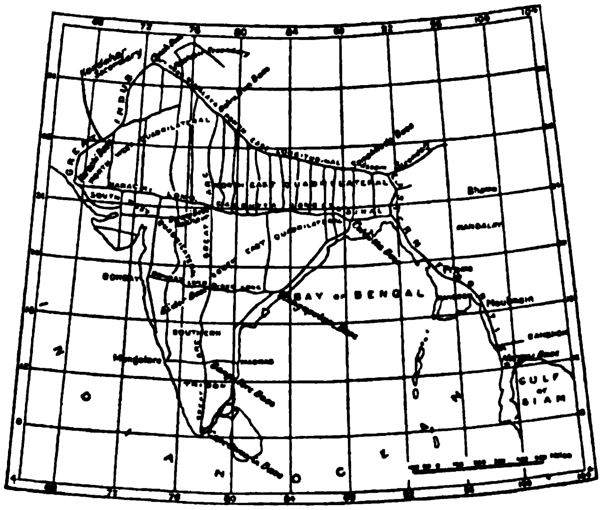

FIG. 1.

Base-lines.

2. *Modern Base-Lines.*—All these were measured with the Colby apparatus of compensation bars and microscopes. The bars, 10 feet long, were set up horizontally on tripod stands; the microscopes, 6 inches apart, were mounted in pairs revolving round a vertical axis and were set up on tribrachs fitted to the ends of the bars. Six bars and five central and two end pairs of microscopes—the latter with their vertical axes perforated for a look-down telescope—constituted a complete apparatus, measuring 63 feet between the ground pins or registers. For explanation of compensation see EARTH, FIGURE OF THE, vol. vii. p. 517–18. Compound bars are necessarily more liable to accidental changes of length than simple bars; they were therefore tested from time to time by comparison with a standard simple bar; the microscopes were also tested by comparison with a standard 6-inch scale. At the very first base-line the compensated bars were found to be liable to sensible variations of length with the diurnal variations of temperature; these were supposed to be due, not to error in effecting the compensation, but to the different thermal conductivities of the brass and the iron components. It became necessary, therefore, to determine the mean daily length of the bars very precisely, for which reason they were systematically compared with the standard before and after, and sometimes at the middle of, the base-line measurement throughout the entire day for a space of three days, and under conditions as nearly similar as possible to those obtaining during the measurement. Eventually thermometers were applied experimentally to both components of a compound bar, when it was found that the diurnal variations in length were principally due to difference of position relatively to the sun, not to difference of conductivity,—the component nearest the sun acquiring heat most rapidly or parting with it most slowly, notwithstanding that both were in the same box, which was always kept under the cover of a tent and carefully sheltered from the sun's rays. Happily the systematic comparisons of the compound bars with the standard were found to give a sufficiently exact determination of the mean daily length. An elaborate investigation of theoretical probable errors at the Cape Comorin base showed that, for any base-line measured as usual without thermometers in the compound bars, the *p.e.* may be taken as ± 1.5 millionth parts of the length, excluding unascertainable constant errors, and that on introducing thermometers into these bars the *p.e.* was diminished to ± 0.55 millionths.

In all base-line measurements the weak point is the determination of the temperature of the bars when that of the atmosphere is rapidly rising or falling; the thermometers acquire and lose heat more rapidly than the bar if their bulbs are outside, and more slowly if inside the bar. Thus there is always more or less lagging, and its effects are only eliminated when the rises and falls are of equal amount and duration; but as a rule the rise generally predominates greatly during the usual hours of work, and whenever this happens lagging may cause more error in a base-line measured with simple bars than all other sources of error combined. In India the probable average lagging of the standard-bar thermometer was estimated as not less than 0.3° Fahr., corresponding to an error of — 2 millionths in the length of a base-line measured with iron bars. With compound bars lagging would be much the same for both components and its influence would consequently be eliminated. Thus the most perfect base-line apparatus would seem to be one of compensation bars with thermometers attached to each component; then the comparisons with the standard need only be taken at the times when the temperature is constant, and there is no lagging.

Expansion of standard bar.

3. *Factor of Expansion of Standard Bar.*—This was first determined in 1832 by measuring the increment in length between temperatures of 76° and 212° Fahr.; in 1870 the increment between 52° and 96° was measured; the results indicated an increase of expansion with temperature. They were therefore combined on the empirical assumption that the expansion is the sum of two terms, —the first x times the temperature, the second y times

the square of the temperature; x and y were then determined from the two equations of condition given by the two sets of measurements. The resulting value of the expansion at 62° was found to be 5 per cent. less than the previously derived value at the mean temperature of 144°, thus showing the importance of employing a factor varying with the mean temperature of each base-line; and this was done in the final reductions.

Plan of triangulation.

4. *Plan of Triangulation.*—This was broadly a system of internal meridional and longitudinal chains with an external border of oblique chains following the course of the frontier and the coast lines. The design of each chain was necessarily much influenced by the physical features of the country over which it was carried. The most difficult tracts were plains of great extent, devoid of any commanding points of view, in some parts covered with dense forest and jungle, malarious and deadly, and almost uninhabited, in other parts covered with towns and villages and umbrageous trees,—the adjuncts and concomitants of a teeming population. In such tracts triangulation was impossible except by constructing lofty towers as stations of observation, raising them to a sufficient height to overtop at least the earth's curvature, and then either increasing the height to surmount all obstacles to mutual vision, or clearing the lines, both of which were laborious and expensive processes. Thus in hilly and open country the chains of triangles were generally made "double" throughout, *i.e.*, formed of polygonal and quadrilateral figures, to give greater breadth and accuracy; but in tracts of forest and close country they were carried out as series of single triangles, to give a minimum of labor and expense. Symmetry was secured by restricting the angles between the limits of 30° and 90°. The average side length was 30 miles in hill country and 11 in the plains; the longest principal side was 62.7 miles, though in the secondary triangulation to the Himalayan peaks there were sides exceeding 200 miles. Long sides were at first considered desirable, on the principle that the fewer the links the greater the accuracy of a chain of triangles; but it was eventually found that good observations on long sides could only be obtained under exceptionally favorable atmospheric conditions, which were of rare occurrence. The sides were therefore shortened, whereby the observations were much improved and accelerated. In plains the length was governed by the height to which towers could be conveniently raised to surmount the curvature, under the well-known condition, height in feet $= \frac{2}{3} \times$ square of the distance in miles; thus 24 feet of height was needed at each end of a side to overtop the curvature in 12 miles, and to this had to be added whatever was required to surmount obstacles on the ground. In Indian plains refraction is more frequently negative than positive during sunshine; no reduction could therefore be made for it.

Sites for stations.

5. *Selection of Sites for Stations.*—This, a very simple matter in hills and open country, is often very difficult in plains and close country. In the early operations, when the great arc was being carried across the wide plains of the Gangetic valley, which are covered with villages and trees and other obstacles to distant vision, masts 35 feet high were carried about for the support of the small reconnoitring theodolites, with a sufficiency of poles and bamboos to form a scaffolding of the same height for the observer. Other masts 70 feet high, with arrangements for displaying blue lights by night at 90 feet, were erected at the spots where station sites were wanted. But the cost of transport was great; the rate of progress was slow; and the results were unsatisfactory. Eventually a method of touch rather than sight was adopted, feeling the ground to search for the obstacles to be avoided, rather than attempting to look over them; the "rays" were traced either by a minor triangulation, or by a traverse with theodolite and perambulator, or by a simple alignment of flags. The first method gives the direction of the new station most accurately; the second searches the ground most closely; the third is best suited for tracts of uninhabited forest in which there is no choice of either line or site, and the required station may be built at the intersection of the two trial rays leading up to it. As a rule it has been found most economical and expeditious to raise the towers only to the height necessary for surmounting the curvature, and to remove the trees and other obstacles on the lines.

Principal stations.

6. *Structure of the Principal Stations.*—Each has a central masonry pillar, circular and 3 to 4 feet in diameter, for the support of a large theodolite, and around it a platform 14 to 16 feet square for the observatory tent, observer, and signallers. The pillar is carefully isolated from the platform, and when solid carries the station mark—a dot surrounded by a circle—engraved on a stone at its surface, and on additional stones or the rock *in situ*, in the normal of the upper mark; but, if the height is considerable and there is a liability to deflection, the pillar is constructed with a central vertical shaft to enable the theodolite to be plumbed over the ground-level mark, to which access is obtained through a passage in the basement. In early years this precaution against deflection was neglected and the pillars were built solid throughout, whatever their height; the surrounding platforms, being usually constructed of sun-dried bricks or stones and earth, were liable to fall and press against the pillars, some of which thus became deflected during the rainy seasons that intervened between the periods during which operations were arrested or the commencement and close of the successive circuits of triangles. In some instances displacements of mark occurred of which the magnitudes were not ascertainable, but were estimated as equivalent to *p.e.*'s of about ± 9 inches in the length and $\pm 2.4''$ in the azimuth of the side between any two deflected towers; and, as these theoretical errors are identical with what may be expected at the end of a chain of 36 equilateral triangles in which all the angles have been measured with a *p.e.* $= \pm 0.5''$, the old triangulation over solid towers had evidently suffered much more from the deflections of the towers than from errors in the measurements of the angles.

7. *Instruments for Measuring Principal Angles.*—Large theodolites were invariably employed. Repeating circles were highly thought of by French geodesists at the time when the operations in India were being commenced: but they were not used in the survey, and have now been generally discarded.

Theodolites.

The principal theodolites are somewhat similar to the astronomer's alt-azimuth instrument, but with larger azimuthal and smaller vertical circles, also with a greater base to give the firmness and stability which are required in measuring horizontal angles. The azimuthal circles have mostly diameters of either 36 or 24 inches, the vertical circles having a diameter of 18 inches. In all the theodolites the base is a tribrach resting on three levelling foot-screws, and the circles are read by microscopes; but in different instruments the fixed and the rotatory parts of the body vary. In some the vertical axis is fixed on the tribrach and projects upwards; in others it revolves in the tribrach and projects downwards. In the former the azimuthal circle is fixed to the tribrach, while the telescope pillars, the microscopes, the clamps, and the tangent screws are attached to a drum revolving round the vertical axis; in the latter, the microscopes, clamps, and tangent screws are fixed to the tribrach, while the telescope pillars and the azimuthal circle are attached to a plate fixed at the head of the rotatory vertical axis. The former system—called that of *flying microscopes*—permits the vertical axis to be readily opened out and cleaned, and presents the same clamp and tangent screw for employment during a round of angles; the latter—the system of *fixed microscopes*—necessitates the removal and replacement of all the microscopes, clamps, and tangent screws whenever the axis is cleaned, which is very troublesome, and it presents three sets of clamps and tangent screws for successive employment during a round of angles, which is a departure from true differentiality. The vertical axis is perforated for centring over the station mark with the aid of a "look-down telescope" instead of a plummet. The azimuthal circle is invariably read by an odd number of microscopes, either three or five, at equal intervals apart. The telescope rests with its pivots in Y's at the head of two pillars of a sufficient height to enable it to be completely turned round in altitude. The vertical circle is fixed to the transit axis of the telescope, and is read by two microscopes 180° apart, at the extremities of arms projecting from one of the pillars. The stand is a well-braced tripod, carrying an iron ring on which the theodolite rests, and may be turned round bodily whenever desired, as for shifting the position of the zero of the azimuthal circle relatively to the points under observation. The ring is 3 inches broad and of the same diameter as the circle of the foot-screws of the theodolite. In some instruments the foot-screws rest directly on the ring; but the instrument can be raised off the ring and turned round with the aid of an apparatus in the centre of the stand. In others they rest in grooves at the angles of an iron triangle which sits on the ring and can be shifted in position by hand, thus with the stand well levelled in the first instance the circle may be set within 1′ of any required reading. The centring over the station mark is performed by pushing screws placed either in the drum of the stand or at the angles of the triangle.

For travelling the theodolites were packed in two cases, the larger containing the body of the instrument, the smaller the telescope and the vertical circle; the stand constituted a third package. Each was carried on men's shoulders as the safest method of transport; the weights, of the heaviest 36-inch and of the lightest 24-inch instruments, as packed with ropes and bamboos, were, respectively, as follows: body, 649 ℔; telescope, 130; stand, 232; total, 1011 ℔; and 300, 135, and 185, total, 620 ℔.

Signals.

8. *Signals.*—Cairns of stones, poles, or other opaque signals were primarily employed, the angles being measured by day only; eventually it was found that the atmosphere was often more favorable for observing by night than by day, and that distant points were raised well into view by refraction by night which might be invisible or only seen with difficulty by day. Lamps were then introduced, of the simple form of a cup 6 inches in diameter, filled with cotton seeds steeped in oil and resin, to burn under an inverted earthen jar 30 inches in diameter, with an aperture in the side towards the observer. Subsequently this contrivance gave place to the Argand lamp with parabolic reflector; the opaque day signals were discarded for heliotropes reflecting the sun's rays to the observer. The introduction of luminous signals not only rendered the night as well as the day available for the observations, but changed the character of the operations, enabling work to be done during the dry and healthy season of the year, when the atmosphere is generally hazy and dust-laden, instead of being restricted as formerly to the rainy and unhealthy seasons, when distant opaque objects are best seen. A higher degree of accuracy was also secured, for the luminous signals were invariably displayed through diaphragms of appropriate aperture, truly centred over the station mark; and, looking like stars, they could be observed with greater precision, whereas opaque signals are always dim in comparison, and are liable to be seen eccentrically when the light falls on one side.

A signalling party of three men was usually found sufficient to manipulate a pair of heliotropes—one for single, two for double reflection, according to the sun's position—and a lamp, throughout the night and day. Heliotropers were also employed at the observing stations to flash instructions to the signallers.

Measuring horizontal angles.

9. *Measuring Horizontal Angles.*—The theodolites were invariably set up under tents for protection against sun, wind, and rain, and centred, levelled, and adjusted for the runs of the microscopes. Then the signals were observed in regular rotation round the horizon, alternately from right to left, and *vice versa;* after the prescribed minimum number of rounds, either two or three, had been thus measured, the telescope was turned through 180°, both in altitude and azimuth, changing the position of the face of the vertical circle relatively to the observer, and further rounds were measured; additional measures of single angles were taken if the prescribed observations were not sufficiently accordant. As the microscopes were invariably equidistant, and their number was always odd, either three or five, the readings taken on the azimuthal circle during the telescope pointings to any object in the two positions of the vertical circle, "face right" and "face left" were made on twice as many equidistant graduations as the number of microscopes. The theodolite was then shifted bodily in azimuth by being turned on the ring on the head of the stand, which brought new graduations under the microscopes at the telescope pointings; then further rounds were measured in the new positions, face right and face left. This process was repeated as often as had been previously prescribed, the successive angular shifts of position being made by equal arcs bringing equidistant graduations under the microscopes during the successive telescope pointings to one and the same object. By these arrangements all periodic errors of graduation were eliminated, the numerous graduations that were read tended to cancel accidental errors of division, and the numerous rounds of measures to minimize the errors of observation arising from atmospheric and personal causes.

The following table (I.) gives details of the procedure at different times; in the headings M stands for the number of microscopes over the azimuthal circle of the theodolite, Z for the number of the zero settings of the circle, N for the number of graduations brought under the microscopes, A = 360° ÷ N, the arc between the graduations, R the prescribed number of rounds of measures, and P = R × Z, the minimum number of telescope pointings to any station, excluding repetitions for discrepant observations:

Period.	M	Z	N	A	R	P
1830-45	5	8	40	9° 0′	3	24
1845-55	5	10	50	7° 12′	2	20
1855-80	5	10	50	7° 12′	3	30
	3	12	36	10° 0′	3	36

Under this system of procedure the instrumental and ordinary errors are practically cancelled and any remaining error is most probably due to lateral refraction, more especially when the rays of light graze the surface of the ground. The three angles of every triangle were always measured.

Vertical angles.

10. *Vertical Angles. Refraction.*—The apparent altitude of a distant point is liable to considerable variation during the twenty-four hours, under the influence of changes in the density of the lower strata of the atmosphere. Terrestrial refraction is very capricious, more particularly when the rays of light graze the surface of the ground, passing through a medium which is liable to extremes of rarefaction and condensation, under the alternate influence of the sun's heat radiated from the surface of the ground and of chilled atmospheric vapor. When the back and forward verticals at a pair of stations are equally refracted, their difference gives an exact measure of the difference of height. But the atmospheric conditions are not always identical at the

same moment everywhere on long rays which graze the surface of the ground, and the ray between two reciprocating stations is liable to be differently refracted at its extremities, each end being influenced in a greater degree by the conditions prevailing around it than by those at a distance; thus instances are on record of a station A being invisible from another B, while B was visible from A.

Refraction.

When the great arc entered the plains of the Gangetic valley, simultaneous reciprocal verticals were at first adopted with the hope of eliminating refraction; but it was soon found that they did not do so sufficiently to justify the expense of the additional instruments and observers. Afterwards the back and forward verticals were observed as the stations were visited in succession, the back angles at as nearly as possible the same time of the day as the forward angles, and always during the so-called "time of minimum refraction," which ordinarily commences about an hour after apparent noon and lasts from two to three hours. The apparent zenith distance is always greatest then, but the refraction is a minimum only at stations which are well elevated above the surface of the ground; at stations on plains the refraction is liable to pass through zero and attain a considerable negative magnitude during the heat of the day, for the lower strata of the atmosphere are then less dense than the strata immediately above and the rays are refracted downwards. On plains the greatest positive refractions are also obtained,—maximum values, both positive and negative, usually occurring, the former by night, the latter by day, when the sky is most free from clouds. The values actually met with were found to range from + 1.21 down to — 0.09 parts of the contained arc on plains; the normal "coefficient of refraction" for free rays between hill stations below 6000 feet was about .07, which diminished to .04 above 18,000 feet, broadly varying inversely as the temperature and directly as the pressure, but much influenced also by local climatic conditions.

In measuring the vertical angles with the great theodolites, graduation errors were regarded as insignificant compared with errors arising from uncertain refraction; thus no arrangement was made for effecting changes of zero in the circle settings. The observations were always taken in pairs, face right and left, to eliminate index errors, only a few daily, but some on as many days as possible, for the variations from day to day were found to be greater than the diurnal variations during the hours of minimum refraction.

11. *Results deduced from Observations of Horizontal Angles; Weights.*—In the Ordnance and other surveys the bearings of the surrounding stations are deduced from the actual observations, but from the "included angles" in the Indian Survey. The observations of every angle are tabulated vertically in as many columns as the number of circle settings face left and face right, and the mean for each setting is taken. For several years the general mean of these was adopted as the final result; but subsequently a "concluded angle" was obtained by combining the single means with weights inversely proportional to $g^2 + o^2 \div n$,—g being a value of the *e.m.s.*[1] of graduation derived empirically from the differences between the general mean and the mean for each setting, o the *e.m.s.* of observation deduced from the differences between the individual measures and their respective means, and n the number of measures at each setting. Thus, putting w_1, w_2, ... for the weights of the single means, w for the weight of the concluded angle, M for the general mean, C for the concluded angle, and d_1, d_2, . . . for the differences between M and the single means, we have

Weights.

$$C = M + \frac{w_1 d_1 + w_2 d_2 +}{w_1 + w_2 +} \text{ ....}(1)$$

and

$$w = w_1 + w_2 + \text{ ....}(2).$$

$C - M$ vanishes when n is constant; it is inappreciable when g is much larger than o; it is significant only when the graduation errors are more minute than the errors of observation; but it was always small, not exceeding 0.14″ with the system of two rounds of measures and 0.05″ with the system of three rounds.

The weights of the concluded angles thus obtained were employed in the primary reductions of the angles of single triangles and polygons which were made to satisfy the geometrical conditions of each figure, because they were strictly relative for all angles measured with the same instrument and under similar circumstances and conditions, as was almost always the case for each single figure. But in the final reductions, when numerous chains of triangles composed of figures executed with different instruments and under different circumstances came to be adjusted simultaneously, it was necessary to modify the original weights, on such evidence of the precision of the angles as might be obtained from other and more reliable sources than the actual measures of the angles. This treatment will now be described.

12. *Determination of Theoretical Absolute Errors of Observed Angles.*—Values of theoretical error for groups of angles measured with the same instrument and under similar conditions may be obtained in three ways,—(i.) from the squares of the reciprocals of the weight w deduced as above from the measures of such angle, (ii.) from the magnitudes of the excess of the sum of the angles of each triangle above 180° + the spherical excess, and (iii.) from the magnitudes of the corrections which it is necessary to apply to the angles of polygonal figures and networks to satisfy the several geometrical conditions (indicated in the next section). Let e_1, e_2, and e_3 be the values of the *e.m.s.* thus obtained; then, putting n for the number of angles grouped together, we have

Theoretical errors of angles.

$$e_1^2 = \frac{n}{[w]} \text{ and } e_2^2 = \frac{[\text{squares of triangular errors}]}{n};$$

also putting W for the mean of the weights of the t angles of a polygonal figure having m geometrical equations of condition, and x for the most probable value of the error of any observed angle, we have

$$e_3^2 = \frac{[wx^2]}{W} \cdot \frac{1}{m} = \frac{a}{m} \text{ for a single figure,}$$

$$= \frac{[a]}{[m]} \text{ for a group of figures,}$$

the brackets [] in each case denoting the sum of all the quantities involved. e_3 usually gives the best value of the theoretical error, then e_2. As a rule the value by e_1 is too small; but to this there are notable exceptions, in which it was found to be much too great. The instrument with which the angles were measured in these instances gave very discrepant results at different settings of the circle; but this was caused by large periodic errors of graduation which did not affect the "concluded angles," because they were eliminated by the systematic changes of setting, so the results were really more precise than was apparent.

When weights were determined for the final simultaneous reduction of triangulations executed by different instruments, it became necessary to find a factor ρ to be applied as a modulus to each group of angles measured with the same instrument and under similar conditions, to convert the as yet relative weights into absolute measures of precision. ρ was made $= e_1 \div e_3$ whenever data were available, if not to $e_1 \div e_2$; then the absolute weight of an observed angle in any group was taken as $w\rho^2$ and the *e.m.s.* of the angle as $1 \div \rho\sqrt{w}$. The average values of the *e.m.s.* thus determined for large groups of angles, measured with the 36-inch and the 24-inch theodolites, ranged from ± 0.24″ to ± 0.67″, the smaller values being usually obtained at hill stations, where the atmospheric conditions were most favorable.

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[1] The theoretical "error of mean square" = 1.48 × "probable error."

13. *Harmonizing Angles of Trigonometrical Figures.*—Every figure, whether a single triangle or a polygonal network, was made consistent by the application of corrections to the observed angles to satisfy its geometrical conditions. The three angles of every triangle having been observed, their sum had to be made $=180° +$ the spherical excess; in networks it was also necessary that the sum of the angles measured round the horizon at any station should be exactly $= 360°$, that the sum of the parts of an angle measured at different times should equal the whole, and that the ratio of any two sides should be identical, whatever the route through which it was computed. These are called the *triangular*, *central*, *toto-partial*, and *side* conditions; they present n geometrical equations, which contain t unknown quantities, the errors of the observed angles, t being always $>n$. When these equations are satisfied and the deduced values of errors are applied as corrections to the observed angles, the figure becomes consistent. Primarily the equations were treated by a method of successive approximations; but afterwards they were all solved simultaneously by the so-called method of minimum squares, which leads to the most probable of any system of corrections; it is demonstrated under EARTH, FIGURE OF THE (vol. vii. pp. 517–18). The following is a general outline of the process:

Harmonizing angles.

Let x be the most probable value of the error and u the reciprocal of the weight of any observed angle X, and let $a, b, \ldots n$ be the coefficients of x in successive geometrical equations of condition whose absolute terms are $e_a, e_b, \ldots e_n$; then we have the following group of n equations containing t unknown quantities to be satisfied, the significant coefficients of x being 1 in the triangular, toto-partial, and central, and $\pm$ cot X in the side equations:

$$\left.\begin{array}{l} a_1x_1 + a_2x_2 + \ldots + a_tx_t = e_a \\ b_1x_1 + b_2x_2 + \ldots + b_tx_t = e_b \\ \ldots\ldots\ldots\ldots\ldots \\ n_1x_1 + n_2x_2 + \ldots + n_tx_t = e_n \end{array}\right\} \ldots\ldots\ldots\ldots(3).$$

The values of x will be the most probable when $\left[\frac{x^2}{u}\right]$ is a minimum, a condition which introduces n indeterminate factors $\lambda_a, \ldots \lambda_n$, whose values are obtained by the solution of the following equations:

$$\left.\begin{array}{l} [aa.u]\,\lambda_a + [ab.u]\,\lambda_b + \ldots + [an.u]\lambda_n = e_a \\ [ab.u]\,\lambda_a + [bb.u]\,\lambda_b + \ldots + [bn.u]\lambda_n = e_b \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ [an.u]\,\lambda_a + [bn.u]\,\lambda_b + \ldots + [nn.u]\,\lambda_n = e_n \end{array}\right\} \ldots\ldots.(4),$$

the brackets indicating summations of t terms as to left of (3).

Then the value of any, the pth, x is

$$x_p = u_p\,\{\,a_p\,\lambda_a + b_p\,\lambda_b + \ldots + n_p\,\lambda_n\,\} \ldots\ldots\ldots(5).$$

The minimum or $\left[\frac{x^2}{u}\right]$ is $= [e\lambda]$ ……………………(6).

In the application to a single triangle we have $x_1 + x_2 + x_3 = e$, $\lambda = e \div (u_1 + u_2 + u_3)$; $x_1 = u_1\lambda$; $x_2 = u_2\lambda$; $x_3 = u_3\lambda$.

In the application to a simple polygon, by changing symbols and putting X and Y for the exterior and Z for the central angles, with errors x, y, and z and weight reciprocals u, v, and w, a for cot X and b for cot Y, e for any triangular error, e_c and e_s for the central and side errors, λ_c and λ_s for the factors for the central and side equations, and W for $u+v+w$, the equations for obtaining the factors become

$$\left.\begin{array}{l} \left[w-\frac{w^2}{W}\right]\lambda_c \quad -\left[\frac{w(au-bv)}{W}\right]\lambda_s = e_c - \left[\frac{we}{W}\right] \\ -\left[\frac{w(au-bv)}{W}\right]\lambda_c + \left[a^2u + b^2v - \frac{au-bv}{W}\right]\lambda_s = e_s \\ -\left[\frac{(au-bv)e}{W}\right] \end{array}\right\} (7)$$

and the general expressions for the errors of the angles are—

$$\left.\begin{array}{l} x = \frac{u}{W}\{\,e + (aW - au + bv)\lambda_s - w\lambda_c\,\} \\ y = \frac{v}{W}\{\,e - (bW + au - bv)\lambda_s - \lambda w_c\,\} \\ z = \frac{w}{W}\{\,e - (au - bv)\,\lambda_s + (u + v)\,\lambda_c\,\} \end{array}\right\} \ldots\ldots(8).$$

14. *Calculation of Sides of Triangles.*—The angles having been made geometrically consistent *inter se* in each figure, the side-lengths are computed from the base-line onwards by Legendre's theorem, each angle being diminished by one-third of the spherical excess of the triangle to which it appertains. The theorem is applicable without sensible error to triangles of a much larger size than any that are ever measured.

Sides of triangles.

15. *Calculation of Latitudes and Longitudes of Stations and Azimuths of Sides.*—A station of origin being chosen of which the latitude and longitude are known astronomically, and also the azimuth of one of the surrounding stations, the differences of latitude and longitude and the reverse azimuths are calculated in succession, for all the stations of the triangulation, by Puissant's formulæ (*Traité de Géodésie*, Paris, 1842, 3d ed.).

Latitude and longitude of stations; azimuth of sides.

Problem.—Assuming the earth to be spheroidal, let A and B be two stations on its surface, and let the latitude and longitude of A be known, also the azimuth of B at A, and the distance between A and B at the mean sea-level; we have to find the latitude and longitude of B and the azimuth of A at B.

The following symbols are employed: a the major and b the minor semi-axis; e the eccentricity, $=\left\{\frac{a^2-b^2}{a^2}\right\}^{\frac{1}{2}}$; ρ the radius of curvature to the meridian in latitude, $\lambda = \frac{a(1-e^2)}{\{1-e^2\sin^2\lambda\}^{\frac{3}{2}}}$; ν the normal to the meridian in latitude $\lambda, = \frac{a}{\{1-e^2\sin^2\lambda\}^{\frac{1}{2}}}$; λ and L the given latitude and longitude of A; $\lambda + \Delta\lambda$ and $L + \Delta L$ the required latitude and longitude of B; A the azimuth of B at A; B the azimuth of A at B; $\Delta A = B - (\pi + A)$; c the distance between A and B. Then, all azimuths being measured from the south, we have

$$\Delta\lambda'' = \left\{\begin{array}{l} -\frac{c}{\rho}\cos A \operatorname{cosec} 1'' \\ -\frac{1}{2}\frac{c^2}{\rho.\nu}\sin^2 A \tan\lambda \operatorname{cosec} 1'' \\ -\frac{3}{4}\frac{c^2}{\rho.\nu}\frac{e^2}{1-e^2}\cos^2 A \sin 2\lambda \operatorname{cosec} 1'' \\ +\frac{1}{6}\frac{c^3}{\rho.\nu^2}\sin^2 A \cos A\,(1+3\tan^2\lambda) \operatorname{cosec} 1'' \end{array}\right\} (9)$$

$$\Delta L'' = \left\{\begin{array}{l} -\frac{c}{\nu}\frac{\sin A}{\cos\lambda}\operatorname{cosec} 1'' \\ +\frac{1}{2}\frac{c^2}{\nu^2}\sin 2A\frac{\tan\lambda}{\cos\lambda}\operatorname{cosec} 1'' \\ -\frac{1}{6}\frac{c^3}{\nu^3}\frac{(1+3\tan^2\lambda)\sin 2A\cos A}{\cos\lambda}\operatorname{cosec} 1'' \\ +\frac{1}{3}\frac{c^3}{\nu^3}\frac{\sin^3 A\,\tan^2\lambda}{\cos\lambda}\operatorname{cosec} 1'' \end{array}\right\} (10)$$

$$\begin{array}{c}\Delta A''\text{ or}\\ B-(\pi+A)\end{array} = \left\{\begin{array}{l} -\frac{c}{\nu}\sin A\tan\lambda\operatorname{cosec} 1'' \\ +\frac{1}{4}\frac{c^2}{\nu^2}\left\{1+2\tan^2\lambda+\frac{e^2\cos^2\lambda}{1-e^2}\right\}\sin 2A\operatorname{cosec} 1'' \\ -\frac{c^3}{\nu^3}\left(\frac{5}{6}+\tan^2\lambda\right)\frac{\tan\lambda}{2}\sin 2A\cos A\operatorname{cosec} 1'' \\ +\frac{1}{6}\frac{c^3}{\nu^3}\sin^3 A\tan\lambda\,(1+2\tan^2\lambda)\operatorname{cosec} 1'' \end{array}\right. (11)$$

Each Δ is the sum of four terms symbolized by δ_1, δ_2, δ_3 and δ_4; the calculations are so arranged as to produce the terms in the order $\delta\lambda$, δL, and δA, each term entering as a factor in calculating the following term. The arrangement is shown below in equations in which the symbols $P, Q, \ldots Z$ represent the factors which depend on the adopted geodetic constants, and vary with the latitude; the logarithms of their numerical values are tabulated in the *Auxiliary Tables to Facilitate the Calculations of the Indian Survey.*

(12).

$\delta_1\lambda = -P.\cos A.c$ $\quad\delta_1L = +\delta_1\lambda.Q.\sec\lambda.\tan A$ $\quad\delta_1A = +\delta_1L\sin\lambda$

$\delta_2\lambda = +\delta_1A.R.\sin A.c$ $\quad\delta_2L = -\delta_2\lambda.S.\cot A$ $\quad\delta_2A = +\delta_2L.T$

$\delta_3\lambda = -\delta_2A.V.\cot A$ $\quad\delta_3L = +\delta_3\lambda.U.\sin A.c$ $\quad\delta_3A = +\delta_3L.W$

$\delta_4\lambda = -\delta_3A.X.\tan A$ $\quad\delta_4L = +\delta_4\lambda.Y.\tan A$ $\quad\delta_4A = +\delta_4L.Z$

By this artifice the calculations are rendered less laborious and made susceptible of being readily performed by any persons who are acquainted with the use of logarithmic tables.

16. *Limits within which Geodetic Formulæ may be employed without Sensible Error.*—Each Δ is expressed as a series of ascending differentials in which all terms above the third order are neglected; for the

side-length c in no case exceeded 70 miles, nor was the latitude ever higher than 36°, and for these extreme values the maximum magnitudes of the fourth differential are only 0.002″ in latitude and 0.004″ in longitude and azimuth.

Limits of geodetic formulæ.

Far greater error may arise from uncertainties regarding the elements of the earth's figure, which was assumed to be spheroidal, with semi-axes $a = 20,922,932$ feet and $b = 20,853,375$ feet. The changes in $\Delta\lambda$, ΔL, and ΔA which would arise from errors da and db in a and b are indicated by the following formulæ:

$$\left.\begin{aligned} d.\Delta\lambda &= -\Delta\lambda.\frac{d\rho}{\rho} - \delta_2\lambda.\frac{d\nu}{\nu} - \delta_3\lambda\left(\frac{d\nu}{\nu} - \frac{2de}{(1-e^2)e}\right) - 2\delta_4\lambda.\frac{d\nu}{\nu} \\ d.\Delta L &= -\Delta L.\frac{d\nu}{\nu} - \delta_2 L.\frac{d\nu}{\nu} - (\delta_3 L + \delta_4 L)2\frac{d\nu}{\nu} \\ d.\Delta A &= -\Delta A.\frac{d\nu}{\nu} - \delta_2 A\left\{\frac{d\nu}{\nu} - \frac{\nu}{\rho}\left(\frac{d\nu}{\nu} - \frac{d\rho}{\rho}\right)\frac{1}{2\tan^2\lambda + \frac{\nu}{\rho}}\right\} \\ &\qquad - (\delta_3 A + \delta_4 A)\,2\frac{d\nu}{\nu} \end{aligned}\right\}(13).$$

in which

$$\left.\begin{aligned} \frac{d\rho}{\rho} &= -.000,000,0478\{da - 2db - 3(da - db)\sin^2\lambda\} \\ \frac{d\nu}{\nu} &= +.000,000,0478\{da + (da - db)\sin^2\lambda\} \\ \frac{2de}{(1-e^2)e} &= +.000,0145\{da - db\} \end{aligned}\right\}(14).$$

The adopted values of the semi-axes were determined by Colonel Everest in an investigation of the figure of the earth from such data as were available in 1826. Forty years afterwards an investigation was made by Captain (now Colonel) A. R. Clarke with additional data, which gave new values, both exceeding the former.[1] Accepting these as exact, the errors of the first values are $da = -3130$ feet and $db = -1746$ feet, the former being 150, the latter 84 millionth parts of the semi-axis. The corresponding changes in arcs of 1° of latitude and longitude, expressed in seconds of arc and in millionth parts (μ) of arc-length, are as follows:

In lat. 5° $d.\Delta\lambda = -.069''$ or 19 μ and $d.\Delta L = -''.540$ or 150 μ;
" 15° " $-.113''$ " 31 " " " $-.554''$ " 154 ";
" 25° " $-.195''$ " 54 " " " $-.581''$ " 161 ";
" 35° " $-.303''$ " 84 " " " $-.617''$ " 171 ".

These assumed errors in the geodetic latitudes and longitudes are of service when comparisons are made between independent astronomical and geodetic determinations at any points for which both may be available; they indicate the extent to which differences may be attributable to errors in the adopted geodetic constants, as distinct from errors in the trigonometrical or the astronomical operations.

17. *Final Reduction of Principal Triangulation.*—The calculations described so far suffice to make the angles of the several trigonometrical figures consistent *inter se*, and to give preliminary values of the lengths and azimuths of the sides and the latitudes and longitudes of the stations. The results are amply sufficient for the requirements of the topographer and land surveyor, and they are published in preliminary charts, which give full numerical details of latitude, longitude, azimuth, and side-length, and of height also, for each portion of the triangulation—secondary as well as principal—as executed year by year. But on the completion of the several chains of triangles further reductions became necessary, to make the triangulation everywhere consistent *inter se* and with the verificatory base-lines, so that the lengths and azimuths of common sides and the latitudes and longitudes of common stations should be identical at the junctions of chains, and that the measured and computed lengths of the base-lines should also be identical.

Reduction of principal triangulation.

How this was done will now be set forth. But first it must be noted that the triangulation might at the same time have been made consistent with any values of latitude, longitude, or azimuth which had been determined by astronomical observations at either of the trigonometrical stations. This, however, was undesirable, because such observations are liable to errors from deflection of the plumb-line from the true normal under the influence of local attraction, and these errors are of a much greater magnitude than those that would be generated in triangulating between astronomical stations which are not a great distance apart. The trigonometrical elements could not be forced into accordance with the astronomical without altering the angles by amounts much larger than their probable errors, and the results would be useless for investigations of the figure of the earth. The only independent facts of observation which could be legitimately combined with the angular adjustments were the base-lines, and all these were employed, while the several astronomical determinations—of latitude, differential longitude, and azimuth—were held in reserve for future geodetic investigations.

As an illustration of the problem for treatment, suppose a combination of three meridional and two longitudinal chains comprising seventy-two single triangles, with a base-line at each corner, as shown in the accompanying diagram (Fig. 2); suppose the three angles of every triangle to have been measured and made consistent. Let A be the origin, with

Specific illustration.

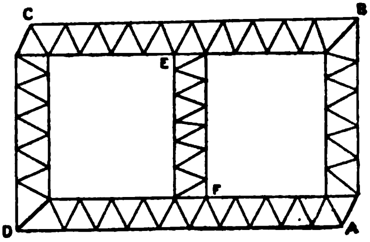

Fig. 2.

its latitude and longitude given, and also the length and azimuth of the adjoining base-line. With these data processes of calculation are carried through the triangulation to obtain the lengths and azimuths of the sides and the latitudes and longitudes of the stations, say in the following order: from A through B to E, through F to E, through F to D, through F and E to C, and through F and D to C. Then there are two values of side, azimuth, latitude, and longitude at E,—one from the right-hand chains *via* B, the other from the left-hand chains *via* F; similarly there are two sets of values at C; and each of the base-lines at B, C, and D has a calculated as well as a measured value. Thus eleven absolute errors are presented for dispersion over the triangulation by the application of the most appropriate correction to each angle, and as a preliminary to the determination of these corrections, equations must be constructed between each of the absolute errors and the unknown errors of the angles from which they originated. For this purpose assume X to be the angle opposite the flank side of any triangle, and Y and Z the angles opposite the sides of continuation; also let x, y, and z be the most probable values of the errors of the angles which will satisfy the given equations of condition. Then each equation may be expressed in the form $[ax + by + cz] = E$, the brackets indicating a summation for all the triangles involved. We have first to ascertain the values of the coefficients a, b, and c of the unknown quantities. They are readily found for the side equations on the circuits and between the base-lines, for x does not enter them, but only y and z, with coefficients which are the cotangents of Y and Z, so that these equations are simply $[\cot Y.y - \cot Z.z] = E$. But three out of four of the circuit equations are geodetic, corresponding to the closing errors in latitude, longitude, and azimuth, and in them the coefficients are very complicated. They are obtained as follows: The first term of each of the three expressions for $\Delta\lambda$, ΔL, and B is differentiated in terms of c and A, giving

$$\left.\begin{aligned} d.\Delta\lambda &= \Delta\lambda\left\{\frac{dc}{c} - dA\tan A\sin 1''\right\} \\ d.\Delta L &= \Delta L\left\{\frac{dc}{c} + dA\cot A\sin 1''\right\} \\ dB &= dA + \Delta A\left\{\frac{dc}{c} + dA\cot A\sin 1''\right\} \end{aligned}\right\}(15).$$

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[1] See *Account of the Principal Triangulation of the Ordnance Survey*, 1858 and *Comparisons of Standards of Length*, 1866.

in which dc and dA represent the errors in the length and azimuth of any side c which have been generated in the course of the triangulation up to it from the base-line and the azimuth station at the origin. The errors in the latitude and longitude of any station which are due to the triangulation are $d\lambda_r = [d.\Delta\lambda]$, and $dL_r = [d.\Delta L]$. Let station 1 be the origin, and let 2, 3, ... be the succeeding stations taken along a predetermined line of traverse, which may either run from vertex to vertex of the successive triangles, zigzagging between the flanks of the chain, as in

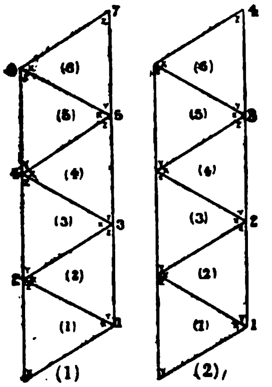

FIG. 3.

Fig. 3 (1), or be carried directly along one of the flanks, as in Fig. 3 (2). For the general symbols of the differential equations substitute $\Delta\lambda_n$, ΔL_n, ΔA_n, c_n, A_n, and B_n, for the side between stations n and $n+1$ of the traverse; and let δc_n and δA_n be the errors generated between the sides c_{n-1} and c_n; then

$$\frac{dc_1}{c_1} = \frac{\delta c_1}{c_1}; \quad \frac{dc_2}{c_2} = \frac{\delta c_1}{c_1} + \frac{\delta c_2}{c_2}; \quad \ldots \quad \frac{dc_n}{c_n} = {}_1^n\left[\frac{\delta c}{c}\right];$$

$$dA_1 = \delta A_1; \; dA_2 = dB_1 + \delta A_2; \; \ldots \; dA_n = dB_{n-1} + \delta A_n.$$

Performing the necessary substitutions and summations, we get

$$dB_n = \begin{cases} {}_1^n[\Delta A]\dfrac{\delta c_1}{c_1} + {}_2^n[\Delta A]\dfrac{\delta c_2}{c_2} + \ldots + \Delta A_n\dfrac{\delta c_n}{c_n} \\ + (1 + {}_1^n[\Delta A \cot A]\sin 1'')\delta A_1 + (1 + {}_2^n[\Delta A \cot A]\sin \\ \quad 1'')\delta A_2 + \ldots + (1 + \Delta A_n \cot A_n \sin 1'')\delta A_n. \end{cases}$$

$$d\lambda_{n+1} = \begin{cases} {}_1^n[\Delta\lambda]\dfrac{\delta c_1}{c_1} + {}_2^n[\Delta\lambda]\dfrac{\delta c_2}{c_2} + \ldots + \Delta\lambda_n\dfrac{\delta c_n}{c_n} \\ - \{ {}_1^n[\Delta\lambda \tan A]\delta A_1 + {}_2^n[\Delta\lambda \tan A]\delta A_2 + \ldots \\ \quad + \Delta\lambda_n \tan A_n \delta A_n \} \sin 1'' \end{cases}$$

$$dL_{n+1} = \begin{cases} {}_1^n[\Delta L]\dfrac{\delta c_1}{c_1} + {}_2^n[\Delta L]\dfrac{\delta c_2}{c_2} + \ldots + \Delta L_n\dfrac{\delta c_n}{c_n} \\ + \{ {}_1[\Delta L \cot A]\delta A_1 + {}_2^n[\Delta L \cot A]\delta A_2 + \ldots \\ \quad + \Delta L_n \cot A_n \delta A_n \} \sin 1'' \end{cases}$$

Thus we have the following expression for any geodetic error—

$$\mu_1\frac{\delta c_1}{c_1} + \ldots + \mu_n\frac{\delta c_n}{c_n} + \phi_1\delta A_1 + \ldots + \phi_n\delta A_n = E, \quad \ldots (16),$$

where μ and ϕ represent the respective summations which are the coefficients of δc and δA in each instance but the first, in which 1 is added to the summation in forming the coefficient of δA.

The angular errors x, y, and z must now be introduced in place of δc and δA, into the general expression, which will then take different forms, according as the route adopted for the line of traverse was the zigzag or the direct. In the former the number of stations on the traverse is ordinarily the same as the number of triangles, and, whether or no, a common numerical notation may be adopted for both the traverse stations and the collateral triangles; thus the angular errors of every triangle enter the general expression in the form

$$\pm\phi x + \cot Y.\mu'y - \cot Z.\mu'z,$$

in which $\mu' = \mu \sin 1''$, and the upper sign of ϕ is taken if the triangle lies to the left, the lower if to the right, of the line of traverse. When the direct traverse is adopted, there are only half as many traverse stations as triangles, and therefore only half the number of μ's and ϕ's to determine; but it becomes necessary to adopt different numberings for the stations and the triangles, and the form of the coefficients of the angular errors alternates in successive triangles. Thus, if the pth triangle has no side on the line of the traverse but only an angle at the lth station, the form is

$$+\phi_l.x_p + \cot Y_p.\mu'_l.y_p - \cot Z_p.\mu'_l.z_p.$$

If the qth triangle has a side between the lth and the $(l+1)$th stations of the traverse, the form is

$$\cot X_q(\mu'_l - \mu'_{l+1})x_q + (\phi_l + \mu'_{l+1}\cot Y_q)y_q - (\phi_{l+1} - \mu'_l \cot Z_q)z_q.$$

As each circuit has a right-hand and a left-hand branch, the errors of the angles are finally arranged so as to present equations of the general form

$$[ax + by + cz]_r - [ax + by + cz]_l = E.$$

The eleven circuit and base-line equations of condition having been duly constructed, the next step is to find values of the angular errors which will satisfy these equations, and be the most probable of any system of values that will do so, and at the same time will not disturb the existing harmony of the angles in each of the seventy-two triangles. Harmony is maintained by introducing the equation of condition $x + y + z = 0$ for every triangle. The most probable results are obtained by the method of minimum squares, which may be applied in two ways.

(i.) A factor λ may be obtained for each of the eighty-three equations under the condition that $\left[\dfrac{x^2}{u} + \dfrac{y^2}{v} + \dfrac{z^2}{w}\right]$ is made a minimum, u, v, and w being the *reciprocals* of the weights of the observed angles. This necessitates the simultaneous solution of eighty-three equations to obtain as many values of λ. The resulting values of the errors of the angles in any, the pth, triangle, are

$$x_p = u_p[a_p\lambda]; \; y_p = v_p[b_p\lambda]; \; z_p = w_p[c_p\lambda] \ldots (17).$$

(ii.) One of the unknown quantities in every triangle, as x, may be eliminated from each of the eleven circuit and base-line equations by substituting its equivalent $-(y+z)$ for it, a similar substitution being made in the minimum. Then the equations take the form $[(b-a)y + (c-a)z] = E$, while the minimum becomes

$$\left[\frac{(y+z)^2}{u} + \frac{y^2}{v} + \frac{z^2}{w}\right].$$

Thus we have now to find only eleven values of λ by a simultaneous solution of as many equations, instead of eighty-three values from eighty-three equations; but we arrive at more complex expressions for the angular errors as follows:

(18).

$$y_p = \frac{v_p}{u_p + v_p + w_p}\{(u_p + w_p)[(b_p - a_p)\lambda] - u_p[(c_p - a_p)\lambda]\}$$

$$z_p = \frac{w_p}{u_p + v_p + w_p}\{(u_p + v_p)[(c_p - a_p)\lambda] - v_p[(b_p - a_p)\lambda]\}$$

The second method has invariably been adopted, originally because it was supposed that the number of the factors λ being reduced from the total number of equations to that of the circuit and base-line equations, a great saving of labor would be effected. But subsequently it was ascertained that in this respect there is little to choose between the two methods; for when x is not eliminated, and as many factors are introduced as there are equations, the factors for the triangular equations may be readily eliminated at the outset. Then the really severe calculations will be restricted to the solution of the equations containing the factors for the circuit and base-line equations, as in the second method.

Reduction of principal triangulation.

In the preceding illustration it is assumed that the base-lines are errorless as compared with the triangulation. Strictly speaking, however, as base-lines are fallible quantities, presumably of different weight, their errors should be introduced as unknown quantities of which the most probable values are to be determined in a simultaneous investigation of the errors of all the facts of observation, whether linear or angular. When they are connected together by so few triangles that their ratios may be deduced as accurately, or nearly so, from the triangulation as from the measured lengths, this ought to be done; but, when the connecting triangles are so numerous that the direct ratios are of much greater weight than the trigonometrical, the errors of the base-lines may be neglected. In the reduction of the Indian triangulation it was decided, after examining the relative magnitudes of the probable errors of the linear and the angular measures and ratios, to assume the base-lines to be errorless (see § 19, p. 740 below).

The chains of triangles being largely composed of polygons or other networks, and not merely of single triangles, as has been assumed for simplicity in the illustration, the geometrical harmony to be maintained involved the introduction of a large number of "side," "central," and "toto-partial" equations of condition, as well as the triangular. Thus the problem for attack was the simultaneous solution of a number of equations of condition = that of all the geometrical conditions of every figure + four times the number of circuits formed by the chains of triangles + the number of base-lines — 1, the number of unknown quantities contained in the equations being that of the whole of the observed angles; the method of procedure, if rigorous, would be precisely similar to that already indicated for "harmonizing the angles of trigonometrical figures," of which it is merely an expansion from single figures to great groups.

The rigorous treatment would, however, have involved the simultaneous solution of about 4000 equations between 9230 unknown quantities, which was quite impracticable. The triangulation was therefore divided into sections for separate reduction, of which the most important were the five between the meridians of 67° and 92° (see Fig. 1, p. 732), consisting of four quadrilateral figures and a trigon, each comprising several chains of triangles and some base-lines. This arrangement had the advantage of enabling the final reductions to be taken in hand as soon as convenient after the completion of any section, instead of being postponed until all were completed. It was subject, however, to the condition that the sections containing the best chains of triangles were to be first reduced; for, as all chains bordering contiguous sections would necessarily be "fixed" as a part of the section first reduced, it was obviously desirable to run no risk of impairing the best chains by forcing them into adjustment with others of inferior quality. It happened that both the northeast and the southwest quadrilaterals contained several of the elder chains; their reduction was therefore made to follow that of the collateral sections containing the modern chains.

But the reduction of each of these great sections was in itself a very formidable undertaking, necessitating some departure from a purely rigorous treatment. For the chains were largely composed of polygonal networks and not of single triangles only as assumed in the illustration, and therefore cognizance had to be taken of a number of "side" and other geometrical equations of condition, which entered irregularly and caused great entanglement. Equations 17 and 18 of the illustration are of a simple form because they have a single geometrical condition to maintain, the triangular, which is not only expressed by the simple and symmetrical equation $x+y+z=0$, but—what is of much greater importance—recurs in a regular order of sequence that materially facilitates the general solution. Thus, though the calculations must in all cases be very numerous and laborious, rules can be formulated under which they can be well controlled at every stage and eventually brought to a successful issue. The other geometrical conditions of networks are expressed by equations which are not merely of a more complex form but have no regular order of sequence, for the networks present a variety of forms; thus their introduction would cause much entanglement and complication, and greatly increase the labor of the calculations and the chances of failure. Wherever, therefore, any compound figure occurred, only so much of it as was required to form a chain of single triangles was employed. The figure having previously been made consistent, it was immaterial what part was employed, but the selection was usually made so as to introduce the fewest triangles. The triangulation for final simultaneous reduction was thus made to consist of chains of single triangles only; but all the included angles were "fixed" simultaneously. The excluded angles of compound figures were subsequently harmonized with the fixed angles, which was readily done for each figure *per se*.

This departure from rigorous accuracy was not of material importance, for the angles of the compound figures excluded from the simultaneous reduction had already, in the course of the several independent figural adjustments, been made to exert their full influence on the included angles. The figural adjustments had, however, introduced new relations between the angles of different figures, causing their weights to increase *cæteris paribus* with the number of geometrical conditions satisfied in each instance. Thus, suppose w to be the average weight of the t observed angles of any figure, and n the number of geometrical conditions presented for satisfaction; then the average weight of the angles after adjustment may be taken as $w.\dfrac{t}{t-n}$, the factor thus being 1.5 for a triangle, 1.8 for a hexagon, 2 for a quadrilateral, 2.5 for the network around the Sironj base-line, etc.

In framing the normal equations between the indeterminate factors λ for the final simultaneous reduction, it would have greatly added to the labor of the subsequent calculations, if a separate weight had been given to each angle, as was done in the primary figural reduction; this was obviously unnecessary, for theoretical requirements would now be amply satisfied by giving equal weights to all the angles of each independent figure. The mean weight that was finally adopted for the angles of each group was therefore taken as

$$w.\rho\frac{t}{t-n},$$

ρ being the modulus already indicated in section 12.

The second of the two processes for applying the method of minimum squares having been adopted, the values of the errors y and z of the angles appertaining to any, the pth, triangle were finally expressed by the following equations, which are derived from (18) by substituting u for the reciprocal final mean weight as above determined:

$$\left.\begin{array}{l} y_p=\dfrac{u_p}{3}\left[(2b_p-a_p-c_p)\lambda\right] \\ z_p=\dfrac{u_p}{3}\left[(2c_p-a_p-b_p)\lambda\right] \end{array}\right\}\text{............ (19).}$$

The most laborious part of the calculations was the construction and solution of the normal equations between the factors λ. On this subject a few hints are desirable, because the labor involved is liable to be materially influenced by the order of sequence adopted in the construction. The normal equations invariably take the form of (4), the coefficients on the diagonal containing summations of squares of the coefficients in the primary equations, while those above and below contain summations of products of the primary quantities, such that the coefficient of the pth λ in the qth equation is the same as that of the qth λ in the pth equation. In practice, as any single angular error only enters a few of the primary equations of condition, many of the coefficients vanish, both in the primary and in the normal equations; and it is an object of great importance so to arrange the normal equations that most blanks shall occur *above* and fewest blanks *between* the significant values on each vertical line of coefficients; in other words, the significant values above and below the diagonal should lie as closely as possible to the diagonal, every value on which is always significant. This advantage is secured when the primary equations are arranged in groups in which each contains a number of angular errors in common and as many as possible of those entering the group on each side. Thus the arrangement must follow the natural succession of the chains of triangles rather than the characteristics of the primary equations; if, for example, all the side equations were grouped together, and all the latitude equations, and so on, great entanglement would arise in the solution of the normal equations, enormously increasing the labor and the chances of failure. The best arrangement was found to be to group the side and the three geodetic equations of each circuit together in the order of sequence of the meridional chains of triangles, and then to introduce the side equations connecting base-lines between the groups with which they had most in common.

The following table (II.) gives the number of equations of condition and unknown quantities—the angular errors—in the five great sections of the triangulation, which were respectively included in the simultaneous general reductions and relegated to the subsequent adjustments of each figure *per se:*

Section.	Simultaneous.			External Figural.					
	Equations.		Angular Errors.	Equations.				Angular Errors.	No. of Figures.
	Circuit and Base-line.	Tri-angular.		Tri-angular.	Central.	Side.	Toto-partial.		
1. N.W. Quad.	23	550	1650	267	104	152	6	762	110
2. S.E. Quad..	15	277	831	164	64	92	2	476	66
3. N.E. Quad.	49	573	1719	112	56	69	0	341	50
4. Trigon	22	303	909	192	79	101	2	547	77
5. S.W. Quad.	24	172	516	83	32	52	1	287	40

The magnitudes of the 2481 angular errors determined simultaneously in the first two sections were very small, 2240 being under 0.1″, 205 between 0.1″ and 0.2″, 33 between 0.2″ and 0.3″, 2 between 0.3″ and 0.4″, and 1 between 0.4″ and 0.5″. In the third section, which contained a number of old chains, executed with instruments inferior to the 2 and 3 foot theodolites, they were larger: 780 were under 0.1″, 911 between 0.1″ and 1.0″, 27 between 1.0″ and 2.0″, and 1 between 2.0″ and 2.1″. Thus the corrections to the angles were generally very minute, rarely exceeding the theoretical probable errors of the angles, and therefore applicable without taking any liberties with the facts of observation.

18. *Theoretical Errors of any Function of Angles of a Geometrically corrected Triangulation.*—The investigation of such theoretical errors was no easy matter. When first essayed it was generally assumed by mathematicians in England that any attempt to exhibit the theoretical error by a purely algebraical process soon led to results of intolerable complexity, so that it was desirable to introduce numbers as soon as possible for every symbol except the absolute terms of the geometrical or primary equations of condition. But on continuing the algebraical process certain relations were found to exist between the coefficients of the indeterminate factors in the normal equations of the minimum square method and the coefficients of the unknown quantities in the primary equations of condition, which enormously simplified the process and led to a general algebraical expression of no great complexity; it was also found that, the number of primary equations being n, the labor of calculation by the formula was reduced to an nth of that involved by resorting at once to numbers.

Theoretical errors of functions of angles.

Let F be any function whatever of the corrected angles X_1-x_1), (X_2-x_2), . . . of a trigonometrical figure; let

$$f_1=\frac{dF}{dX_1},\ f_2=\frac{dF}{dX_2}\cdots;$$

also let u_1, u_2, . . . , symbols hitherto employed to represent the relative reciprocal weights of the observed angles X_1, X_2, . . . , in future represent absolute measures of precision, the $p.e.^2$ of the observed angles; then the following formula expresses the $p.e.$ of any function of the corrected angles rigorously:

$$p.e.^2 \text{ of } F = f^2.u-\left\{\begin{array}{l} +[fa.u]\,\{\,[fa.u]A_a+[fb.u]A_b+\ldots+[fn.u]A_n\,\} \\ +[fb.u]\,\{\,[fa.u]B_a+[fb.u]B_b+\ldots+[fn.u]B_n\,\} \\ +\ \cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\ +[fn.u]\,\{\,[fa.u]N_a+[fb.u]N_b+\ldots+[fn.u]N_n\,\} \end{array}\right. \qquad (20).$$

The symbols a, b, . . . n have the same signification as in (3) to (6) of section 13. A, B, . . . N are coefficients which must be determined in the process of solving the normal equations as follows:

$$\left.\begin{array}{l} \lambda_a=A_ae_a+A_be_b+\ldots+A_ne_n \\ \lambda_b=B_ae_a+B_be_b+\ldots+B_ne_n \\ \cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\ \lambda_n=N_ae_a+N_be_b+\ldots+N_ne_n \end{array}\right\}\ \ldots\ldots\ldots\ldots(21),$$

where the coefficient represented by any two letters in one order is identical with that represented by the same letters in the reverse order: thus $A_n=N_a$. Hence to find the $p.e.$ of any angle, as (X_1-x_1), in a single triangle we have

$$f_1=1, \text{ and } A_a=\frac{1}{[aa.u]}=\frac{1}{u_1+u_2+u_3};$$

all the other factors vanish, and

$$p.e.^2 \text{ of } (X_1-x_1)=u_1-\frac{u_1}{u_1+u_2+u_3}=p.e.^2 \text{ of } X_1-p.e.^2 \text{ of } x_1.$$

To find the $p.e.$ of the ratio R of either side to the base,—if

$$R=\sin(X_1-x_1)\div\sin(X_2-x_2),$$

then $f_1=R\cot X_1\sin 1''$, $f_2=R\cot X_2\sin 1''$, $f_3=0$, and $p.e.^2$ of R

$$=R^2\sin^2 1''\left\{u_1\cot^2 X_1+u_2\cot^2 X_2-\frac{(u_1\cot X_1-u_2\cot X_2)^2}{u_1+u_2+u_3}\right\}\ (22).$$

When the function of the corrected angles is the ratio of the terminal to the initial side of an equilateral triangle or a regular quadrilateral or polygon (either of two sides being taken if the figure has an odd number of exterior sides), then, assuming all the angles to be of equal weight, we have the following values of the $p.e.$'s and the relative weights of the ratios:

Figure.	p.e.	Weight.	Figure.	p.e.	Weight.
Triangle	$\pm.82\sqrt{u}\sin 1''$	1.49	Pentagon	$\pm 1.21\sqrt{u}\sin 1''$	0.68
Quadrilateral .	1.00 "	1.00	Hexagon	1.29 "	0.60
Trigon.	1.05 "	0.90	Heptagon	1.41 "	0.50
Tetragon	1.15 "	0.75	Octagon	1.57 "	0.41

In ordinary ground seven single triangles will span about as much as two hexagons and the weights of the terminal sides would be as twenty-one by the former to thirty by the latter. In a flat country two quadrilaterals would not span more than one hexagon, giving terminal side weights as five to six; but in hills a quadrilateral may span as much as any polygon and give a more exact side of continuation. Thus in the Indian Survey polygons predominate in the plains and quadrilaterals in the hills.

The theoretical errors of the lengths and azimuths of the sides, and of the latitudes and longitudes of the stations, at the termini of the chains of triangles or at the circuit closings, might be calculated with the coefficients a, b, and c of x, y, and z in the circuit and base-line equations as the f's, and the known $p.e.$'s of X, Y, and Z and the other data of the figural reductions. Such calculations are, however, much too laborious to be ordinarily undertaken. Thus the exactitude of a triangulation is very generally estimated merely on the evidence of the magnitudes of the differences between the trigonometrical and the measured lengths of the base-lines; for, though the combined influence of angular precision and geometrical configuration is what really governs the precision of the results, it is not readily ascertainable, and is therefore generally ignored. But, when questions as to the intrinsic value of a triangulation arise, the theory of errors should always be appealed to, and its intimations accepted rather than the evidence of base-line discrepancies, which if very small are certainly accidental, and if seemingly large may be no greater than what we should be prepared to expect. Good work has occasionally been redone unnecessarily, and inferior work upheld, because their merits were erroneously estimated. The following formulæ will be found useful in acquiring a fairly approximate knowledge of the magnitude of the errors which theory would lead us to expect, not only in side, but in latitude, longitude, and azimuth also, at the close of any chain of triangles. They indicate rigorously the $p.e.$'s at the terminal end of a chain of equilateral triangles of which all the angles have been measured and corrected and are of equal weight; the results may be made to serve for less symmetrical chains, including networks of varying weight, by the application of certain factors which can be estimated with fair precision in each instance.

Let c be the side length, ϵ the $p.e.$ of the angles, n the number of triangles, and R the ratio (here $=1$) of the terminal to the initial side, then

$$\left.\begin{array}{r} p.e. \text{ of } R=\epsilon\sin 1''\,R\sqrt{\tfrac{2}{3}n} \\ p.e. \text{ of azimuth}=\epsilon\sqrt{\tfrac{2}{3}n} \\ p.e. \text{ of either coordinate}=\epsilon c\,\dfrac{\sin 1''}{6}\sqrt{2n^3+3n^2+10n} \end{array}\right\}\ (23).^1$$

When the form of the triangles deviates much from the equiangular, the $p.e.$ must be multiplied by a factor increasing up to 1.4 as the angles diminish from 60° to 30°, and a mean value of c must be adopted. When the chain is double throughout, the $p.e.$ must be diminished by a factor taking cognizance of the greater weight of compound figures than of single triangles. When the chain is composed of groups of angles measured with different instruments, a separate value of ϵ must be employed for each group, and the final result obtained from $\sqrt{[p.e.^2]}$. The $p.e.$ of R may be determined rigorously for any chain of single triangles, with angles of varying magnitudes and weights, by (22), with little labor of calculation.

19. *Relations between Theoretical Errors of Base-lines and those of a Triangulation.*—These relations have to be investigated in order to ascertain whether the base-lines may be assumed to be errorless in the general reduction of the triangulation; being fallible quantities, their errors must be included among the unknown quantities to be investigated simultaneously, if their respective $p.e.$'s differ sensibly, or if the $p.e.$'s of their ratios are not materially smaller than those of the corresponding trigonometrical ratios. By (23) the $p.e.$ of the ratio of any two sides of an equilateral triangle is $\epsilon\sin 1''\sqrt{2\div 3}$; but the $p.e.$ of the ratio of two base-lines of equal length and

Theoretical errors of base-lines and of a triangulation.

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[1] For an investigation of these formulæ, see Appendix No. 2, vol. vii. of *Account of Operations of Great Trigonom. Survey*, 1882.

weight is $\eta\sqrt{2}$, where η is the *p.e.* of either base-line; thus weight of trigonometrical ratio : weight of base-line ratio : $3\eta^2 : \epsilon^2 \sin^2 1''$, or as 3 : 1 when $\epsilon = \pm 0.3''$ and $\eta = \pm 1.5$ millionth parts, which happens generally in the Indian triangulation. But the chains between base-lines were always composed of a large number of triangles, and the average weight of the base-line ratios was about eleven times greater by the direct linear measurements than by the triangulation, even when all the unascertainable constant or accidental errors—as from displacements of mark-stones—which might be latent in the latter were disregarded. Moreover, the base-lines were practically all of the same precision; they were therefore treated as errorless, and the triangulation was made accordant with them.

If a base-line AD be divided at B and C into three equal sections connected together by equilateral triangles, and every angle has been measured with a *p. e.* $= \epsilon$, the *p.e.* of any trigonometrical ratio may be put $= \kappa.\epsilon \sin 1''$, κ being a coefficient which has two values for each ratio,—the greater value when the triangulation has been carried along one flank of the line, the smaller when along both flanks, as follows: for ratio $\frac{BC}{AB}$, $\kappa = 1.41$ and 1; for $\frac{CD}{AB}$, 1.83 and 1.23; for $\frac{AD}{AB}$, 2.94 and 1.99; for $\frac{AD}{BC}$ 2.16 and 1.46. The values for the last two ratios show that, when the length of a base-line is determined partly by measurement and partly by triangulation, the *p.e.* is smallest if the central section rather than an end section is measured.

If, with linear and angular *p.e.*'s as in the Indian operations, a single section is measured once only, and the lengths of the other sections are derived from it by triangulation, the *p.e.* of the entire length will be greater than that of the whole line once measured; it will be less if the section is measured oftener than once and the mean taken.

Azimuth observations.

20. *Azimuth Observations in connection with Principal Triangulation.*—These were invariably determined by measuring the horizontal angle between a referring mark and a circumpolar star, shortly before and after elongation, and usually at both elongations in order to eliminate the error of the star's place. Systematic changes of "face" and of the zero settings of the azimuthal circle were made as in the measurement of the principal angles (§ 9); but the repetitions on each zero were more numerous; the azimuthal levels were read and corrections applied to the star observations for dislevelment. As already mentioned (§ 17), the triangulation was not adjusted, in the course of the final simultaneous reduction, to the astronomically determined azimuths, because they are liable to be vitiated by local attractions; but the azimuths observed at about fifty stations around the primary azimuthal station, which was adopted as the origin of the geodetic calculations, were referred to that station, through the triangulation, for comparison with the primary azimuth. A table was prepared of the differences (observed at the origin—computed from a distance) between the primary and the geodetic azimuths; the differences were assumed to be mainly due to the local deflections of the plumb-line and only partially to error in the triangulation, and each was multiplied by the factor

$$p = \frac{\text{tangent of latitude of origin}}{\text{tangent of latitude of comparing station}},$$

in order that the effect of the local attraction on the azimuth observed at the distant station—which varies with the latitude and is = the deflection in the prime vertical × the tangent of the latitude—might be converted to what it would have been had the station been situated in the same latitude as the origin. Each deduction was given a weight, w, inversely proportional to the number of triangles connecting the station with the origin, and the most probable value of the error of the observed azimuth at the origin was taken as

$$x = \frac{[\,(\text{observed} - \text{computed})\, p\, w\,]}{[w]} \text{ ....(24)};$$

the value of x thus obtained was $-1.1''$.

The formulæ employed in the reduction of the azimuth observations were as follows: In the spherical triangle PZS, in which P is the pole, Z the zenith, and S the star, the co-latitude PZ and the polar distance PS are known, and, as the angle at S is a right angle at the elongation, the hour angle and the azimuth at that time are found from the equations:

$$\cos P = \tan PS \cot PZ,$$
$$\cos Z = \cos PS \sin P.$$

The interval, δP, between the time of any observation and that of the elongation being known, the corresponding azimuthal angle, δZ, between the two positions of the star at the times of observation and elongation is given rigorously by the following expression—$\tan \delta Z$

$$= \frac{2\sin^2 \frac{1}{2}\delta P}{\cot PS \sin PZ \sin P \{ 1 + \tan^2 PS \cos\delta P + \sec^2 PS \cot P \sin\delta P \}} \text{ (25)},$$

which is expressed as follows for logarithmic computation—

$$\delta Z = -\frac{m \tan Z \cos^2 PS}{1 - n + l},$$

where $m = 2\sin^2\frac{\delta P}{2} \operatorname{cosec} 1''$, $n = 2\sin^2 PS \sin^2\frac{\delta P}{2}$, and $l = \cot P \sin \delta P$; l, m, and n are tabulated.

Height and refraction.

21. *Calculation of Height and Refraction.*—Let A and B (Fig. 4) be any two points the normals at which meet at C, cutting the sea-level at p and q; take $Dq = Ap$, then BD is the difference of height; draw the tangents Aa and Bb at A and B, then aAB is the depression of B at A and bBA that of A at B; join AD, then BD is determined from the triangle ABD. The triangulation gives the distance between A and B at the sea-level, whence $pq = c$; thus, putting Ap, the height of A above the sea-level, $= H$, and $pC = r$.

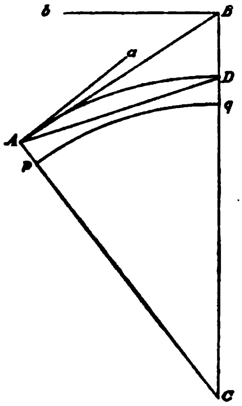

FIG. 4.

$$AD = c\left(1 + \frac{H}{r} - \frac{c^2}{24r^2}\right) \text{ .... (26)}.$$

Putting D_a and D_b for the actual depressions at A and B, S for the angle at A, usually called the "subtended angle," and h for BD—

$$S = \tfrac{1}{2}(D_b - D_a) \text{ .... (27},$$

and

$$h = AD\,\frac{\sin S}{\cos D_b} \text{ ....(28)}.$$

The angle at C being $= D_a + D_b$, S may be expressed in terms of a single vertical angle and C when observations have been taken at only one of the two points. C, the "contained arc," $= c\dfrac{\rho + \nu}{2\rho\nu}$ cosec 1″ in seconds. Putting D'_a and D'_b for the observed vertical angles, and ϕ_a, ϕ_b for the amounts by which they are affected by refraction, $D_a = D'_a + \phi_a$ and $D_b = D'_b + \phi_b$; ϕ_a and ϕ_b may differ in amount (see § 10), but as they cannot be separately ascertained they are always assumed to be equal; the hypothesis is sufficiently exact for practical purposes when both verticals have been measured under similar atmospheric conditions. The refractions being taken equal, the observed verticals are substituted for the true in (27) to find S, and the difference of height is calculated by (28); the third term within the brackets of (26) is usually omitted. The mean value of the refraction is deduced from the formula

$$\phi = \tfrac{1}{2} \{ C - D'_a + D'_b) \} \text{..............................(29).}$$

An approximate value is thus obtained from the observations between the pairs of reciprocating stations in each district, and the corresponding mean "coefficient of refraction," $\phi \div C$, is computed for the district, and is employed when heights have to be determined from observations at a single station only. When either of the vertical angles is an elevation $- E$ must be substituted for D in the above expressions.[1]

II. TRAVERSING, AS A BASIS FOR SURVEY.—RECTANGULAR SPHERICAL COORDINATES.

Traversing.

Traversing is a combination of linear and angular measures in equal proportions: the surveyor proceeds from point to point, measuring the lines between them and at each point the angle between the back and forward lines; he runs his lines as much as possible over level and open ground, avoiding obstacles by working round them. The system is well suited for laying down roads, boundary-lines, and circuitous features of the ground, and is very generally resorted to for filling in the interior details of surveys based on triangulation. It has been largely employed in certain districts of British India, which had to be surveyed in a manner to satisfy fiscal as well as topographical requirements; for, the village being the administrative unit of the district, the boundary of every village had to be laid down, and this necessitated the survey of an enormous number of circuits. Moreover, the traverse system was better adapted for the country than a network of triangulation, as the ground was generally very flat and covered with trees, villages, and other obstacles to distant vision, and was also devoid of hills and other commanding points of view. The principal triangulation had been carried across it, but by chains executed with great difficulty and expense, and therefore at wide intervals apart, with the intention that the intermediate spaces should be provided with points as a basis for the general topography in some other way. A system of traverses was obviously the best that could be adopted under the circumstances, as it not only gave all the village boundaries but was practically easier to execute than a network of minor triangulation.

In Indian Survey.

Procedure of the Indian Survey.—The traverses are executed in minor circuits following the periphery of each village and in major circuits comprising groups of several villages; the former are done with 4″ to 6″ theodolites and a single chain, the latter with 7″ to 10″ theodolites and a pair of chains, which are compared frequently with a standard. The main circuits are connected with every station of the principal triangulation within reach. The meridian of the origin is determined by astronomical observations; the angle at the origin between the meridian and the next station is measured, and then at each of the successive stations the angle between the immediately preceding and following stations; summing these together, the "inclinations" of the lines between the stations to the meridian of the origin are successively determined. The distances between the stations, multiplied by the cosines and sines of the inclinations, give the distance of each station from the one preceding it, resolved in the directions parallel and perpendicular respectively to the meridian of the origin; and the algebraical sums of these quantities give the corresponding rectangular coordinates of the successive stations relatively to the origin and its meridian. The area included in any circuit is expressed by the formula

$$\text{area} = \text{half algebraical sum of products } (x_1 + x_2)(y_2 - y_1) \text{ (30),}$$

x_1, y_1 being the coordinates of the first, and x_2, y_2 those of the second station, of every line of the traverse in succession round the circuit.

Of geometrical tests there are two, both applicable at the close of a circuit: the first is angular, viz., the sum of all the interior angles of the described polygon should be equal to twice as many right angles as the figure has sides, less four; the second is linear, viz., the algebraical sum of the x coordinates and that of the y coordinates should each be $= 0$. The astronomical test is this: at any station of the traverse the azimuth of a referring mark may be determined by astronomical observations; the inclination of the line between the station and the referring mark to the meridian of the origin is given by the traverse; the two should differ by the convergency of the meridians of the station and the origin. In practice the angles of the traverse are usually adjusted to satisfy their special geometrical and astronomical tests in the first instance, and then the coordinates of the stations are calculated and adjusted by corrections applied to the longest, that the angles may be least disturbed, as no further corrections are given them.

Convergency of meridians.

Convergency of Meridians.—The exact value of the convergence, when the distance and azimuth of the second astronomical station from the first are known, is that of $B - (\pi + A)$ of equation (11); but, as the first term is sufficient for a traverse, we have

$$\text{convergency} = x \tan \lambda \frac{\text{cosec } 1''}{\nu},$$

substituting x, the coordinate of the second station perpendicular to the meridian of the origin, for $c \sin A$.

Adjustment of traverses to triangulation.

Adjustment of a System of Traverses to a Triangulation.—The coordinates of the principal stations of a trigonometrical survey are usually the spherical coordinates of latitude and longitude; those of a traverse survey are always rectangular, plane for a small area but spherical for a large one. It is often necessary, therefore, for purposes of comparison and check at stations common to surveys of both descriptions, to convert either rectangular coordinates into latitudes and longitudes, or *vice versa*, in order that the errors of traverses may be dispersed by proportion over the coordinates of the traverse stations, if desired, or adjusted in the final mapping. The latter is generally all that is necessary, more particularly when the traverses are referred to successive trigonometrical stations as origins, as the operations are being extended, in order to prevent any large accumulation of error. Similar conversions are also frequently necessary in map projections. The method of effecting them will now be indicated.

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[1] In topographical and levelling operations it is sometimes convenient to apply small corrections to observations of the height for curvature and refraction simultaneously. Putting d for the distance, r for the earth's radius, and κ for the coefficient of refraction, and expressing the distance and radius in miles and the correction to height in feet, then correction for curvature $= \frac{2}{3}d^2$; correction for refraction $= -\frac{4}{3}\kappa d^2$; correction for both $= \dfrac{2 - 4\kappa}{3} \cdot d^2$.

Transformation of Latitude and Longitude Coordinates into Rectangular Spherical Coordinates, and vice versa.—Let A and B be any two points, Aa the meridian of A, Bb the parallel of latitude of B; then Ab, Bb will be their differences in latitude and longitude; from B draw BP perpendicular to Aa; then AP, BP will be the rectangular spherical coordinates of B relatively to A. Put $BP = x$, $AP = y$, the arc $Pb = \eta$, and the arc Bb, the difference of longitude, $= \omega$; also let λ_a, λ_b, and λ_p be the latitudes of A, B, and the point P, ρ_p, the radius of curvature of the meridian, and ν_p the normal terminating in the axis minor for the latitude λ_p; and let ρ_0 be the radius of curvature for the latitude $\frac{1}{2}(\lambda_a + \lambda_p)$. Then, when the rectangular coordinates are given, we have, taking A as the origin, the latitude of which is known,

Transformation of coordinates.

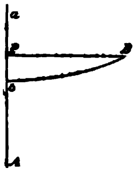

FIG. 5.

(31).

$$\lambda_p = \lambda_a + \frac{y}{\rho_0} \operatorname{cosec} 1''; \ \eta = \frac{x^2}{2\rho_p \nu_p} \tan \lambda_p \operatorname{cosec} 1'';$$

$$\lambda_b - \lambda_a = \frac{y}{\rho_0} \operatorname{cosec} 1'' - \eta; \ \omega = \frac{x}{\nu_p} \sec (\lambda_b + \tfrac{1}{2}\eta) \operatorname{cosec} 1''.$$

And, when the latitude and longitude are given, we have[1]

$$\left.\begin{aligned} \eta &= \left(\frac{\omega}{2}\right)^2 \frac{\nu_b}{\rho_b} \sin 2\lambda_b \sin 1'' \\ y &= \rho_0 \{ \lambda_b - \lambda_a + \eta \} \sin 1'' \\ x &= \omega \nu_p \cos (\lambda_b + \tfrac{1}{2}\eta) \sin 1'' \end{aligned}\right\} \ldots\ldots\ldots\ldots \ \ldots\ldots\ldots(32).$$

Graphic Method of Determining the Coordinates of an Unvisited Point observed from Several Stations.—When a hill peak or other prominent object has been observed from a number of stations whose coordinates are already fixed, the converging rays may be projected graphically, and from an examination of their several intersections the most probable position of the object may be obtained almost as accurately as by calculations by the method of least squares, which are very laborious and out of place for the determination of a secondary point. The following is a description of the application of this method to points on a plane surface in the calculations of the Ordnance Survey. Let s_1, s_2, . . . be stations whose rectangular coordinates, x_1, x_2, . . . perpendicular, and y_1, y_2, . . . parallel, to the meridian of the origin are given; let a_1, a_2, . . . be the bearings—here the direction-inclinations with the meridian of the origin—of any point P, as observed at the several stations; and let p be an approximate position of P, with coordinates x_p, y_p, as determined by graphical projection on a district map or by rough calculation. Construct a diagram of the rays converging around p, by taking a point to represent p and drawing two lines through it at right angles to each other to indicate the directions of north, south, east, and west. Calculate accurately $(y_p - y_1) \tan a_1$, and compare with $(x_p - x_1)$; the difference will show how far the direction of the ray from s_1 falls to the east or west of p. Or calculate $(x_p - x_1) \cot a_1$, and compare with $(y_p - y_1)$ to find how far the direction falls to the north or south of p. Set off the distance on the corresponding axis of p, and through the point thus fixed draw the direction a_1 with a common protractor. All the other rays around p may be drawn in like manner; they will intersect each other in a number of points, the centre of which may be adopted as the most probable position of P. The coordinates of P will then be readily obtained from those of $p \pm$ the distances on the meridian and perpendicular. In the annexed diagram (Fig. 6) P is supposed to have been observed from five stations, giving as many intersecting rays, (1, 1), (2, 2), . . . ; there are ten points of intersection, the mean position of which gives the true position of P, the assumed position being p. The advantages claimed for the method are that the bearings being independent, an erroneous bearing may be redrawn without disturbing those that are correct; similarly new bearings may be introduced without disturbing previous work, and observations from a large number of stations may be readily utilized, whereas, when calculation is resorted to, observations in excess of the minimum number required are frequently rejected because of the labor of computing them.[2]

Coordinates of unvisited point.

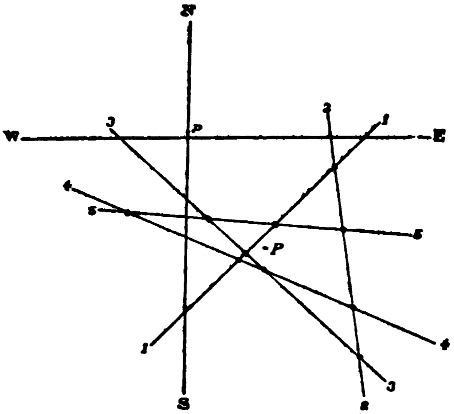

FIG. 6.

III. LEVELLING.

Levelling.

Levelling is the art of determining the relative heights of points on the surface of the ground as referred to a hypothetical surface which cuts the direction of gravity everywhere at right angles. When a line of instrumental levels is commenced at the sea-level, a series of heights is determined corresponding to what would be found by perpendicular measurements upwards from the surface of water communicating freely with the sea in underground channels; thus the line traced indicates a hypothetical prolongation of the surface of the sea inland, which is everywhere conformable to the earth's curvature.

The trigonometrical determination of the relative heights of points at known distances apart, by the measurements of their mutual vertical angles—as already described in section I.—is a method of levelling. But the method to which the term "levelling" is always applied is that of the direct determination of the differences of height from the readings of the lines at which graduated staves, held vertically over the points, are cut by the horizontal plane which passes through the eye of the observer. Each method has its own advantages. The former is less accurate, but best suited for the requirements of a general geographical survey, to obtain the heights of all the more prominent objects on the surface of the ground, whether accessible or not. The latter may be conducted with extreme precision, and is specially valuable for the determination of the relative levels, however minute, of easily accessible points, however numerous, which succeed each other at short intervals apart; thus it is very generally undertaken *pari passu* with geographical surveys, to furnish lines of level for ready reference as a check on the accuracy of the trigonometrical heights. In levelling with staves the measurements are always taken from the horizontal plane which passes through the eye of the observer; but the line of levels which it is the object of the operations to trace is a curved line, everywhere conforming to the normal curvature of the earth's surface, and deviating more and more from the plane of reference as the distance from the station of observation increases. Thus, either a correction for curvature (see footnote, page 742) must be applied to every staff reading, or the instrument must be set up at equal distances from the staves; the curvature correction, being the same for each staff, will then be eliminated from the difference of the readings, which will thus give the true difference of level of the points on which the staves are set up.

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[1] In the Indian Survey, tables are employed for these calculations which give the value of 1″ of arc in feet on the meridian, and on each parallel of latitude, at intervals of 5′ apart; also a corresponding table of arc-versines (Pb) of spheroidal arcs of parallel (Bb) 1° in length, from which the arc-versines for shorter or longer arcs are obtained proportionally to the squares of the arcs; x is taken as the difference of longitude converted into linear measure.

[2] For fuller details and an application to spherical surfaces, see *Account of the Graphic Method of the Ordnance Survey*, by J. O'Farrell, London, 1886.

Levelling is an essentially simple operation; but, as it has to be repeated very frequently in executing a long line of levels—say seven times on an average in every mile—it must be conducted with every precaution against errors of various kinds, instrumental and personal, some accidental and tending to cancel each other, others systematic and cumulative. Instrumental errors arise when the visual axis of the telescope is not perpendicular to the axis of rotation, and when the focusing tube does not move truly parallel to the visual axis on a change of focus. The first error is eliminated, and the second avoided, by placing the instrument at equal distances from the staves; and, as this procedure has also the advantage of eliminating the corrections for both curvature and refraction, it should invariably be adopted. Errors of staff readings should be guarded against by having the staves graduated on both faces, but differently figured, so that the observer may not be biassed to repeat an error of the first reading in the second. The staves of the Indian survey have one face painted white with black divisions—feet, tenths, and hundredths—from 0 to 10, the other black with white divisions from 5.55 to 15.55. Deflection from horizontality may be either measured and allowed for by taking the readings of the ends of the bubble of the spirit-level and applying corresponding corrections to the staff readings, or be eliminated by setting the bubble to the same position on its scale at the reading of the second staff as at that of the first, both being equidistant from the observer.

Certain errors are liable to recur in a constant order and to accumulate to a considerable magnitude, though they may be too minute to attract notice at any single station, as when the work is carried on under a uniformly sinking or rising refraction—from morning to midday or from midday to evening—or when the instrument takes some time to settle down on its bearings after being set up for observation. They may be eliminated (i.) by alternating the order of observation of the staves, taking the back staff first at one station and the forward first at the next; (ii.) by working in a circuit, or returning over the same line back to the origin; (iii.) by dividing a line into sections and reversing the direction of operation in alternate sections. Cumulative error, not eliminable by working in a circuit, may be caused when there is much northing or southing in the direction of the line, for then the sun's light will often fall endwise on the bubble of the level, illuminating the outer edge of the rim at the nearer end and the inner edge at the further end, and so biassing the observer to take scale readings of edges which are not equidistant from the centre of the bubble; this introduces a tendency to raise the south or depress the north ends of lines of level in the northern hemisphere. On long lines, the employment of a second observer, working independently over the same ground as the first, station by station, is very desirable. The great lines are usually carried over the main roads of the country, a number of "bench-marks" being fixed for future reference. In the Ordnance Survey of Great Britain lines have been carried across from coast to coast, in such a manner that the level of any common crossing point may be found by several independent lines. Of these points there are 166 in England, Scotland, and Wales; the discrepancies met with at them were adjusted simultaneously by the method of minimum squares.

Sea-level

Sea-Level.—The sea-level is the natural datum plane for levelling operations, more particularly in countries bordering on the ocean. The earliest surveys of coasts were made for the use of navigators, and, as it was considered very important that the charts should everywhere show the minimum depth of water which a vessel would meet with, low water of spring-tides was adopted as the datum. But this does not answer the requirements of a land survey, because the tidal range between extreme high and low water differs greatly at different points on coast-lines. Thus the generally adopted datum plane for land surveys is the mean-sea level, which, if not absolutely uniform all the world over, is much more nearly so than low water. Tidal observations have been taken at nearly fifty points on the coasts of Great Britain, which were connected by levelling operations; the local levels of mean sea were found to differ by larger magnitudes than could fairly be attributed to errors in the lines of levels, having a range of 12 to 15 inches above or below the mean of all at points on the open coast, and more in tidal rivers.[1] But the general mean of the coast stations for England and Wales was practically identical with that for Scotland. The observations, however, were seldom of longer duration than a fortnight, which is insufficient for an exact determination of even the short period components of the tides, and ignores the annual and semi-annual components, which occasionally attain considerable magnitudes. The mean-sea levels at Port Said in the Mediterranean and at Suez in the Red Sea have been found to be identical, and a similar identity is said to exist in the levels of the Atlantic and the Pacific Oceans on the opposite coasts of the isthmus of Panama. This is in favor of a uniform level all the world over; but, on the other hand, lines of level carried across the continent of Europe make the mean-sea level of the Mediterranean at Marseilles and Trieste from 2 to 5 feet below that of the North Sea and the Atlantic at Amsterdam and Brest, —a result which it is not easy to explain on mechanical principles. In India various tidal stations on the east and west coasts, at which the mean-sea level has been determined from several years' observations, have been connected by lines of level run along the coasts and across the continent; the differences between the results were in all cases due with greater probability to error generated in levelling over lines of great length than to actual differences of sea-level in different localities.

Geoid or deformed surface.

The sea-level, however, may not coincide everywhere with the geometrical figure which most closely represents the earth's surface, but may be raised or lowered, here and there, under the influence of local and abnormal attractions, presenting an equipotential surface—an ellipsoid or spheroid of revolution slightly deformed by bumps and hollows—which Bruns calls a "geoid." Archdeacon Pratt has shown that, under the combined influence of the positive attraction of the Himalayan Mountains and the negative attraction of the Indian Ocean, the sea-level may be some 560 feet higher at Kurrachee than at Cape Comorin; but, on the other hand, the Indian pendulum operations have shown that there is a deficiency of density under the Himalayas and an increase under the bed of the ocean, which may wholly compensate for the excess of the mountain masses and deficiency of the ocean, and leave the surface undisturbed. If any bumps and hollows exist, they cannot be measured instrumentally; for the instrumental levels will be affected by the local attractions precisely as is the sea-level, and will thus invariably show level surfaces even should there be considerable deviations from the geometrical figure.

IV. SURVEY OF INTERIOR DETAIL.

General principles.

(1) *General Principles.*—We have seen that the skeleton framework of a survey may be either a triangulation or a system of traverses; very generally it is a combination of both. The method of filling in the details is neces-

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[1] In tidal estuaries and rivers the mean-water level rises above the mean-sea level as the distance from the open coast line increases; for instance, in the Hooghly river, passing Calcutta, there is a rise of 10 inches in 42 miles between Sagar (Saugor) Island at the mouth of the river and Diamond Harbor, and a further rise of 20 inches in 43 miles between Diamond Harbor and Kidderpur.

sarily influenced to some extent by the nature of the framework, but it depends mainly on the magnitude of the scale and the requisite degree of minutiæ. In all instances the principal triangles and circuit traverses have to be broken down into smaller ones, to furnish a sufficient number of fixed points and lines for the subsequent operations. The filling in may be performed wholly by linear measurements or wholly by direction intersections, but is most frequently effected by both linear and angular measures, the former taken with chains and tapes and offset poles, the latter with small theodolites, sextants, optical squares, or other reflecting instruments, magnetized needles, prismatic compasses, and plane tables. When the scale of a survey is large, the linear and angular measures are usually recorded on the spot in a field-book and afterwards plotted in office; when small they are sometimes drawn on the spot on a plane table and the field-book is dispensed with.

Scale.

(2) *The Scale.*—In every country the scale is generally expressed by the ratio of some fraction or multiple of the smallest to the largest national units of length, but sometimes by the fraction which indicates the ratio of the length of a line on the paper to that of the corresponding line on the ground. The latter form is obviously preferable, being international and independent of the various units of length adopted by different nations. See tables of maps and scales under MAP, vol. xv., p. 529–30. In the Ordnance Survey of Great Britain and Ireland both forms of expression are adopted, the smaller scales being 1 inch and 6 inches to a mile for provinces and counties, the larger $\frac{1}{2500}$ for parishes and $\frac{1}{500}$ for towns. In the Indian Survey the standard topographical scale is 1 inch to a mile, diminishing to ½ and ¼ inch for geographical reconnaissance, and rising by multiples of 2 to higher scales, of which the greatest, for other than city surveys, is 32 inches, for cadastral purposes. In both surveys the double unit of the foot and the Gunter's link (= $\frac{66}{100}$ths of a foot) is employed, the former invariably in the triangulation, the latter very generally in the traversing and filling in, because of its convenience in calculations and measurements of area, a square chain of 100 Gunter's links being exactly one-tenth of an acre.

Ordnance Survey methods;

(3) *Ordnance Survey Methods.*—All linear measures are made with the Gunter's chain, all angular with small theodolites only; neither magnetized nor reflecting instruments nor plane tables are ever employed, except in hill sketching, when bearings are taken with the prismatic compass. As a rule the filling in is done by triangle-chaining only; traverses with theodolite and chain are occasionally resorted to, but only when it is necessary to work round woods and hill tracts across which right lines cannot be carried.

Detail surveying by triangles;

(*a*) *Detail Surveying by Triangles.*—This is based on the points of the minor triangulation. The sides are first chained perfectly straight, all the points where the lines of interior detail cross the sides being fixed; the alignment is effected with a small theodolite, and marks are established at the crossing points and at any other points on the sides where they may be of use in the subsequent operations. The surveyor is given a diagram of the triangulation, but no side lengths, as the accuracy of his chaining is tested by comparison with the trigonometrical values. Then straight lines are carried across the intermediate detail between the points established on the sides; they constitute the principal "cutting up or split lines"; their crossings of detail are marked in turn and straight lines are run between them. The process is continued until a sufficient number of lines and marks have been established on the ground to enable all houses, roads, fences, streams, railways, canals, rivers, boundaries, and other detail to be conveniently measured up to and fixed. Perpendicular offsets are limited to eighty and twenty links for the respective scales of 6 inches to a mile and $\frac{1}{2500}$.

(*b*) *Detail Surveying by Traverses.*—When a considerable area has to be thus treated it is divided into a number of blocks of convenient size, bounded by roads, rivers, or parish boundaries and a "traverse on the meridian of the origin" is carried round the periphery of each block. Commencing at a trigonometrical station, the theodolite is set to circle reading 0° 0′ with the telescope pointing to the north, and at every "forward" station of the traverse the circle is set to the same reading when the telescope is pointed at the "back" station as was obtained at the back station when the telescope was pointing to the forward one. When the circuit is completed and the theodolite again put up at the origin and set on the last back station with the appropriate circle reading, the circle reading, with the telescope again pointed to the first forward station, will be the same as at first, if no error has been committed. This system establishes a convenient check on the accuracy of the operations and enables the angles to be readily protracted on a system of lines parallel to the meridian of the origin. As a further check the traverse is connected with all contiguous trigonometrical stations by measured angles and distances. Traverses are frequently carried between the points already fixed on the sides of the minor triangles; the initial side is then adopted, instead of the meridian, as the axis of coordinates for the plotting, the telescope being pointed with circle reading 0° 0′ to either of the trigonometrical stations at the extremities of the side.

by traverses.

Plotting and examination.

(*c*) *Plotting and Examination.*—The plotting is done from the field-books of the surveyors by a separate agency. Its accuracy is tested by examination on the ground, when all necessary addenda are made. The examiner—who should be both surveyor, plotter, and draftsman—mounts the plot on his sketching block, and verifies the accuracy of the detail by intersections and productions and occasional direct measurements, and generally endeavors to cause the details under examination to prove the accuracy of each other rather than to obtain direct proof by measurement. He fixes conspicuous trees and delineates the woods, footpaths, rocks, precipices, steep slopes, embankments, etc., and supplies the requisite information regarding minor objects—whether pit, shaft, level, spring, well, conduit, weir, quarry, refuse heap, waste, orchard, stackyard, railway, canal, manufacturing and mineral works, viaducts, bridges, tramways, plantations, etc.—to enable a draftsman to make a perfect representation according to the scale of the map. In examining a coast-line he delineates the foreshore and sketches the strike and dip of the stratified rocks. In tidal rivers he ascertains and marks the highest points to which the ordinary tides flow. The examiner on the 25.344 inch scale (= $\frac{1}{2500}$) is required to give all necessary information regarding the parcels of ground of different character—whether arable, pasture, wood, moor, moss, sandy—defining the limits of each on a separate tracing if necessary. He has also to distinguish between turnpike, parish, and occupation roads, to collect all names, and to furnish notes of military, baronial, and ecclesiastical antiquities to enable them to be appropriately represented in the final maps. The latter are subjected to a double examination—first in the office, secondly on the ground; they are then handed over to the officer in charge of the levelling to have the levels and contour lines inserted, and finally to the hill sketchers, whose duty it is to make an artistic representation of the features of the ground.

Indian Survey methods.

(4) *Indian Survey Methods.*—All filling in is invariably done by plane-tabling on a basis of points previously fixed; the methods differ simply in the extent to which linear measures are introduced to supplement the direction rays of the plane table. When the scale of the survey is small, direct measurements of distance are rarely made and the filling is usually done wholly by direction intersections, which fix all the principal points, and by eye-sketching; but as the scale is increased linear measures with chains and offset poles are introduced to the extent that may be desirable. A sheet of drawing paper is mounted on cloth over the face of the plane table; the points, previously fixed by triangulation or otherwise, are projected on it—the collateral meridians and parallels, or the rectangular coordinates, when these are more convenient for employment than the spherical, having first been drawn; the plane table is then ready for use. Operations are commenced at a fixed point by aligning with the sight rule on another fixed point, which brings the meridian line of the table on that of the station. The magnetic needle may now be placed on the table and a position assigned to it for future reference. Rays are drawn from the station point on the table to all conspicuous objects around with the aid of the sight rule. The table is then taken to other fixed points, and the process of ray-drawing is repeated at each; thus a number of objects, some of which may become available as stations of observation, are fixed. Additional stations may be established by setting up the table on a ray, adjusting it on the back station

—that from which the ray was drawn—and then obtaining a cross intersection with the sight rule laid on some other fixed point, also by interpolating between three fixed points situated around the observer. The magnetic needle may not be relied on for correct orientation, but is of service in enabling the table to be set so nearly true at the outset that it has to be very slightly altered afterwards. The error in the setting is indicated by the rays from the surrounding fixed points intersecting in a small triangle instead of a point, and a slight change in azimuth suffices to reduce the triangle to a point, which will indicate the position of the station exactly. Azimuthal error being less apparent on short than on long lines, interpolation is best performed by rays drawn from near points, and checked by rays drawn to distant points, as the latter show most strongly the magnitude of any error of the primary magnetic setting. In this way, and by self-verificatory traverses "on the back ray" between fixed points, plane-table stations are established over the ground at appropriate intervals, depending on the scale of the survey; and from these stations all surrounding objects which the scale permits of being shown are laid down on the table, sometimes by rays only, sometimes by a single ray and a measured distance. The general configuration of the ground is delineated simultaneously.

Checking and examination.

Checking and Examination.—Various methods are followed. For large scale work in plains it is customary to run arbitrary lines across it and make an independent survey of the belt of ground to a distance of a few chains on either side for comparison with the original survey; the smaller scale hill topography is checked by examination from commanding points, and also by traverses run across the finished work on the table.

V. Representation of Ground.

Main lines of ground.

The master lines of ground are the main ridges and water-partings of the hills, the watercourses, and the horizontal contour lines of the coasts; the subordinate lines are those which define the undulations and minor features falling between the low-lying plains and the crests of the hills. These lines must first be laid down on a horizontal projection to fix the dimensions of each feature of the ground, after which the slopes must be indicated with sufficient relief and character to present a true picture of the corrugations of surface. In ancient maps the hills are represented as seen against the sky in profile by a spectator standing on the ground below at some distance off. This system of "natural representation," as it was called, was serviceable in enabling persons looking at the hills from the quarter from which they had been sketched to identify them readily, for which reason such views of distant inland hills are still commonly given on the margins of marine charts of coast-lines for the assistance of navigators. But, when all other objects except the hills are shown in a map by their horizontal projections, hills represented in perspective are false to their surroundings, and misleading to all who approach them from other directions than that of the adopted point of view, for the vertical projection of the profile is practically turned over and confused with the horizontal plane. Hence in course of time hills came to be drawn as if seen from a high bird's-eye point of view, the position of which was shifted until at last the point of sight was supposed to be vertically over them; thus the evils of the perspective system were diminished, whilst something of natural representation was still preserved. About the end of the 18th century the perspective and the bird's-eye systems gave way to the true method of indicating the forms of hills, viz., by their horizontal projections, like all the other details of the ground, and by adding the requisite shading to bring every feature into proper relief.

Hill-shading.

Hill-Shading.—There are two rival methods of hill-shading,—one by horizontal contours, the other by vertical hachures. A contour being the line of intersection of a hill by a horizontal plane, contour lines indicate the markings which would be made by the successive risings of a flood to different levels above the sea; vertical hachures indicate the directions which the particles of a volume of water, equally disseminated over the top of a hill would naturally take in running down the sides and slopes. The most perfect representation of ground is obtained when the shade lines, whether horizontal or vertical, are sufficiently close and well graduated in tone and intensity to imitate good mezzotint shading in Indian ink. A good effect may be and is frequently produced by assuming light to fall on the hills obliquely from a specific direction, illuminating them on one side and throwing the reverse slopes into shadow. But this has the disadvantage of giving similar slopes different intensities of shade according to their position with reference to the assumed direction of the light; on the other hand, vertical lighting, which gives the same intensity to the same slope wherever situated, fails in relief and perspicacity. A commission of citizens appointed by the republican Government of France in 1803 to formulate rules on the subject of topography, condemned the representation of hills in demi-perspective as absurd, but approved the system of oblique side-light; it also condemned contours, except for engineering works, and recommended vertical hachures, under the idea that the slope lines of the fall of water represent a material effect of which the eye is witness every moment, and recalls the general cause, if not of the formation, at least of the figure and characteristics, of the mountains.

Scale of shade.

Scale of Shade.—For military purposes it is very desirable that maps should be so drawn as to enable the angles of inclination of all slopes to be readily ascertained, with a view to determining what portions of the ground are suited for the manœuvres of each of the three arms,—infantry, cavalry, and artillery. Thus military topographers of different nationalities have proposed a variety of scales to regulate the thickness and distance apart of the shade lines, and generally the proportion of black to white, for different angles of slope, that the map may convey to the mind as accurate a knowledge of the slopes of the ground as of the horizontal outlines. All slopes, however, are not of equal practical importance, but only those which are of most common occurrence and most liable to be gone over by men and horses and wheeled vehicles, and their inclination rarely exceeds 25°; consequently it is of most importance to be able to distinguish variations of slope below that angle: it is occasionally desirable to know the sharper slopes up to 45° or 50°, but greater inclinations are comparatively of rare occurrence and unimportant. Now in a true scale of shade the intensity increases with the inclination from 0° to 9°; thus putting black + white = 1, the proportion of black to white for any inclination i by a scale of cosines will be black = 1 − cos i, white = cos i. But that scale does not sufficiently accentuate the lower inclinations, which are the most important, and have therefore to be dealt with more emphatically; this has led to the introduction of a variety of conventional scales, each with the special characteristics which commended themselves to its author. Major Lehmann of the German army supposed light to be admitted in parallel vertical rays and gave the horizontal plane the fullest light, because the reflected coincides with the vertical ray; at an inclination of 45° the reflected ray is perfectly horizontal, and this slope was therefore least illumined. Disregarding all greater slopes, he placed 45° at the head of his scale and represented it by absolute black; the scale was divided into nine equal parts of 5° each, from 0° to 45°, up to which the illumination varies inversely as the angle of inclination. General van Gorkum of the Netherlands army improved on Lehmann's system: he adopted certain groups of contours arranged according to the slope, making the vertical distances between the contours equal in each group but greater in the higher groups, and between the contours he drew vertical hachures the lengths of which showed by reference to a scale the angles of slope. His lowest group included all angles up to 25°, the vertical distance between the contours being so regulated with reference to the scale of the map as to permit the draftsman to represent the slopes without inconveniently long hachures. For higher angles he doubled and trebled the vertical interval of his contours and the thickness of his hachures. Thus the relative altitudes of any required points might be deduced with comparative facility by noting the thickness and counting the number of the vertical hachures between them. In this respect the system satisfies the requirements of a military map, but the effect is unpleasing and unsuggestive of hill forms. In 1828 a second French commission, having Laplace for its president, was appointed to report on topographical drawing. It reversed the decision of the first commission in favor of oblique side light, as being difficult to execute and inaccurate in giving different intensities to the same angles of slope facing differently; and, after trying various scales of shade, it determined to increase the intensity in proportion to the sines of double the angles of inclination diminished by $\frac{1}{15}$, which gives a more rapid increase of shade for the gentle than the steep slopes. In subsequent instructions of the "depôt de la guerre" the proportion of black to white is fixed at one and a half times the angle of slope. In England various scales of shade have been proposed by Colonel Scott and Captain Webber of the Royal Engineers, and by the Council of Military Education. Colonel Scott's scale is interesting as having been derived from the average of measurements taken from the best examples of hill sketching in the Ordnance and other surveys, whereas all the others were deduced from a conventional application of geometrical principles. The following table (III.) gives the several scales:

Table showing the Proportion of Black to White on any Unit of Area, in Horizontal Plan.

Angle of Slope.	Scale of Cosines.		Major Lehmann.		First French.		Second French.		Colonel Scott.		Captain Webber.		Council of Military Education.	
	B.	W.	B.	W.	B.	W.	B.	W.	B.	W.	B.	W.	B.	W.
90°	1.000	.000	..	..	..	..	..	..	..	..	..	..	..	..
45°	.293	.707	1.000	0.000	.600	.400	.675	.325	.708	.292	.803	.197	..	..
35°	.181	.819	.780	.220	.512	.488	.425	.575	..	..	.724	.276	.640	.360
25°	.094	.906	.560	.440	.389	.611	.375	.625	.339	.661	.550	.450	.457	.543
20°	.060	.940	.450	.550	.350	.650	.300	.700	.255	.745	.455	.545	.333	.667
15°	.034	.966	.340	.660	.286	.714	.225	.775	.189	.811	.338	.662	.254	.746
10°	.015	.985	.230	.770	.209	.791	.150	.850	.126	.874	.250	.750	.160	.840
7°	.007	.993	.155	.845	.155	.845	.105	.895	.083	.917	.173	.827	..	..
5°	.004	.996	120	.880	.110	.890	.075	.925	.055	.945	.108	.892	.052	.948
4°	.002	.998	.077	.923	.095	.905	.060	.940	.049	.951	.065	.935	..	..
3°	.001	.999	.066	.934	.073	.927	.045	.955	.038	.962	.033	.967	.047	.953
2°	.001	.999	.044	.956	.050	.950	.030	.970	.025	.975	.014	.986	.025	.975

Mezzotint shading.

Of late years the system of shading by lines has been abandoned for the English army, and a method of representing slopes by mezzotint shading over a few governing contour lines, laid down by actual survey, has been introduced instead. The effect aimed at is a transparent shade, dark in proportion to the steepness of the ground represented; its object is to give body and expression to the contours and to explain and develop minor features of the ground which may lie between them. This style of shading, being distinct from all line drawing, may be applied over the most crowded details without causing confusion, such as would be produced by hachure shading. The contours are indicated by continuous red lines of constant thickness, strong enough to be everywhere visible through the shading, which is effected by applying lead with a soft pencil over the parts where it is wanted, and then rubbing it in firmly with a piece of chamois leather folded into a small pad. No pencil marking is allowed; lightening is done with india-rubber; the shading is finally fixed with a wash of thin gum-water.

It is to be noted that the several scales of shade above given were devised for military maps to be drawn on a scale of not less than 4 inches to the mile and possibly much greater. The harshness and mannerism to which all line-shading by rule is liable are of less importance in maps of small areas represented on large scales than on maps of large areas on small scales. In the former the sacrifice of pictorial effect is more than compensated by the additional information regarding the slopes of the ground; in the latter any attempt to introduce so much information would tend to crowd the map objectionably, and confuse the vertical with the horizontal details. The smaller the scale of a map of hill country the more necessary it is to abandon mechanical conventionalism, and to aim at achieving an artistic representation which will convey an immediate and accurate impression of the general character of the ground.

In India the topography has been mainly executed on scales of or less than 1 inch = 1 mile and rarely exceeding 2 inches, and, as the range of altitude varies considerably in different parts of the country, from plains and undulations little above the sea-level to mountains rising to an altitude of 29,000 feet, scales of shade were long deemed wholly unsuitable for employment. The higher mountains had necessarily to be brought into prominence over the lower by giving them a darker shade than was due simply to their slopes, and similarly the elevated plateaus had to be more lightened and illuminated than the low-lying plains. But in course of time, as the number of hands employed in the operations increased more rapidly than the available supply of artistic draftsmen, the introduction of a scale of shade became necessary, in order that the multitude of workers might be put more nearly on a par with the few. For men who have been accustomed to associate a certain depth of shade with a certain angle of slope will work together within narrower limits of error and divergence than if left entirely to their own unaided judgment and untutored proclivities. The field sketchers should therefore learn to work on a system which gives every hachure line a definite meaning, so that their sketches may be rightly interpreted and appropriately translated and rendered in the final representation of the ground, when it is the duty of the draftsman to enhance the tone of the map as much as possible while maintaining its truthfulness.

Ordnance Survey delineation of ground.

Ordnance Survey System of Delineating Ground.—As a rule the features of the ground are sketched in the field on the 6-inch scale, and afterwards reduced and published on the 1-inch scale. The Highlands of Scotland were sketched partly on the 1-inch and partly on the 2-inch scale; in Ireland the 1-inch scale only was used; and this scale is now being adopted for hill sketching in England and Wales. In the parts where the 6-inch scale was used the ground was first contoured instrumentally; a plan of the contours and of all surveyed outlines was supplied to the sketcher, who proceeded to insert the hill features with the aid of a prismatic compass, protractor, plotting scale, and a "hill-sketcher's scale," graduated to show the horizontal intervals between the contours which correspond to various angles of inclination from 0° to 45°. He was required to delineate slopes up to 45° by horizontal hachures, and slopes beyond 45° by vertical hachures. The thickness and number of the strokes, the relation to light and shade, and the character of the touch were left to the skill and experience of the sketcher. The introduction of scales of shade adapted to various inclinations and altitudes was frequently mooted, with a view to securing greater uniformity; but no such scale was adopted, for it was found that, though at first different workmen produced different results, long practice and constant comparison, together with the aid derived from the instrumental contours, effected all desirable uniformity. Thus in good sketches it was found that the maximum breadth of stroke used in the representation of very steep mountain slopes was $\frac{1}{45}$ inch, and the minimum used in low and nearly flat country, $\frac{1}{500}$ inch, also that the average proportions of light to shade were 1 to 3 at the maximum and 25 to 1 at the minimum inclinations. In the field sketches the light is supposed to fall vertically, and all slopes of like altitude and inclination are similarly expressed. The 6-inch sketches are reduced to the 1-inch scale for publication by an artist working with Indian-ink and the camel-hair brush on an impression in outline of the 1-inch map. He makes a careful study of the several sketches which he has to combine together, in order to determine which features should be retained and which omitted in the reduction, and he divides the ground into zones of different altitude to guide him in giving a strength of shade proportioned to the altitude rather than to the slope as in the field sketches; and in drawing he increases the contrasts between light and shade and introduces light from a corner of the map to give a stronger relief, and to attract the eye to the highest points and enable it to distinguish readily the higher from the lower ground. His general aim is to produce a more pictorial and less mechanical study of the ground than is supplied by the field sketches. Many exquisite maps have been thus produced and afterwards engraved; see sheets 32, 33, 38, 53, and 64 of Scotland, 38 and 48 of England, 75 of Wales, 93, 94, 191, and 192 of Ireland. These sheets, however, though admirable specimens of engraving, fall short of the original drawings in tone and relief, for in them the hill-shading is necessarily shown by line-etching, and it does not produce such effective contrasts and gradations of light and shade as the original brush work.[1]

Instrumental contouring.

Delineation by Instrumental Contouring.—A very precise knowledge of the configuration of surface may be acquired by carrying true contour lines over the ground and projecting them on the map of the survey. But the contours do not give a true representation of the ground, for they seldom represent actual lines on the surface, as do the lines on the map which indicate roads, watercourses, walls, inclosures, etc.; they give, however, a conventional representation which is sufficient *per se* for the engineer and the expert, and they furnish guiding lines for all shading, whether by hachures or mezzotint, which may be subsequently executed to produce an artistic delineation of the features of the ground. In instrumental contouring we have first to decide on the vertical intervals to be maintained between the contours. They depend on the scale of the survey and the nature of the ground. In the Ordnance Survey they are made as small as from 5 to 10 feet, when special plans on large scales are being prepared for engineering requirements; but for the general maps they are 50 feet up to an elevation of 100 feet above the sea-level, and 100 beyond up to 900 feet, which elevation, being the practical limit of cultivation, is the highest generally marked, though in the northern counties of England and in parts of Scotland additional contours have been executed at the altitudes of 1000, 1250, 1500, 1750, 2000, 2500, 3000, etc., feet. The intervals having been determined on, instrumental levelling is commenced at either the top or the bottom of those slopes which best define the general lay of the ground, or at some previously established bench mark of which the height above the sea is known. Points are marked out on the slopes with pickets at the prescribed vertical intervals, and then the contour lines of the horizontal planes passing in succession through each of these points are traced with a levelling instrument and staff and surveyed by traverse, the two processes being performed either simultaneously or consecutively as may be most convenient.

The instruments generally used in the Ordnance Survey are a 5-inch theodolite—employed as a levelling instrument—and a contouring staff, 8 feet long, provided with a sliding vane which may be fixed at any required height; the staff is shifted about until the vane is brought into the horizontal plane of the theodolite, when the bottom of the staff will be on the contour line. A serviceable contouring instrument of very simple construction is the water-level, which consists of a pair of transparent vials partially filled with water; the vials are placed upside down at the ends of a hollow bar fixed on a rotatory vertical axis, and have their mouths connected with piping of any available material,—brass, tin, or gutta-percha. The water in both vials is in free communication, and the water surfaces indicate the horizontal plane naturally, without any mechanical contrivance. The instrument is well suited for short sights not requiring a telescope, and may be readily manipulated by persons ignorant of the use of instruments of a higher class. Eye-reflecting levels, clinometers, orometers, and other light instruments, which may be held in the hand and do not require a fixed support, are frequently employed for interpolating minor between major contours. In military sketching on large scales hypothenusal inclinations and lengths are sometimes measured; the bases and perpendiculars are deduced on the spot from a table of gradients; and then the contour lines, and the orthogonals also if required, are laid down.

VI. GEOGRAPHICAL RECONNAISSANCE.

Geographical reconnaissance.

When a traveller passes through an unknown or little known region the opportunity afforded him of acquiring some new geographical knowledge depends largely on the configuration and aspects of the ground, the condition of the atmosphere, the attitude of the inhabitants, and the time available. If hills are numerous and prominent and free from forest, and other conditions are favorable, a large area may be covered in a short time by reconnaissance from the stations of a chain of triangles carried along the line of route, fixing points in advance, some of which become stations of observation whence further points are fixed; and thus the continuity of the operations is maintained. But the ground may be flat and devoid of prominent points, the view circumscribed by forests and other obstacles, the atmosphere dense and unfavorable for distant vision, the inhabitants hostile, and the time short, and the traveller may be restricted to his line of route and unable to deviate from it; he must then endeavor to maintain a continuous traverse of the route, sketching in the ground in its immediate vicinity. Whenever breaks of continuity occur he must resort to astronomical observations to effect a connection between the dissociated sections of his survey and to obtain an independent check on the general accuracy of the operations. He has therefore to be prepared to measure base-lines, to carry on a triangulation in some regions and a traverse in others, and to make any astronomical observations which may be wanted, and, if possible, to complete his mapping on the ground instead of postponing it to be done elsewhere. He should supply himself with some instruments suited for rough and rapid work and with others for better work when time and opportunity permit, and he should be careful to arrange beforehand the general character of the proposed operations and the scales and projections to be adopted for the mapping; he should also provide himself with blank sheets of paper duly graticulated to scale for work in detail in the vicinity of the line of route and for general geography. For measures of base-lines and distances on the ground, chains, rolls of crinoline wire, long Assam canes, and perambulators may be employed, also omnimeters and subtense theodolites, to measure the angle subtended by a pole of known length, whence the distance may be deduced. For measures of angles and bearings, either theodolites,[2] or sextants, or prismatic compasses may be used, according as more or less accuracy is required. For the general survey the plane table is a most valuable instrument; it enables bearings to be at once laid down on the paper without previous measurement, and much detail to be sketched in on the spot, instead of being plotted subsequently from a field-book; then the only independent angular measurements which need be taken are those of the principal triangles and of very distant points beyond the range of the table. Rough and rapid route surveys may be made by pacing the distances, taking the magnetic bearings, and combining with the results of astronomical observation. Many thousand miles of itinerary through regions in Central Asia have been surveyed by Asiatic employés of the Indian Government in this way; the northings and southings were controlled by latitude observations, and the factors thus obtained were applied to the eastings and westings, longitudes being impracticable. The theodolite should be employed to fix points on very distant ranges, for it will give good results, even with short bases and very acute angles, provided the objects actually observed are well identified in each instance. Observations should be taken from three stations, giving two triangles with a common side, which will at once show up any mistake, whether of identity, circle reading, or calculation. Whenever a break of continuity occurs in the triangulation or the traversing, astronomical observations must be resorted to. Much may be done by a judicious introduction of latitudes and azimuths, more particularly where there is considerable northing and southing, for then differences of longitude may be obtained from the azimuths and differences of latitude. A prominent peak, visible from great distances all round, may be made to serve as a connecting link between regions which cannot be continuously connected, by measuring its azimuth and distance from a base-line in each region; the addition of latitudes at the azimuth stations will much strengthen the work.

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[1] With certain exceptions, principally of a military nature, the hill features are now sketched on the 1-inch scale, on photographic reductions of the 6-inch contoured sheets, faintly printed in orange color, as a guide to the sketchers.

[2] In many respects a theodolite is more suitable than a sextant: (1) it measures horizontal angles directly, whereas the sextant measures oblique angles, which have to be reduced to the horizon; (2) it measures a round of several angles with much greater facility; (3) it measures all vertical angles with equal facility, including the small elevations and depressions of distant peaks which cannot be readily seen by reflection from mercury for measurement with a sextant; (4) its telescopic power is usually far higher; (5) it may be so manipulated as to eliminate the effects, without ascertaining the magnitudes, of the constant instrumental errors,—excentricity, index, and collimation; and (6) when much accuracy is required the influence of graduation errors may be greatly reduced by systematic changes of the settings of the horizontal circle.

Collateral Astronomical Determinations.—Determinations of azimuth, latitude, time, and longitude may all be required for geographical reconnaissance,—the first two more particularly, as they can be obtained readily with much accuracy; the fourth, being much the most troublesome to get and the least reliable when got, is only resorted to when it cannot be dispensed with.

Azimuth.

The azimuth of an object may be determined without calculation by observing the angles between the object and a star at equal altitudes on opposite sides of the meridian; but it is generally found by observing the angle in one position of the star and applying thereto the azimuth of the star as obtained by calculation. In the spherical triangle *PZS*, in which *P* represents the pole, *Z* the zenith, and *S* the star, the angle *PZS* is the star's azimuth, which can be computed when any three parts of the triangle are given. *PS*, the polar distance of the star, is given by the tables, and *PZ*, the co-latitude, must be previously determined; then, for the third part, we may have either (1) *PSZ*, a right angle, by observing a circumpolar star at its maximum elongation, or (2) the hour angle *P* for any star, by taking the time of the observation, or (3) the zenith distance *ZS*, by measurement simultaneously with the horizontal angle. Of these three methods the first is the most accurate, but it is not always convenient; the second requires, in addition, special observations for time; the third is generally the most convenient, for it may be performed between sunset and dark, when the stars are coming into view, but when there is still sufficient light to illuminate the wires of the telescope and the referring mark, and thus enable lamps to be dispensed with.

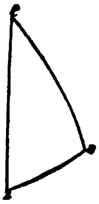

FIG. 7.

Latitude.

The latitude is most readily determined by measures of stars' zenith distances on the meridian, duly corrected for refraction; then, the polar distance being known, the latitude is at once ascertained. The stars should be observed in pairs of nearly equal zenith distance, north and south, for this eliminates all constant instrumental errors, as of index, excentricity, and graduation, and also errors in the adopted refractions. When a single star is employed, circum-meridian observations of zenith distance may be taken and reduced to the meridian by calculation; tables for the pole star are given in the *Nautical Almanac*, which enable an observation, taken at any known time in the 24 hours, to be reduced to the pole.

Time.

The time is usually best determined by measuring the zenith distances of stars situated not far from the prime vertical; then, the latitude and polar distance being known, the hour angle *P* of the spherical triangle is found by calculation. Time may also be determined by observing the transits of stars over the wires of the telescope of a theodolite set up in the meridian.

Longitude.

The longitude may be determined either absolutely, by purely astronomical methods, as by observations of the moon's motion, or differentially, with the aid of telegraph lines and travelling chronometers. Absolute longitude is the geographer's great difficulty; for much time must be devoted to the observations, and much more to their reduction, when undertaken with the object of fixing the relative positions of the stations of a survey. The observations are of various kinds,—(1) lunar distances, *i.e.*, the distance between the moon and the sun or one of the stars given for this purpose in the *Nautical Almanac;* (2) lunar zenith distances, observed at points of the moon's path where the conditions are favorable; (3) lunar transits over the meridian, observed with transits of the moon-culminating stars given in the *Nautical Almanac;* (4) lunar occultations of stars; (5) eclipses of the sun and moon; (6) eclipses of Jupiter's satellites. The first method requires the employment of a sextant or other reflecting instrument; the second may be accomplished with either a reflecting instrument or a theodolite; the third with a theodolite; for the last three a good astronomical telescope is wanted. The first, when carried out strictly, requires three observers,—one to measure the lunar distance, while the others are measuring the zenith distances of the moon and the star; but, as the last two are not wanted with great accuracy, the several observations may be taken in succession by one person, and the observed zenith distances afterwards adjusted to the time of the lunar distance.

The effects of errors of observation in these methods are as follows: In (1) an error in time produces the same error in the longitude, and an error of one second of arc in the distance produces two seconds in time in the longitude. In (2) an error of one second in time produces at least thirty seconds of time error in the longitude, and one second of arc in the zenith distance at least two seconds of time in the longitude. In (3) to (6) an error of time produces the same error in the longitude. The first method is preferred by seamen and travellers, who are more expert in the use of the sextant than of the theodolite. The second method is preferred by those who are more familiar with the theodolite, and who are equipped with one of good telescopic power. It gives very good results when the observations are made at the most favorable time, which occurs when the resultant of the moon's motion in right ascension and in declination lies in the direction of the observer's zenith; this time may be readily found by graphical projection on a chart of the heavens.

Differential longitude.

Differential longitude may be determined chronometrically, on land as at sea, by carrying about several well-rated chronometers and comparing their times with the local times deduced from observations of the sun and stars; or electro-telegraphically, by interchanging signals between two stations connected by a telegraph wire, and ascertaining the local times at which the signals are transmitted from and received at each station.

Hypsometry.

Hypsometry.—Determinations of height form a very necessary part of geographical reconnaissance. Whenever triangulation is possible, vertical angles may be measured and the heights ascertained in regular succession. But in a traverse this is scarcely practicable; breaks of continuity in the verticals are liable to be of frequent occurrence, and then recourse must be had to observations of the pressure and temperature of the atmosphere, or of the temperature of the vapor of boiling water, from either of which fairly correct heights may be deduced differentially under normal atmospheric conditions in settled weather. The instruments employed for this purpose are mercurial and aneroid barometers and boiling-point thermometers; descriptions of them, and the formulæ employed in reducing the observations, are given under BAROMETER (vol. iii. pp. 329–34). Here it is only necessary to add that the date and hour of every barometric observation should be recorded, and the observations referred for reduction to those taken at the same time at one or more of the nearest standard meteorological observatories; otherwise corrections should be given to the barometer readings for the hour of the day and the month of the year, in order to reduce them as nearly as may be to the local mean altitude of the mercury. The index errors of aneroid barometers, being liable to variations, should be determined from time to time by observations at stations of known altitude, or by comparisons with boiling-point thermometers.

VII. NAUTICAL SURVEYING.

Nautical surveying.

Nautical surveying has for its object the determination of the configuration of land which is covered and concealed from view by water, more particularly along the foreshore of a coast-line, and wherever navigation is carried on in comparatively shallow waters and a knowledge of the depth of water is of great importance; it has likewise to lay down the positions of oceanic islands, shoals, and rocks, and generally to delineate whatever land exists immediately above or below the surface of the ocean. Its methods differ according as they are performed in or out of sight of land. When in the vicinity of land it is preceded by a survey of the coast-line and a belt of the country beyond, which must be of sufficient breadth to furnish suitable points of reference for the survey operations on the water, and may have to be extended inland to embrace those peaks of distant hill ranges which are prominent objects at sea for the guidance of mariners. This done, the nautical survey is carried on in boats, by taking soundings and determining the positions of the boats by observations to some of the points already fixed on land. The observations are necessarily made with sextants and magnetic compasses only. With the former the angles between conspicuous land-marks are measured, and, as the angle between any two points is half the magnitude of the angle between the same points at the centre of the circle which passes through them and through the boat, the measurement of two angles between three points enables two circles to be drawn on the chart, the intersection of which will generally indicate the position of the boat with sufficient accuracy. Occasionally, however, it happens that the positions of all three points on shore and the boat also lie actually, or very nearly, on the circumference of one and the same circle; then a bearing taken with the compass will fix the position of the boat on the circumference of the circle. Time is noted whenever soundings are taken, that due allowance may be made for the rise and fall of the tide. All the sounding stations are not fixed by observations to points on shore, as just indicated, but only a certain proportion, and between them straight lines of sounding are run, with intervals measured either by a patent log, or by time, or by counting the strokes of the oars; whenever possible the lines of sounding are carried parallel to each other. Sounding is the most important part of a nautical surveyor's duty and that on which his character mainly depends. It is essentially the work of the sailor, for in carrying it out the accidents of wind and water—the direction and force of the wind, the rise and fall of the tide, and the velocity of currents—must be duly taken cognizance of and the work managed to suit wind and weather; on the other hand, the work on land may be done by landsmen. Nautical surveying, out of sight of land, rests on astronomical determinations of latitude and time, chronometric longitudes, and dead reckoning by log. When triangulation is resorted to, base-lines are measured sometimes with a patent log, sometimes by sound, by noting the interval in time between the flash and the report of a gun. The great length of modern ironclads presents a base-line which is occasionally very convenient; points are taken at each end of the ship, as far apart as possible, from which two observers can see each other; they are carefully marked, and the distances between them determined for future reference; then angles between moderately distant objects and observers standing at these points, taken simultaneously from each point, enable the required distances to be obtained. The magnetic variation is determined by observing the azimuth of the sun, when on or near the horizon, with a standard compass fixed amidship, care being taken beforehand to determine any deviation of the needle which may be due to the attraction of the surrounding ironwork, by observing the bearing of a distant mark as the ship is swung round and her head laid on different points of the compass. See also NAVIGATION (Practical), vol. xvii. p. 282.

VIII. MAPPING.

Graticulation.

Graticulation.—The sheets of paper on which the details of the survey of any large area of country are to be laid down must be furnished with a system of conventional lines, drawn with a view to assimilate the margins of contiguous sheets and to form a graticulation within which the details may be accurately inserted. The graticule is sometimes rectangular, sometimes spherical, sometimes a combination of both, as when points of which the latitude and longitude coordinates are given have to be plotted within rectangular marginal lines. Spherical graticules are constructed in various ways, usually in accordance with some specific method of projection; see GEOGRAPHY (Mathematical), vol. x. p. 178 *sq.* The following convenient method is not referable to any demonstrated projection, but is generally employed on the Indian Survey. Suppose the intersection of two meridians by two parallels to form a small spherical quadrilateral, with sides of aliquot parts of a degree in latitude and in longitude; let m be the length of each of the meridional arcs, p, p' the lengths of the arcs on the upper and lower parallels, and let q be a diameter, then

$$q=\sqrt{m^2+p.p'};$$

thus, m, p, and p' being given, q is calculated. With these data, which are tabulated for different arcs and scales, the corner points of a number of quadrilaterals are laid off in succession on either side of an adopted meridian, the lines are drawn through the points to indicate the collateral meridians and the parallels of latitude. The latter are always curved, more or less sensibly; the former are also curved, though in a much less degree, being concave to their initial meridian, and the more so the farther they are from it. When the area is small and the scale large, the meridians are practically straight lines, and the several sheets of a map, each projected on its own meridian, will fit together closely when carried on in any direction. But, when the area is large—exceeding 8 or 10 square degrees—and the scale small, the sheets will not fit together continuously unless they are projected with reference to a single meridian for the whole map, to which the meridians on either side will be increasingly concave, or unless all the meridians are made straight lines, by slightly contracting each of the intermediate arcs of parallel to a length which is exactly proportioned to the lengths and relative distances of the upper and lower parallels of the map from it. There must be some distortion in either case; in the first, meridians which are actually straight lines are represented as being curved; in the second, straight meridians are obtained, but the distances between them are exact only on the upper and lower parallels, and are too small elsewhere, more particularly on the middle parallel, the length of which necessarily exceeds the mean length of the upper and lower parallels.[1] But distortion is inevitable whenever a spherical surface is projected on a plane.

When a map is constructed in rectangular sheets, some station is adopted as the origin and its meridian as the principal axis, to which the corner points of the sheets are to be referred; the coordinates of these points are given such dimensions as are most suitable for the size and scale of the map, and are equivalent to the rectangular spherical coordinates of imaginary points on the curved surface of the earth, at corresponding distances from the origin and its meridian. These being given, the distances of the points from the origin in latitude and longitude may be computed, as already shown (p. 742); thus data become available for projecting the graticulation of meridians and parallels within the rectangular marginal lines of each sheet, or for introducing the divisions of latitude and longitude on the marginal lines if preferred. Conversely, when the latitudes and longitudes are given, the rectangular spherical coordinates are computed and the marginal lines projected around the graticulation. Filling in is then commenced; the principal stations are laid down by their coordinates and the topographical details pencilled around them by copying or tracing the field sheets of the survey; the names and the outlines are then inked in; the shading for delineating the features and general configuration of the ground is usually done last of all. The manner in which the details are inked in and rendered permanent depends on whether the map is to be reproduced by hand only—as when it is to be engraved or lithographed—or whether in its reproduction photography is to be employed and the action of light invoked, either in entire supersession of or in partial co-operation with the labor of the draftsman. In the former case the map is made as perfect a pictorial representation of the surface of the ground as possible, the hill features being represented artistically in mezzotint shading with a brush or in chalk drawing, and a variety of colors used to facilitate discrimination of differences of topographical detail. In the latter no colors are used which will not photograph well, nor flat shades of any color, nor—as a rule—mezzotint shading, but only some substitute therefore in pen and ink. This last condition is essential for the commonly employed processes of photo-zincography and photo-lithography; but endeavors have recently been made, with some degree of success, to reproduce mapping in middle tones by the processes of photo-collotype and photo-gravure.

Photography in mapping.

Photography is much employed as an auxiliary in mapping; for when a map is to be published on various scales the hand-drawn details of the largest scale edition may be reduced by its means as accurately as by the familiar pantagraph, and of course very much more rapidly. Thus in the Ordnance Survey town maps on the scale of $\frac{1}{500}$ are reduced to the scale of $\frac{1}{2500}$ for incorporation into the parish maps; the latter are reduced for insertion in the 6-inch maps, and they in turn for the 1-inch map. By limiting the dimensions of each sheet for reduction to 3 feet by 2, and by a judicious use of stops to lenses, the reductions are made without any error in scale or any distortion that can be detected by the most rigid examination. But photography reduces every part of the original alike, the printing of words and names as well as the topographical details, and it reproduces all the minor and less important as well as the more important features; hence a reduction is rarely suited for reproduction without intermediate modification, the printing being generally too small to be easily legible, and the mass of minor detail tending to confuse the principal sub-lines. The draftsman is therefore called in and the procedure so arranged as to obtain the best results with the least labor. Either he may construct a new map by tracing from a silver print of the photograph whatever topographical details are required for it and omitting the rest, or he may ink in such details at once with black ink on a blue print taken from a transfer of the photograph to stone or zinc, in both cases adding names and writing of appropriate sizes; either result may be reproduced by photography, as the unblackened details of the blue print will disappear in the process. This done, a transfer to stone or zinc may be made from the second photograph for the printing off. Prints from photographic reproductions to full scale exhibit all the blemishes of the hand drawing and somewhat exaggerate them, whereas prints from photo-reductions are freer from blemish, and often as clear and sharp as good hand lithographs. In employing a process of double photography therefore, the first photo is usually made on a larger scale than that for publication; the lines of the printing and topographical detail are correspondingly exaggerated by the draftsman; and then the second photo is a reduction, which should be sharp, clear, and free from blemish.

IX. MAP PRINTING.

Various processes are employed for the reproduction of maps in large numbers for general issue; some are purely manual, the map being redrawn by hand on copper, stone, or other substance presenting a suitable surface from which prints may be taken, or on paper specially prepared for transfer to such substance; others are carried out with the aid of photography, whereby an exact copy of the original can be obtained either directly upon, or for subsequent transfer to, the surface to be printed from. The former include the processes of copper-plate engraving and lithography, which are the oldest, and still in some respects the best of all, but slow and expensive; the latter include the processes of photo-lithography, photo-zincography, photo-gravure, and photo-collotype. Engraving on stone is much employed on the Continent for map work, being cheaper and quicker than engraving on copper. Electro-metallurgic processes are frequently employed in connection with copper-plate engraving, either to protect and harden the surface of the plate with a facing of steel or to furnish duplicates to be printed from, instead of the plate itself being used; sometimes the wear of the plate is prevented by transferring a print from it to a lithographic stone or a zinc plate, from which the printing is done in its stead. By the anastatic process an old print of a map may be transferred to a zinc plate to be printed from.

Engraving.

Engraving may be performed on copper, wood, zinc, or stone; see vol. viii. p. 388. As done on copper plate for mapping, it is a combination of ploughing with the burin and etching with an acid the former being used for the names and topographical outlines, the latter for the features of the ground. The system adopted in the Ordnance Survey of Great Britain—where it has been largely employed and carried to great perfection—is as follows. The 6-inch maps of the survey are engraved on copper plates measuring 36 by 24 inches within the marginal lines and weighing about 35 ℔; the 1-inch maps are 18 by 12 for England and 24 by 18 for Scotland. The corners of the maps, the prescribed marginal subdivisions, and the trigonometrical points are first marked on the plate by a scoring machine, in which it is laid, and which is provided with a travelling carriage holding a steel pricker. The carriage is moved along a graduated scale and the pricker along another scale at right angles to the former, and all points of which the rectangular coordinates are known are laid off by vernier-read measurements from the two scales. The plate is then removed from the scoring machine, heated, and given a thin coating of white wax, to form a surface on which the topographical details are plotted before the graving is commenced. This surface is divided into a number of rectangles by fine lines joining marginal subdivisions, the distances between which are usually so regulated as to introduce sixteen of the survey sheets on the $\frac{1}{2500}$ scale into one sheet on the 6-inch scale. The reductions to this scale are made by photography, and the subsequent reductions to the 1-inch scale either by the pantagraph or by photography. Tracings of the reductions in lamp-black, made to fit into the rectangles, are transferred to the wax ground by rubbing with a steel burnisher.

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[1] In Mr. O'Farrell's pamphlet *On the Construction and Use of the Six Sheets of Marginal Lines for Maps of every Part of the World*, published by the Ordnance Survey, tables are given of the lengths of meridional and longitudinal arcs, their versines and diagonals for every ten minutes in latitude from the equator to 80° N. and 80° S.

The plate is then ready to be placed in the hands of the engravers, who complete first the outlines, then the printing and writing, and afterwards the ornament, each class of work being usually done by a different person. The figures of latitudes, longitudes, and altitudes, and various conventional symbols, are stamped with steel punches. Parks and sands are ruled with a dotting wheel, and buildings shaded in lines with a ruling machine. When a plate of the 1-inch map is being engraved, all the printing is completed, and line-engraving with the exception of the contour lines, and then an electrotype duplicate of the plate is taken. The contour-lines are engraved on the duplicate, and the hills are etched on the original plate; thus two editions of the map are obtained, one with contours but without hills, the other with hills but without contours, the topographical details and writing being the same in both. In etching, the surface of the plate is thinly coated with an acid-resisting substance composed of asphalt, Burgundy pitch, and virgin wax, forming an etching ground, on which the outlines of the hill features are traced, and then marked through with a needle which removes the ground where it passes, exposing the surface of the copper. Aquafortis is applied to bite in the finer lines and then poured off; the parts which are bitten sufficiently are painted over with "stopping varnish"; and acid is again applied. The processes of stopping out and biting in are alternately repeated until all the required tints from the lightest to the darkest are produced. In printing from a copper plate, a much more powerful press has to be used than in printing from stone or zinc, as the ink lies in the furrows that have been ploughed or bitten into the plate and not on its surface; the process of printing is also much slower. In engraving on stone or zinc, the surface is coated with a preparation of gum and lampblack, and on it the detail is traced with red chalk and afterwards cut in with very fine steel or diamond points so as just to lay bare the surface of the ground without penetrating to any depth, as in copper-plate engraving. A little oil having been rubbed over the surface, the gummy composition is washed away and printing-ink applied; the printing is performed almost exactly in the same way as in ordinary lithography, except that the printing-ink is in the first instance spread over the stone or the zinc plate with a dabber instead of a roller.

Electrotyping.

Electrotyping is employed to conserve work engraved on copper, either by depositing a thin surface of steel over an engraved plate, which enables it to be printed from very much oftener without injury, or by producing a duplicate to be employed in its stead in the printing. In the latter case, a double process is gone through; first, a cast or matrix is produced in relief by the deposition of copper on the surface of the original plate, and then an intaglio of the matrix—which is therefore a duplicate of the original—is formed by depositing copper on the surface of the matrix. For details of these processes, see ELECTRO-METALLURGY, vol. viii. p. 109. In the Ordnance Survey electrotyping was first employed to obtain duplicates on which to make the corrections and additions necessary to show the growth of railroads and towns since the time of the original survey. The alterations are effected more easily when obsolete details are scraped off the electrotype matrix than when they are scooped out of an intaglio; the original plate is also preserved intact.[1] Electrotyping is further serviceable in producing the two editions of the general map, one with contour lines, the other with hill-shading, already mentioned, as well as editions for geological and other details. It is also serviceable in effecting a combination of portions of several plates: matrices of the different portions are riveted together to form a single plate; then an intaglio of this plate is taken, on which any details lost at the junction of the matrices are made good by hand. The dimensions of a full-sized plate are 38½ by 26½ inches; the weight of a matrix is 18 ℔, and of the duplicate 38 ℔.

Lithography.

There are two essentially distinct processes of lithography,—one in which the map is wholly drawn by hand on the stone, the other, a much quicker but coarser process, in which it is traced with greasy ink on specially prepared paper, which is then laid face downwards on the stone. When lithographs are to be produced by a single printing, all hill features, as well as topographical outlines and names, are drawn with a pen or fine camel-hair brush in ink of one color. Double printing is necessary when the hills are drawn in chalk, two stones being required, one for the chalk work, the other for the pen-and-ink work; and in chromo-lithography a separate stone is required for the work in each color. For full details, see LITHOGRAPHY, vol. xiv. p. 703.

Zincography.

Zincography has of late years largely taken the place of lithography for printing from hand-drawn transfers, though not for hand-drawing on the surface of the zinc, as on stone and copper. Zinc plates are less costly and bulky than lithographic stones, and are much more conveniently handled; thus a plate measuring about 43 by 28½ inches and $\frac{3}{16}$ of an inch thick weighs 60 ℔, is easily carried by one man, and costs 16 shillings [$3.89]; a lithographic stone of the same surface is 4½ inches thick, weighs 450 ℔, requires four men to lift it, and costs about £7 [$34]. Prints from transfers to a zinc plate are as satisfactory as prints from transfers to stone, and there is no liability of the plate being fractured in the press, which not unfrequently happens to the stone. The surface of the plate is prepared by scraping it evenly all over with a razor blade in parallel lines, until all irregularities are removed; the plate is then bent so as to present a slightly convex surface, which is ground with pumice-stone and water, and smoothed with a piece of steatite, and then given a grained surface with sand. It is flattened by being passed through a press, after which it is ready to receive the transfer. The subsequent procedure depends, as in lithography, on the circumstance that greasy substances do not mix with water and are repelled by gummy substances. The greasy ink lines of the transfer are readily absorbed by the surface of the plate; then a preparation of gum and decoction of gall nuts (to which a little phosphoric acid is added), applied to the entire surface of the plate, serves to etch the blank ground without affecting the lines of the transfer; but it prevents the ink from spreading, and also fills up the pores of the blank parts of the plate with a gummy substance, which repels a greasy ink. Printing ink, therefore, applied as usual with a roller to the entire surface of the plate adheres to the inked lines only and can be readily washed off the blank spaces, and then a print taken will show the inked lines only. The tracing for transfer is drawn on paper thinly coated with starch to prevent the graphic writing-ink from soaking into it; the ink is a mixture of Paris black, Castile soap, white wax, tallow or sweet oil, and shellac, which being greasy is readily absorbed by the zinc. The tracing is laid face downwards on the plate and passed several times under the pressure of the roller of the printing press. It is then wetted and peeled off, the ink remaining on the zinc. The surface of the plate is again washed with the etching liquid, which removes stains from the blank spaces and renders them more susceptible of being equally wetted with water, and also—after a few drops of turpentine have been added—removes the unabsorbed writing-ink and helps to fix the lines. The plate is then ready to be printed from. The printing-ink is composed of lampblack—with a little Prussian blue added—and linseed oil varnish of a thickness depending on the temperature and the subject. Small corrections on the plate can be made by removing the surface with a strong solution of hydrate of potash, and then preparing a new surface to be drawn on by applying dilute nitric acid and afterwards washing off the nitrate of zinc.

Anastatic printing.

Anastatic printing produces facsimiles of any inked print by transfer to a zinc plate, the inked lines on it being absorbed in a greater or less degree by the plate. The print is laid face downwards on blotting-paper, and brushed with a solution of nitric acid diluted with five times its bulk of water until thoroughly and evenly saturated; it is then placed face downwards on a zinc plate with a well-grained surface, and passed under the roller of a powerful copper-plate printing press. The grease of the ink, being set free by the acid, adheres to the surface of the plate [illegible] but, as the amount of ink absorbed is much less than in the case of an ordinary transfer, it is strengthened by working up with lithographic ink, oil, and gum water until the surface is sufficiently strong to bear etching with the usual preparation of gum, nut galls, and phosphoric acid. The plate is now ready to be printed from in the usual manner. If the original print is an old one, it must first have its ink softened by immersion in hot water containing half an ounce of caustic strontia for every pint of water, the time of immersion varying, with the condition of the print, from a few minutes to an hour. A print well worked up is often superior to the original.

Photography.

Photography having already been described in detail (see vol. xviii. p. 834), its application to mapping and map-printing need only be noticed here. The action of light can be employed either by placing the map in contact with a sheet of sensitized paper and against a glass plate in a printing frame, when the light will pass through the map and produce a picture of it on the paper, or by using a camera furnished with an object-glass, through which rays of light from the map are transmitted so as to produce a picture on a sensitized glass plate, which can afterwards be printed from. The best known of the processes in which the camera is not used is the "cyanotype"; the paper is sensitized with a mixture containing nearly equal proportions of solutions of ammonio-citrate of iron and the ferrid-cyanide of potassium; the prints give white lines on a dark-blue ground, and are very inexpensive. There are other processes of printing with the salts of iron, uranium, etc., which give an exact transcript of the original drawing with dark lines on a white ground. But they are only suitable for maps drawn in pen and ink not larger than the glass plate of the printing frame; being therefore only serviceable in special cases when few copies are wanted, they are little employed and may be regarded more as curiosities than as ordinary methods of map-printing. Photography is generally effected with the aid of a camera, and employed to obtain a negative of a map on glass, from which prints may be taken either for use *per se* or for transfer to a flat surface of zinc, stone, or other suitable material to print from. The map is usually attached to a board suspended vertically in an adjustable frame, while the camera is placed on an adjustable stand set at right angles to the map frame on a tramway, along which it can be moved to any desired distance from the map. The camera is furnished with a ground-glass focusing screen, on which is pencilled a rectangle whose dimensions are proportional to those of a corresponding rectangle on the map, in the ratio of the scale of the required photograph to that of the map. The map and the focusing screen are brought into parallelism at such a distance that the image of the rectangle on the map exactly coincides with the rectangle on the focusing screen. A sensitized collodion plate is then substituted for the screen and a negative taken, which is afterwards "fixed" and "intensified" so as to produce the greatest transparence in the lines and an almost opaque density of the ground. Printing from a negative is usually performed by the action of light when only a few copies are wanted, and mechanically when many are wanted; the prints are taken directly from the negative in the one instance, and from a transfer of the negative to the surface of a stone or metal plate in the other. Of the processes of printing directly from the negative, silver printing, the oldest, is as yet unsurpassed for the delicacy of its results, but it is expensive and perishable; the prints are taken on paper coated with albumen containing an alkaline chloride, such as common salt, floated on a bath of nitrate of silver, and allowed to dry in the dark. After exposure to light in a printing frame, the prints are washed, toned with a solution of gold, and then fixed in a bath of hyposulphate of soda, which dissolves all the remaining unaltered chloride of silver. At the Ordnance Survey office platinum printing is now (1887) largely used instead of silver printing for all purposes where only a few copies of a map are required. It is more expensive, but the prints are absolutely permanent and are produced more quickly than silver prints. Their rich velvety black color and freedom from glaze render them peculiarly suitable. The paper is sensitized with a preparation of platinum and ferric oxalate. After exposure to light, the image is developed almost instantaneously by laying the print on a hot solution of potassic oxalate; it is then washed in successive baths of dilute acid to remove the soluble iron salts, and after that in a few changes of water. Various processes of "collo-chromate" printing are also most usefully employed in map-printing; they depend on the reaction of the salts of chromium—particularly the alkaline bichromates—on gelatin, gum, albumen, or other colloid substances, which, in proportion to the amount of the action of light upon them, become more or less insoluble in and unabsorbent of water, and acquire the property of taking up greasy ink and not attracting plumbago or other fine dry pigment in powder. When the subject is in line the print is taken on paper that is usually coated with a mixture of gelatin and bichromate of potash, colored with Indian ink or any other suitable pigment; after a few minutes' exposure in the copying frame the paper is plunged into tepid water, which dissolves the unaltered gelatin in the blank parts of the print—they have been protected from the light under the dark parts of the negative—leaving a clear image in pigment on the white ground. When the subject is in half-tone, the gelatin film has to be detached from the paper that it may be developed by being washed on the unexposed side, a temporary support being employed to preserve the image from injury during the washing; the most delicate shades in the half-tones are thus perfectly preserved.

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[1] In the French and Austrian surveys corrections are made on fresh copper deposited by electricity over the faulty parts, which are scooped out.

In the processes noticed above it is necessary to repeat the operation by exposure to light for every print produced; the rate of printing will therefore be more or less dependent on the sensitiveness of the paper, the strength of the light, and the condition of the atmosphere. In the processes about to be described these disadvantages are obviated by transferring the photographic image to a surface of stone or metal, from which prints may be made mechanically in any numbers independently of light or weather.

Photo-mechanical printing.

The photo-mechanical processes are broadly divisible into two classes,—one comprising photo-lithography, photo-zincography, and photo-typography, for the reproduction of subjects in line only; the other, photo-collotype and photogravure, for subjects in mezzotint or half-tone as well as line.

Photo-lithography and photo-zincography.

Photo-lithography and the analogous photo-zincography are the processes which have hitherto been most extensively employed for map printing. They are the simplest to carry out; they allow the photographs of several sections of a map which may be too large to be reproduced as a whole to be combined; and additions and corrections may be readily made by hand on the stone or zinc plate. The prints for transfer from the negatives are taken on paper coated with a mixture of gelatin and potassium bichromate, as in the pigment printing process, except that the greasy ink or coloring matter is not mixed with the gelatin, but applied evenly over the surface of the prints after exposure to the light. The inked print is immersed for a few minutes in tepid water to soften the gelatin still remaining soluble in the parts not acted upon by light, and is then laid on a sloping plate and washed with a soft sponge until all the unaltered soluble gelatin and the ink overlying it are removed. The lines on which the light has acted remain insoluble and retain the ink, forming a clear image of the subject in a greasy ink. When a map is photographed in several sections, as often happens, each section overlaps well all round to enable the transfers from the different negatives to be neatly joined together without showing lines of junction; if the whole is too large to be printed on a single sheet of paper, it is cut up into sections for printing separately.

Photo-typography.

The object of photo-typography is to obtain by photographic agency a surface block which may be set up with type and printed in the same way as a woodcut. The image may be obtained on a zinc plate by transfer in the same way as for photo-zincography, or it may be printed directly from a reversed negative. In the latter case the zinc plate is usually prepared with a thin coating of bitumen, a substance which has the property of becoming insoluble under the influence of light, so that, when after exposure the plate is washed with turpentine or benzole, the image remains on the zinc, while the ground is washed away. In both cases the image is strengthened by careful inking and by the application of powdered resin, which the plate is heated sufficiently to melt. The image is then etched with nitric acid. The operations of inking, applying resin, and biting with acid are repeated several times, until the plate is bitten sufficiently deeply to give clear prints. In another process, which is perhaps preferable for fine work, a mould is obtained by electrotyping a relief in swollen gelatin, the surface of which has been metallized with plumbago or bronze powder. These processes are largely used for producing small maps to illustrate books and newspapers, but not for maps of ordinary size.

The three mechanical processes just noticed are only applicable to maps drawn in line, and to get good prints every line should be of the same blackness, though of different breadth. Attempts have been made to reproduce brush-shaded drawings, exhibiting continuous gradations of shade, by photo-lithography and photo-zincography, but with very partial success, and only by breaking up and destroying the continuity of gradation. The following processes are specially suited for reproducing maps in half-tone.

Photo-collotype.

In photo-collotype, so-called from the printing surface being of gelatin, a plate with a perfectly smooth surface, usually of thick glass, either is coated with a sensitive mixture of gelatin and bichromate of potash, upon which the photographic image is produced by the action of light through a *reversed* negative, or is employed to support a gelatin film on which the image has been imprinted from an ordinary negative, and which is attached to the plate with suitable cement. The gelatin when properly moistened possesses the valuable property of receiving a greater or less amount of ink in different parts of the image in exact proportion to the intensity of the action of the light on each part; thus it is capable of reproducing the most delicate gradations of shade. The process is admirable for maps of small size, which only require a single plate, but is not suited for making a combination of sections to form a map of ordinary size; nor can additions or corrections be made on the gelatin film, which is, moreover, so tender that it does not readily permit of a large number of prints of uniform quality being taken, and is easily damaged.

Photogravure.

The several methods of obtaining an incised image on a copper plate by means of photography are broadly divisible into the two groups of electrotyping and etching processes; one of each will be briefly noticed. (1) A positive pigment print, forming a relief in hardened gelatine, is developed on a silvered copper plate by the ordinary operations of the autotype or pigment printing process; it is then blackleaded and copper is deposited on it to form an electrotype intaglio, from which prints may be taken in the usual way, three to four weeks being required for the deposition of enough copper to produce a plate of sufficient thickness. (2) A negative pigment print is developed on a highly polished copper plate, upon a which a very fine grain of powdered resin has been deposited and fixed by heat. The intaglio is obtained directly on the plate by biting in with a solution of perchloride of iron, which penetrates the gelatin film with comparative ease in those parts representing the shades and lines of a map, where there is little or no gelatin, and thus bites the copper to a considerable depth, while in the parts representing the blank spaces and ground of the map, where the gelatin is thicker, it penetrates with more and more difficulty as the thickness of the gelatin increases, and in the highest blanks should leave the copper untouched. The operation of biting takes only a few minutes, and the gravure is remarkable for its delicacy of gradation and richness of effect; there is, however, some difficulty in etching to the proper depth so that the plate may stand much printing without the loss of the finest tint. In both cases the copper plates have to be protected by a facing of steel before they can be printed from. The processes have not yet been used to any great extent for maps with half-tones, but they are very promising. For maps in line the first method gives excellent results, and is largely employed in the Austrian and Italian surveys.

X. INSTRUMENTS.

The instruments employed in survey operations are broadly divisible into two classes, one for making the requisite linear and angular measurements on the ground, the other for plotting the data thus acquired on paper, and for measuring from the map, when completed, lengths and areas which it may not be convenient to calculate from the numerical data. As a rule different instruments are employed for the mensuration on the ground and for the plotting on paper; but to this rule there is a notable exception in the plane table, by means of which all bearings may be drawn directly on paper with a sight rule, without previous measurement of any kind, and thus a plot of the ground may be constructed without employing any other instrument.

Field instruments.

Field Instruments.—These are of two classes,—linear, for determining distances directly by actual measurement along the surface of the ground, and angular, for determining the bearings of, or the angles between, any objects. Some instruments are automatic, as the needle, which points to the magnetic north, the plumb-line and the spirit-level, which indicate the direction of gravity, and hypsometers of various kinds, for measuring altitudes; others are entirely controlled by the manipulator. Some require to be rigidly supported on the ground, as measuring bars and theodolites; others are adapted for flexible supports, as reflecting and magnetic instruments, which may be employed either on land or on the oscillating deck of a ship at sea. Some, as magnetic compasses, measure angles in the horizontal plane only; others, as theodolites, in two planes—one horizontal, the other vertical; others, as reflecting instruments, in all planes; others, as levelling instruments, measure nothing, but simply indicate a plane of reference. And there are certain instruments by which angles are measured in the ordinary way, and direct distances are determined by micrometric measures of the small angles subtended at a distance by objects of known dimensions.

Linear instruments.

Linear instruments are of two classes,—one for exact measurement of base-lines the lengths of which are required to be known with great precision, the other for ordinary and rough measurements. Among the former may be included the Colby apparatus of compensation bars and microscopes, described in sect. I., § 2 (p. 732 above), Bessel's apparatus, those of Struve and the United States Coast Survey, and Porro's (adopted by the Spaniards and the French in Algiers), which have already been described in EARTH (FIGURE OF THE), vol. vii. pp. 517, 518, and GEODESY vol. x. pp. 146–7. For less exact but still essentially accurate measures the instruments most commonly employed are the brass or steel chain of 100 links, the graduated metallic tape, and the offset pole.

For reconnaissance and rough measurement, perambulators, with wheels of known periphery and dials to indicate the number of revolutions, are largely used in India. Crinoline wire has been employed with advantage in Australia; it is so light that a length of 1000 feet or more may be easily carried, rolled on a drum, by one man, who pays it out as wanted; he is usually followed by another, who commences rolling it up at the opposite end when an entire length has been laid out on the ground. Air lines are sometimes measured by stretching the wire over the tops of trees in valleys obstructed with forest, also the breadths of rivers by resting the wire on logs anchored at suitable intervals to support it above water.

Angle-measuring instruments.

Angle-measuring instruments are of two classes, direct and reflecting. Both are provided with an aligner, usually a telescope, which is pivoted over the centre of the graduated circle or sector; in one the aligner is pointed in succession to any two objects the angle between which is being measured; in the other it is pointed to one object, while an image of the second is thrown on the first by double reflection from a pair of mirrors. Reflecting instruments are largely employed in nautical surveys, as they can be held by the hand and do not require a rigid support; but they are very rarely used in land surveys. A description of them will be found under SEXTANT (vol. xxi. pp. 760–2). They give the angle in the plane in which they are held; and, whenever this plane is sensibly oblique to the horizon, the angle must be reduced by calculation to the plane of the horizon before it can be employed in the work of a land survey. The other instruments give the required horizontal angles, whatever the altitudes of the objects observed.

The circles of angle-measuring instruments are usually divided into 360 equal parts called degrees, and subdivided into spaces ranging downwards from thirty to five minutes of arc, according as the diameter of the circle is increased. Smaller arcs are measured by interpolation between the subdivisions, with the aid of a circle reader which moves with the aligner. All instruments except those of the simplest form are supplied with one or more circle readers and spirit-levels and a telescope; these important adjuncts, which are common to so many instruments, will therefore be first described, and afterwards the more important instruments which are employed in connection with survey operations.

Circle readers.

Circle readers are of two kinds,—the vernier and the microscope. Both are held over the circle at the extremity of a radial arm pivoted over its centre. The vernier moves in contact with the surface of the circle, while the microscope views it a short distance off; the former is usually applied to circles whose diameters do not exceed 12 inches, the latter to those of larger diameter. Both kinds of reader are applicable to linear scales as well as to graduated circles, the microscope being usually employed when most precision is desired.

Vernier.

The vernier is so called after its inventor, a Frenchman. Its principle is very simple. The space between any convenient number, n, of graduations on the circle is set off on the vernier and divided into $(n+1)$ equal parts; then some one division of the vernier will always coincide with a graduation of the circle. On counting the divisions from the index onwards it is found that the coinciding division, say the mth, of the vernier is opposite the mth graduation of the circle, counting from the last one passed by the index. This indicates that the distance of the index from the last graduation is $\frac{m}{n+1}$ parts of the space between the graduations; n is invariably taken as an odd number, such that the unit of $(n+1)$ may be some convenient aliquot part of the circle, as a minute for a circle divided into degree spaces.

Micrometer microscope.

The micrometer microscope presents the combination of object and eye glasses met with in ordinary microscopes with the addition of a wire-carrying diaphragm, movable by a screw, for micrometric measurements in the plane of the focus of the object-glass. The tube is conical at the object end and cylindrical at the eye end; the box of the micrometer is mounted between these two parts at right angles with the visual axis. The tube is held at the extremity of the arm of an alidade, in a collar in which it may be moved closer to or away from the surface of the circle, or be turned round so as to place the micrometer tangentially to the circle. The distance between the micrometer and the object-glass is usually about four times that between the object-glass and the face of the circle, and thus a correspondingly magnified image of the spaces between the graduations is obtained in the plane of measurement. The object-glass is held in a small tube which can be screwed in or out of the principal tube, to enable the length of the image to be adjusted to an exact integral number of revolutions of the micrometer. The box of the micrometer and the wire diaphragm are rectangular, the latter sliding to the right or left within the former. Slow motion is communicated to the diaphragm by the micrometer screw, which passes into it through a collar in one side of the box, against which the shoulder of the screw is pressed by an internal spiral spring acting against the sides of the diaphragm and the box. The screw is furnished with a circular head divided into a number of equal parts—usually 60, each equivalent to 1″ for circular arcs, and 100 for linear scales—and is rotated opposite an index arm fixed on the box; complete revolutions are marked by the teeth of a stationary comb, which is fixed above the wire of the diaphragm and viewed with it through the eye-piece.

Spirit-level.

The spirit-level consists of a glass tube not quite filled with alcohol, a small quantity of air being left, which rises as a bubble to the highest part of the tube. In small and coarse levels the diameter of the tube is largest in the middle and decreases uniformly towards the ends which are closed by the blow-pipe; in long and delicate levels the tube is cylindrical, but with a longitudinal portion of the interior surface ground to the curvature of a circle of greater or less radius according as the level is designed to be more or less sensitive, and it is sometimes closed by circular glass stoppers cemented into the ends. When the tube is held horizontally, with the curved surface of the interior uppermost, the middle part is occupied by the air bubble. Lines are etched on the outer surface at equal distances from the central point, to enable the tube to be set with the bubble exactly in the middle, or a scale graduated throughout its entire length is provided, to enable any deviation from centricality to be measured and the corresponding dislevelment to be calculated and allowed for subsequently in the reduction of the observations. The glass tube is commonly fixed in a metal tube, with plaster of Paris for protection; but, as it is then liable, under changes of temperature, to torsion and strain, which may sensibly alter its curvature, it is preferable to place it in a metallic cradle and rest it on cork bearings, with due provision against sliding, the whole being covered with a glass cylinder if need be for further protection. The metallic cradle or tube is attached to any instrument on which the level is to be mounted by adjusting screws, for setting it correctly with reference to the axis of rotation with which it is associated. The value of a division of the scale, in seconds of arc, is usually called the "run," and is determined by attaching the level with its scale to a (generally) vertical circle, and taking both the circle and the bubble end readings in different positions of the circle. As the length of the bubble is much affected by changes of temperature, and the curvature of the tube may not be identical at all points, values of the run are commonly obtained under widely differing temperatures.

Telescope.

The telescope consists of a tube, carrying an achromatic object-glass and an eye-piece which holds either a pair of lenses for viewing the inverted image transmitted by the object-glass or a combination of four lenses for inverting the image and causing all objects to be viewed naturally. The former is usually employed for observing celestial objects, the latter for observing terrestrial. The field of view being more or less extensive, a central point is established in the tube, usually by the intersection of a pair of fine wires or spider lines—one vertical, the other horizontal—in the plane of the image, and the telescope is directed by bringing this point on any specific object in the field. As the interval between the object-glass and the image varies with the distance of the object, a tube is provided to slide within the telescope tube and carry the object-glass at one end, while the telescope tube carries the diaphragm and eye-piece at the other end, or *vice versa*. The image and the wires are brought into the same plane by a focusing screw, which acts on the inner through the outer tube. The wires are attached to the surface of an adjustable annular diaphragm, which is held in position by two pairs of antagonizing screws—one pair horizontal, the other vertical—with shoulders working against the exterior of the tube in which the diaphragm is contained, so as to move it to the right or left and up or down, in order to bring the point of intersection of the wires into the visual axis of the telescope. In practice the first adjustment is to set the eye-piece to distinct vision of the wires; the object-glass is then set truly to focus, which is accomplished when no apparent parallax, or movement of the image relatively to the wires, is seen on shifting the position of the eye, for this would indicate that the image is either in front of or behind the plane of the wires. The line joining the point of intersection of the wires with the centre of the object-glass is called the "line of collimation," and the diaphragm should be so fixed that this line may always be perpendicular to the axis on which the telescope revolves.

Surveying compass.

The surveying compass gives the magnetic bearing of any object, and is the simplest of all instruments for measuring horizontal angles. It consists of a magnetized needle, with an agate centre, poised on the point of an upright pivot in the centre of the bottom of a circular box and carrying a concentric circular card or silver ring, the circumference of which is graduated into 360°, and is sometimes further subdivided. The aligner is constituted by a pair of sight vanes attached to the box at opposite extremities of a diameter, one vane having a narrow slit for the eye to look through, the other with a wider opening bisected by a vertical wire to be set on the observed object. There is no circle reader, the prolongation of the wire on to the graduations being estimated by the eye; and there is no level, for the circle poises itself horizontally on the supporting pivot.

Prismatic compass.

The prismatic compass is similar to the surveying compass, with the addition of a prism in the eye vane through which the wire of the sight vane and the divisions of the circle are viewed apparently together; the division with which the wire coincides when the needle is at rest indicates the magnetic azimuth of any object bisected by the wire. The sight vane carries a mirror turning on a hinge, to enable objects to be seen by reflection which may be too high to be seen on the wire; the eye vane is furnished with a pair of dark glasses to be employed when the sun is being observed.

Magnetic instruments are useful for rapid reconnaissance and rough survey, and for filling in the minor details of an exact survey, but they are not to be relied on to give bearings with errors less than ten to fifteen minutes. In plotting, however, bearings are preferable to angles, for, by drawing a number of meridional lines parallel to each other on the paper, each bearing may be plotted from an independent meridian without any accumulation of error, such as arises when a number of angles are plotted in succession with the protractor adjusted on short lines.

Plane table.

The plane table is in its usual form simply a rectangular board mounted horizontally on a stand, on which it may be turned round and set in any required position; it is furnished with a flat sight rule, which usually carries a pair of sight vanes and has a bevelled edge, parallel to the line of sight, to serve as a ruler, also with a magnetic needle. Occasionally the construction is more elaborate and the board is surrounded by a marginal frame with graduations radiating from the centre as the degrees of a circle, so that it may be used as an instrument for measuring horizontal angles, while the sight rule is furnished with a telescope, which takes the place of the vanes and is mounted on an axle to measure vertical angles. The size is made as great as is consistent with the limits of portability in each instance, so that the sheet of paper to be drawn on may be as large as possible. The standard plane table of the Indian Survey measures 30 inches by 24, and is made of planks of well-seasoned wood, one inch thick, with transverse edge bars below to prevent warping and buckling. It is set up on a stand, usually a braced tripod, to which it is clamped by a powerful hand screw passing through the head of the stand into a brass socket fixed centrally under the table; the screw when relaxed serves as a pivot, round which the table may be turned in azimuth and set in any required position. The table is then firmly clamped so as to maintain a constant position during all the subsequent laying off of bearings. The sight rule is 30 inches long, 2 wide, and one-third of an inch thick, of ebony, with a brass sight vane at each end, and a fiducial edge parallel to the line of sight; the vanes are about 5 inches high, which gives sufficient elevation and depression for general use. The magnetic needle is about 6 inches long and is held in a rectangular brass box an inch broad, placed on the table whilst it is being set and afterwards removed. Heights may be determined on the spot with the aid of a clinometer, formed of a bar carrying a spirit-level and a pair of sights, one of which has a scale of tangents graduated to radius = the interval between the sights. For the method of employing the table see § 4, p. 745 above.

Theodolite.

The theodolite, the most important of all instruments for the purposes of a survey, is a combination of two graduated circles placed at right angles to each other, for the measurement of horizontal and vertical angles, a telescope, which turns on axes mounted centrically to the circles, and an alidade for each circle, which carries two or more readers of the arcs through which the telescope is moved. The whole is supported by a pedestal resting on foot-screws, which are also employed to level the instrument. The size varies from a minimum with circles 3 inches in diameter to a maximum with a 36-inch horizontal and an 18-inch vertical circle, the weight ranging from 4 ℔ to 1000 ℔; the dimensions and magnifying powers of the telescope increase with the diameter of the horizontal circle. The telescope may be connected rigidly with the alidade and move with it while the circle remains stationary, or with the circle and move with it while the alidade remains stationary. The varieties of form as well as of size are numerous: in some the telescope may be completely turned round in altitude as well as azimuth, and pointed to any object celestial or terrestrial; in others the range of movement in altitude is restricted to about 25° above and 25° below the horizon, and a pair of sectors are substituted for the complete vertical circle; in some the telescope and vertical circle are placed between, in others outside of, the pillars which support their common axis; in some the pedestal is a simple tribrach resting on three foot-screws, in others it takes the objectionable form of a ball carrying the vertical axis and a socket holding the ball between two parallel plates, which are antagonized and set firm by two pairs of foot-screws, turning in sockets fixed to the lower plate, while their heads are pressed against the upper plate, to fix it and bring the instrument into level at the same time. There are numerous other specialities of form which have been introduced to meet specific requirements; but these cannot be noticed here.

Transit theodolite.

The transit theodolite is an alt-azimuth instrument with the graduated circles of equal diameter, usually 6 to 8 inches. The telescope is mounted between a pair of conical arms which taper outwards and end in cylindrical pivots, constituting what is called the transit axis of the instrument. The pivots rest on Y's or in semicircular collars, on the heads of a pair of pillars, which are made of sufficient height to enable the telescope to revolve between them and be pointed to stars in the zenith. These pillars stand on a circular plate, which serves as the alidade of the horizontal circle and is usually constructed to revolve round a vertical axis fixed in the centre of the plate of the horizontal circle; this axis passes downwards into a socket in the centre of a tribrach, which forms the pedestal of the instrument and rests on three mill-headed foot-screws by which the instrument is levelled. The vertical circle is mounted centrically on one of the cones of the transit axis, near the pivot end; its alidade, usually a rectangular plate carrying a pair of verniers, is fitted centrically over that axis, in contact with the circle but nearer the shoulder of the pivot, and, while the telescope and the circle revolve together, it is held stationary by an adjustable arm the end of which is pinched between a pair of antagonizing screws mounted on the nearest pillar. The alidade of the horizontal circle carries two or three equidistant verniers, because any error in centring an alidade over a circle is eliminated in the mean of the readings whenever two or more verniers, placed at equal distances apart round the circle, are read. A clamp, with a tangent screw for communicating slow motion, is attached to the nearest pillar, to act on the vertical circle and the telescope; another is attached to the plate of the horizontal circle, to act on the alidade of that circle and so also on the telescope for azimuthal motion; and a third to the pedestal, to act on the plate of the horizontal circle. The first two are employed in measuring the vertical and azimuthal angles, the third in setting the zero-diameter of the horizontal circle in any specific direction, with a view to the repetition of the measurements of the azimuthal angles at different parts of the circle. For levelling the instrument, two levels are fixed at right angles to each other on the plate of the alidade of the horizontal circle; a third is attached to the telescope, or, preferably, to the alidade of the vertical circle; a fourth is mounted on the transit axis when levelling for astronomical observations. A magnetic compass or needle is added, and also a plummet for centring the instrument over the station mark.

Theodolites are designed to measure horizontal angles with greater accuracy than vertical, because it is on the former that the most important work of a survey depends, and they are measurable with greatest accuracy; measures of vertical angles are liable to be much impaired by variations in the refractive condition of the lower strata of the atmosphere, more particularly on long lines, so that when heights have to be determined with much accuracy the theodolite must be discarded for a levelling instrument, to be set up repeatedly with staves at short distances. When truly adjusted the theodolite measures the horizontal angle between any two objects, however much they may differ in altitude, as the pole star and any terrestrial object; but, as adjustments are not always made with accuracy nor permanently maintained, it is desirable always to take the observations in pairs, with the face of the vertical circle alternately to the right and left of the observer, for this eliminates collimation error from the horizontal angles and index error in the setting of the spirit-level from the vertical angles.

When a horizontal angle is measured several times for greater accuracy, one of two methods of procedure is adopted. (1) The angle is measured once or oftener in the usual way, the horizontal circle remaining clamped and the telescope and alidade moving over it; then the position of the horizontal circle is shifted[1] as often as may be desired, and after each shifting the angle is again measured as formerly; thus a separate numerical result is obtained for each operation. Or (2), the first object A having been observed and the telescope set on the second object B, the horizontal circle is unclamped and turned round until the telescope is brought back on A, when it is again clamped; then the alidade is unclamped and the telescope again moved over the horizontal circle to be set on B. The operation is repeated as often as may be desired. The vernier readings are only taken for the first telescope pointing to A and the last to B; their difference + 360° for every complete revolution of the circle, divided by the number of repetitions, gives the angle. This method is objectionable when a round of several angles has to be measured, but it enables the value of a single angle—more particularly a small one, as between objects in the same field of the telescope—to be determined accurately with much greater rapidity than the first method.

An auxiliary telescope is sometimes fixed below the plate of the horizontal circle of a theodolite, to be pointed to a referring mark while the upper telescope is being moved about, and thus to serve as a check on the general stability of the instrument and on the permanence of the initial setting of the circle during the measurement of a round of angles. When a theodolite is set up on a lofty scaffolding which is liable to be swayed by the wind, or on a stand which cannot be readily isolated from the observer, horizontal angles may be measured accurately by employing a second observer to keep the auxiliary telescope truly pointed to a referring mark while the observing telescope is being pointed.

Subtense transit theodolite.

The subtense transit theodolite differs from the ordinary transit theodolite merely in having a pair of wire-carrying micrometers mounted in the telescope tube, in order that the small angle subtended by a distant object of known dimensions, or by two objects sufficiently near each other to be seen in the same field of the telescope, may be measured with greater facility and precision than on the graduated circles in the usual way. The micrometers are held in a rectangular box, one on the right hand, the other on the left, with the wires brought as closely as possible into the plane of the fixed wires in the ordinary diaphragm; the box can be turned on the telescope tube through an angle of rather more than 90°, to enable the micrometer wires to be set parallel to either the horizontal or the vertical wire of the diaphragm, or to be placed at any desired angle of inclination. The subtense object usually employed in survey work is a pole of known length; if held perpendicularly to the line of sight of the telescope, its direct distance may be determined from the angle measured by the micrometers with a sufficiently small percentage of error to make this method preferable to chaining over rough ground. The instrument has been advantageously employed in carrying traverses of considerable length over ground which was impracticable for direct linear measurements. The micrometers are also serviceable in astronomical observations for time and longitude, for they give additional wires on which to observe the passage of a star, at distances from the fixed wire which may be varied with the speed of the star; and for determining the longitude they permit numerous measures of the distance between the edge of the moon and a star to be taken, immediately before and after occultation.

Eckhold's omnimeter is a theodolite furnished with a microscope of considerable magnitude facing a graduated linear scale; the tube of the microscope is rigidly attached

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[1] This is often done arbitrarily, but systematic shifts which bring equidistant graduations of the circle under the verniers during all the telescope pointings to any one object are always preferable (see sect. I., § 9, p. 784 above).

Eckhold's omnimeter.

to the telescope tube, either at right angles or parallel to it, so that the two always move together. The scale is fixed either parallel or perpendicular to the alidade plate of the horizontal circle; thus, when the telescope is moved through vertical arcs within the range of the scale, the tangents of the arcs are measured by the microscope on the scale. The latest and best form of the instrument is shown in Fig. 8, which represents a transit theodolite converted into an omnimeter by the application of a microscope *AB* to the telescope at right angles to it, and of a scale *C* to the plate of the alidade of the horizontal circle in a plane parallel to that of the vertical circle. The microscope is furnished with a diagonal eye-piece, through which the observer looks down on the scale. The scale is divided into 100 equal parts, and is movable in its bed-plate through the length of one of these divisions by one rotation of a micrometer screw, with a large head, *D*, the circumference of which is divided into 100 equal parts, each divisible into fifths by a vernier. The microscope has a fixed wire in a diaphragm at its eye end, *A*, and when the telescope is set on an object and the wire is seen between a pair of divisions on the scale, the scale is moved by the micrometer screw until the nearest division is brought under the wire; the scale reading corresponding to the horizontal position of the telescope being known, the difference between it and the reading when the telescope is pointing above or below the horizontal plane is the tangent of the arc of elevation or depression, to radius = the perpendicular from the axis of rotation of the telescope to the scale. Thus both the distance and the height of any point over which a staff of known length has been set up vertically may be readily determined with fair accuracy. Let *O* (Fig. 9) be the position of the transit axis of the telescope, *OA* the direction of the telescope when horizontal, and *Oa* the corresponding direction of the microscope at right angles to the scale *amn*; let *M* be a distant point over which the staff *MN* has been set up vertically, and let *m* and *n* be the graduations under the microscope when the telescope is pointing to the bottom and top of the staff; then, since *MN* and *Oa* are known, the horizontal distance *OA* and the height *AM* are determined from the proportions

$$\left.\begin{matrix} OA : Oa \\ AM : am \end{matrix}\right\} :: MN : mn.$$

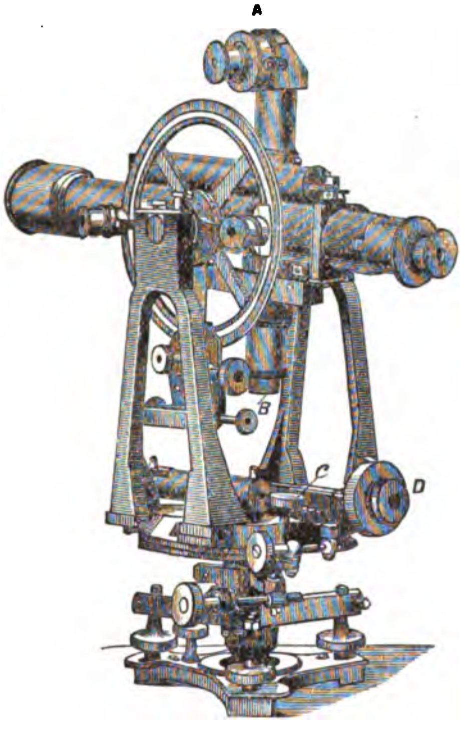

FIG. 8.

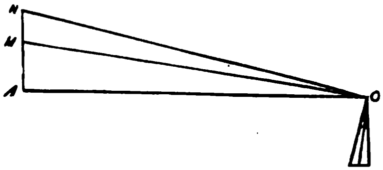

FIG. 9.

It is essential that the focusing tube of the microscope should always move parallel to the visual axis when different divisions of the scale are being brought into focus, otherwise errors materially exceeding the quantities appreciable by the micrometer may be caused. The linear results thus obtained are satisfactory when the subtense staff is set up at a moderate distance; the instrument has often been used with advantage in localities where measuring chains could not be conveniently employed. As an angular instrument it is identical with the ordinary transit theodolite, as will be seen from the figure, which may be referred to as illustrating the description of that instrument; the foot-screws are represented as resting on a plate such as is usually fixed on the head of a folding tripod stand, their lower extremities, as well as the grooves in which they are placed on the plate, being concealed from view by a capping upper plate, which is clamped over their shoulders to prevent the instrument from falling off the stand.

Prismatic reflection theodolites.

In any theodolite with a telescope of the ordinary form the height of the pillars must necessarily be somewhat greater than half the length of the telescope if stars in the zenith are to be observed or if the telescope is to be completely rotated on its transit axis; the higher the pillars the higher the centre of gravity, the less perfect the stability of the instrument when set up for observation, and the greater its weight and cumbersomeness for transport. In Germany and Russia theodolites and transit instruments are sometimes employed in which the eye end of the telescope tube is removed—a counterpoise to the object end being substituted in its place; and a prism is inserted at the intersection of the visual axis with the transit axis, so that the rays of light from the object-glass may be reflected through one of the tubes of the transit axis to an eye-piece in the pivot of this tube. In this case the pillars need only be high enough for the counterpoise to pass freely over the plate of the horizontal circle; but the observer has always to place himself at right angles to the direction of the object he is observing.

Levelling instrument.

The levelling instrument consists of a telescope which carries a long spirit-level parallel to itself and is mounted on a horizontal plate, which is fixed rigidly either on the head of a vertical axis revolving within a socket in the centre of the pedestal or on that of a hollow cone revolving round a vertical axis which projects upwards from the pedestal. There are various forms of the instrument; in the Y-level the telescope rests on a pair of Y's, in which it can be both rotated and turned end for end; in the dumpy level the telescope is rigidly attached to its supports, and its tube is made shorter and of greater diameter, to carry an object-glass of shorter focal length and larger aperture. A magnetic compass is attached to the instrument to enable the bearings of the levelling staves to be taken whenever desired. Levelling staves are of a variety of patterns and are graduated in various ways, best on both faces and dissimilarly, for a check on accidental errors of reading, as indicated in sect. III.

Reflecting levels.

Reflecting levels are portable instruments which may be held by the hand for rough and rapid survey work. They are of two forms: in one an image of the eye of the observer, in the other an image of the bubble of a spirit-level, is seen by reflection on a level with the observed object. The first consists of a square of common looking-glass, which is set in a frame suspended from a ring on the line of prolongation of one of the diagonals in such a manner as to swing freely but not turn round on its axis of suspension; the frame is weighted by a metal plate behind, to which it is so adjusted that, when suspended, the plane of the surface of the mirror will be vertical. A small portion of the glass at one end of the horizontal diagonal is either cut away or unsilvered. When the image of the observer's eye is seen on the diagonal, all objects bisected by the diagonal, whether viewed through the opening in the mirror or by reflection, are on the level of the eye. The second consists of a tube open at the object end and closed at the eye end by a disk which is perforated with a sight hole; a mirror filling up half the section is fixed in the tube, facing the eye end at an angle of 45° with the axis; and an all-round transparent spirit-level is mounted over an opening above the mirror, and its bubble is seen by reflection in the axis of the tube. Abney's level is of the latter construction, but with the spirit-level attached to the alidade of a graduated arc fixed to one side of the (rectangular) tube; thus vertical angles as well as levels may be determined with it.

Abney's level.

Optical square.

The optical square is a reflecting instrument indicating a right angle, and is of great use in laying off perpendiculars for the measurement of offsets from a line of survey. It consists of two glass plates, one wholly the other partially silvered, which are fixed permanently in a shallow circular box at an angle of 45°, so that any two objects seen together through a sight hole in the box—one directly through the transparent portion, the other by reflection in the mirror of the partially silvered glass plate—subtend an angle of 90° at the point where the observer is standing.

Plotting instruments.

Plotting and Plot-measuring Instruments.—These comprise linear scales, common compasses, and angular protractors for laying off distances and angles measured on the ground, proportional compasses and pantagraphs for reproducing a finished plot on some other scale, and opisometers and planimeters for measuring plotted lines and areas.

Scales.

Scales are divided, either decimally or fractionally, into equal parts, each of which is a portion of a fixed unit of length, as a foot or an inch; some are subdivided more or less minutely throughout their entire length between a pair of parallel lines; others are subdivided at their extremities only. Diagonal scales are formed by eleven equidistant parallel lines, the outer ones of which are divided primarily and subdivided into tenths at their extremities. The primary divisions are joined by cross lines perpendicular to the eleven parallel lines; the end subdivisions are joined diagonally, the first on the lower line with the second on the upper, and so on, each diagonal cutting every horizontal line in a point a tenth of a subdivision beyond the cutting point on the parallel line below, as measured from any one of the perpendicular lines; and each of these tenths is further divisible into tenths by measuring from the perpendicular at intervals of tenths between the parallel lines; thus great precision of measurement is obtained.

Marquois scale and triangle.

The Marquois scale and triangle consists of a scale divided throughout into equal parts more or less minutely and a right-angled triangle of which the hypothenuse is three times the shortest side. An arrow is drawn perpendicular to the hypothenuse to serve as a pointer to the divisions of the scale. The third side has a bevelled edge for ruling. When the triangle is placed with its hypothenuse against the scale and is moved along it, all lines drawn along the bevelled edge are parallel to each other, their distances apart being one-third of the distances travelled by the arrow along the scale.

Compasses.

Compasses usually take the form of a pair of legs movable about a joint, so that their extremities, which are of steel, finely pointed, may be set at any required distance apart; the legs may be knee-jointed, and one is usually adapted to hold either a pencil, a ruling pen, or a steel pointer, as may be desired. A beam compass is employed when long lengths are laid off; it consists of a light tubular metal bar, or a rectangular deal rod, fitted with a pair of boxes, which slide along it and carry either pen, pencil, or pointer, and may be set and clamped at any desired distance apart.

Proportional compasses.

Proportional compasses consist of two parts so exactly similar that when held in contact throughout they appear as one; each is pointed at both ends, flat and grooved through one-half its length, and tapering to a point in the other half. The two are coupled together by a pair of similar sliders, one for each groove, turning on a common axle which carries a disk at one end and a clamping screw at the other; by shifting the position of the sliders in the grooves the distances between the points at the opposite ends can be brought into any desired proportion. The settings for different proportions are effected by bringing a line on the slider opposite the lines of a fractional scale engraved on one side of the groove.

Protractors.

Protractors are of two forms circular (or semicircular) and rectangular: the circumferences of the former are divided into 360° or 180°; the latter are divided on three sides of their periphery by lines drawn from the centre of the fourth side to the degree points on the circumference of a semicircle of which that side is the diameter. The protractor being set with its centre on a given point and its zero line on a given line passing through the point, any angle with this line at the point can be readily laid off. Protractors for plotting traverses are commonly annular, that they may be centred over the station of origin with the zero diameter on the initial meridian; their bearings at any other station may be laid off without moving the protractor by drawing lines parallel to the same bearings at the origin. Rectangular protractors sometimes have parallel lines engraved on their faces at equal distances, for setting over paper ruled with parallel lines at unequal distances, and their backs engraved with scales of rhumbs, sines, secants, and tangents and common scales of equal parts.

Station pointer.

The station pointer enables the position of any station at which angles between three fixed points have been measured to be plotted on paper. It consists of three arms; the centre arm carries a graduated circle fixed over an axis at one end; the other two are movable round this axis, and each carries a vernier for reading the circle. Each arm has a straight edge bevelled as a ruler, and the lines on the prolongations of these edges meet in the centre of the axis, where there is a small opening through which a point may be pricked on the paper. The arms having been set to the observed angles, the instrument is moved about until each edge is over one of the fixed points on the paper, when its centre will be exactly over the position of the station if none of the angles are very acute. The instrument is much used in nautical surveying, for laying down the position of a vessel at sea by angles measured to fixed objects on shore.

Triangular compass.

The triangular compass is serviceable in reproducing plans to full scale; it is formed by jointing a third leg to the centre pin of the joint of an ordinary pair of compasses, so as to be movable in any direction.

Pantagraph.

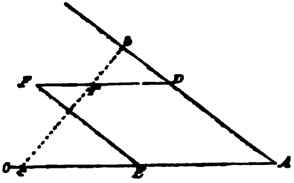

FIG. 10.

The pantagraph is employed in reproducing a map on a different—generally a smaller—scale. It consists of two long arms, *AB* and *AC*, jointed together at *A*, and two short arms, *FD* and *FE*, jointed together at *F* and with the long arms at *D* and *E*; *FD* is made exactly equal to *AE* and *FE* to *AD*, so that *ADFE* is a true parallelogram whatever the angle at *A*. The instrument is supported parallel to the paper on ivory castors, on which it moves freely. A tube is usually fixed vertically at *c*, near the extremity of the long arm *AC*, and similar tubes are mounted on plates which slide along the short arms *BD* and *FD*; they are intended to hold either the axle pin on a weighted fulcrum round which the instrument turns, or a steel pointer, or a pencil, interchangeably. When the centres of the tubes are exactly in a straight line, as on the dotted line *bfc*, the small triangle *bfD* will always be similar to the large triangle *bcA*; and then, if the fulcrum is placed under *b*, the pencil at *f*, and the pointer at *c*, when the instrument is moved round the fulcrum as a pivot, the pencil and the pointer will move parallel to each other through distances which will be respectively in the proportion of *bf* to *bc*; thus the pencil at *f* draws a reduced copy of the map under the pointer at *c*; if the pencil and the pointer were interchanged an enlarged copy would be drawn; if the fulcrum and pencil were interchanged, and the sliders set for *f* to bisect *bc*, the map would be copied exactly. Lines are engraved on the arms *BD* and *FD*, to indicate the positions to which the sliders must be set for the ratios ½, ⅓, ... which are commonly required.

Gavard's square pantagraph.

The square pantagraph of Adrian Gavard consists of two graduated arms which are pivoted on a plain bar and connected by a graduated bar sliding between them throughout their entire length, to be set at any required distance from the plain bar; a sliding plate carrying a vertical tube, to hold either the axle of the fulcrum, the pencil, or the pointer, is mounted on one of the arms and on a prolongation of the plain bar beyond the other arm, and also on the graduated connecting bar; and an additional arm is provided by means of which reductions below or enlargements above the scales given on the instrument can be readily effected.

Eidograph.

The eidograph is designed to supersede the pantagraph, which is somewhat unsteady, having several supports and joints. It is composed of three graduated bars, one of which is held over a fulcrum and carries the others, which are lighter, one at each extremity. The three bars are movable from end to end in box-sockets, each having an index and a vernier in contact with the graduated scale. The box-socket of the principal bar turns round the vertical axle of the fulcrum; that of each side bar is attached to a vertical axle, which also carries a grooved wheel of large diameter and turns in a collar at either end of the principal bar. The two wheels are of exactly the same diameter and are connected by a steel band fitting tightly into the grooves, so that they always turn together through identical arcs; thus the side bars over which they are respectively mounted, when once set parallel, turn with them and always remain parallel. A pointer is held at the end of one of the side bars and a pencil at the diagonally opposite end of the other. The bars may be readily set by their graduated scales to positions in which the distances of the pencil and the pointer from the fulcrum will always be in the ratio of the given and the required map scales.

Opisometer.

The opisometer is intended to measure the lengths of roads, rivers, and other lines on a map. It consists simply of a milled wheel mounted in a forked handle on a steel screw with a very fine thread. The wheel, being turned up to one end of the screw, is put down on the map with the handle held vertically over the point at which the measurement is to commence, and is run over the road or line until the point is reached at which the measurement is to stop; it is then lifted off the paper, placed on the scale of the map, and run backwards to the initial end of the screw, over a length of the scale which corresponds to the length run over on the map.

Polar planimeter.

The polar planimeter was invented by Professor Amsler of Schaffhausen for the measurement of areas on maps and plans. It consists essentially of two arms jointed together and a roller, carried at right angles to one of the arms and moving in touch with the paper, which by its revolutions records the area of a figure whose perimeter is traced by a point on that arm, while the instrument is turned bodily on a point on the other arm as a fixed centre. There are two forms of the instrument: in one the position of the roller is fixed and the arms are jointed on a common pinion; in the other the roller and a pinion, to which the holding arm is attached, are both carried by a slider, which is movable along the tracing arm and can be set at any required distance from the tracing point. The first form gives areas in a single unit of measure only, the second in various units. The annexed figure represents the first form, showing the joint A, the tracing point P, the fixed point O, and the roller with its graduated dial and vernier, for indicating the lengths of line rolled over while the tracer moves round the perimeter of the area under measurement.

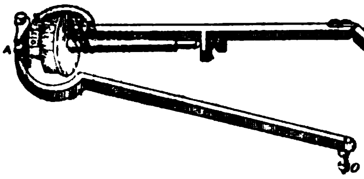

FIG. 11.

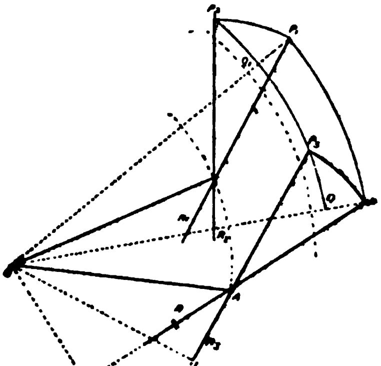

FIG. 12.

The following explanation of the theory of the instrument is due to Professor Greenhill. Let OA, AP be the two arms jointed at A, with the fixed point at O and the tracer at P, and suppose the wheel to be fixed at R on the prolongation of the arm PA. Let $OA = a$, $AP = b$, $AR = c$, and the radius of the roller $= r$; and let the direction of a positive rotation of the roller, as marked by the graduations, be that of rotation on a right-handed screw on the axle of R which would give motion in the direction AR. Drop the perpendicular OI from O on AR, and first suppose the joint A to be clamped. Then, if I is in AR produced, a rotation of the instrument about O with angular velocity ω will give to R the component velocities $OI.\omega$ in the direction IR and $IR.\omega$ in the direction perpendicular to IR, and will therefore compel the roller to turn with the angular velocity $\frac{RI}{r}\omega$; but if I is on the other side of R, the angular velocity of the roller will be $-\frac{RI}{r}\omega$. Therefore, keeping A clamped, the roller will turn through an angle $\frac{RI}{r}\theta$ or $-\frac{RI}{r}\theta$, according as I is or is not on the same side of R as A, when the instrument is rotated through an angle θ about O; but, when I coincides with R, the roller will not turn, and then P describes a circle, called the "zero circle," represented by the middle dotted circular line, of radius

$$\surd(OR^2 + RP^2) = \surd\{a^2 - c^2 + (b+c)^2\} = \surd(a^2 + b^2 + 2bc).$$

Next unclamp the joint A and clamp the arm OA; then the roller will turn through an angle $-\frac{c}{r}\phi$, while AP turns through an angle ϕ. Now suppose P to travel round the finite circuit $PP_1P_2P_3$ by a combination of the preceding motions in the following order. (1) Clamp the joint, and move P to P_1 and A to A_1 on arcs of circles of centre O; then the roller will turn through an angle $\frac{RI}{r}\theta$, θ being $= AOA_1 = POP_1$. (2) Unclamp the joint and clamp the arm, and move the pointer from P_1 to P_2 on the arc of a circle of centre A_1; then the roller will turn through an angle $= \frac{c}{r}\phi$, ϕ being $= P_1A_1P_2$. (3) Unclamp the arm and clamp the joint, and move the pointer from P_2 backwards to P_3 and A_1 to A, on arcs of circles of centre O, through an angle θ; then the roller will turn through an angle $-\frac{RI_1}{r}\theta$, if OI_1 is the perpendicular from O on P_3A. (4) Unclamp the joint and clamp the arm, and move the pointer from P_3 to P on the arc of a circle of centre A, and consequently through an angle ϕ; the roller will turn through an angle $\frac{c}{r}\phi$, which cancels the angle due to motion (2). Thus in completing the finite circuit $PP_1P_2P_3$ the roller will have turned through an angle $(RI - RI_1)\frac{\theta}{r} = (AI - AI_1)\frac{\theta}{r}$.

But the area $PP_1P_2P_3 =$ area PP_1Q_1Q,

$$\begin{aligned} &= \text{sector } OPP_1 - \text{sector } OQQ_1 = \tfrac{1}{2}(OP^2 - OP_3^2)\theta, \\ &= \tfrac{1}{2}\{OA^2 + AP^2 + 2AI\,.\,AP - (OA^2 + AP^2 \\ &\qquad + 2AI_1\,.\,AP)\}\theta, \\ &= (AI - AI_1)\,b\theta, \\ &= br \text{ times the angle turned through by the roller.} \end{aligned}$$

The area $PP_1P_2P_3$ is therefore b times the travel of the circumference of the roller.

Any irregular area, supposed to be built up of infinitesimal elements found in the same manner as $PP_1P_2P_3$, will be accurately measured by the roller when the point P completes a circuit of the perimeter, the arm AP being free to turn on the joint at A and the arm OA on a fixed point O. If, however, O is inside the area, the area of the zero circle must be added to the area deduced from the readings of the roller. When the roller is fixed permanently, this area is constant, and is usually engraved on the arm in units of the adopted length b; when the roller is held on a slider which also carries the pinion of the arm OA, the length b may be so adjusted that the areas described will be expressed in any desired unit of measure.

Literature and Authorities consulted.—*Accounts of the Operations of the Great Trigonometrical Survey of India*; *Manual of Survey for India*; Col. A. R. Clarke, *Geodesy*; *Methods and Processes of the Ordnance Survey*; Col. Waterhouse, *On the Application of Photography to Maps and Plans*; and *Professional Papers of the Royal Engineers*.

(J. T. W.)

SUSA, the Biblical SHUSHAN, capital of Susiana or Elam and from the time of Darius I. the chief residence of the Achæmenian kings, was a very ancient city, which had been the centre of the old monarchy of Elam and undergone many vicissitudes before it fell into the hands of the Persians (see ELAM). The site of the town, which has been fixed by the explorations of Loftus and Churchill, lies in the plain, but within sight of the mountains between the courses of the Kerkha (Choaspes) and the Dizful, one of the affluents of the Pasitigris. The Shápúr, a small tributary of the Dizful, washes the eastern base of the ruin-mounds of Sús or Shúsh. Thus the whole district was fruitful and well watered, fit to support a great city; the surrounding rivers with their canals gave protection and a waterway to the Persian Gulf; while the position of the town between the Semitic and Iranian lands of the empire was convenient for administrative purposes. It is not therefore surprising that Susa became a vast and populous capital; Greek writers assign to it a circuit of 15 or 20 miles,—a statement which is fairly well borne out by the remains. These include three main mounds, of which one is identified with the strong citadel[1] and a second shows the relics of the great palace built by Darius I. and completed by Artaxerxes Mnemon. Susa was still a place of importance under the Sasanians; and after having been razed to the ground in consequence of a revolt seems to have been rebuilt by Shápúr II. under the name of Éránshahr-Shápúr (Nöldeke, *Gesch. d. Perser aus Ṭabari*, p. 58). The fortifications were destroyed at the time of the Moslem conquest (Moḳaddasi, p. 307); but the site, which is now deserted, was inhabited in the Middle Ages, and a seat of sugar-manufacture.

In Daniel viii. 2 the river of Shushan is called Ulai, a name which is identical with Avrai of the Bundehesh and Eulæus of classical writers. What is told of the Eulæus makes it impossible to identify it with the inconsiderable Shápúr; but authorities differ as to whether it is another name for the Choaspes or rather denotes the Dizful or the Pasitigris. Susa in the days of its greatness must have stretched nearly from river to river. There is a sanctuary of the tomb of Daniel on the banks of the Shápúr, and Arabic geographers relate that this tomb was a frequented shrine before the Moslem conquest and that the Arabs turned the stream over the grave.

SUSA, a city of Italy, in the province of Turin, 33½ miles west of Turin by the railway which passes by the Mont Cenis tunnel into France, is situated on the Dora Riparia (tributary of the Po) at 1625 feet above the sea, and is so protected from the northern winds by the Rocciamelone that it enjoys a milder winter climate than Turin itself. The city walls, 20 to 30 feet broad at the base, were about 50 feet in height, but in 1789 their ruinous condition caused them to be reduced by about half their elevation. Numerous remains of Roman buildings and works of art still show the importance of the ancient town; and the triumphal arch erected by Cottius in honor of Augustus still stands on the old Roman road between Italy and Gaul,—a noble structure, 45 feet high, 39 broad, and 23 deep. The inscription, now illegible, mentioned fourteen "civitates" subject to Cottius. Among the modern buildings of Susa the first place belongs to the church of San Giusto, founded in 1029 by Olderico Manfredi II. and the countess Berta, and in 1772 raised to be the cathedral. The population of the city was 3254 in 1871 and 3305 in 1881 (commune, 4418).

Segusio (also Secusio, Siosium, Seutium, Seucia, etc.) was at a very early period the chief town of this Alpine region, and the Cottian Alps themselves preserve the name of the Segusian chief Cottius, who with the title of præfectus became a tributary and ally of Rome in the reign of Augustus, and left his state strong enough to maintain its independence till the reign of Nero. As a Roman municipium and military post Segusio continued to flourish. After the time of Charlemagne a marquisate of Susa was established; and the town became in the 11th century the capital of the famous countess Adelaide, who was mistress of the whole of Piedmont. On his retreat from Legnano, Barbarossa set fire to Susa; but the town became more than ever important when Emanuel Philibert fortified it at great expense in the 16th century.

SUSA (*Súsa*), a city of Tunis, on the coast of the gulf of Ḥamáma, 33 miles south of Ḥamáma. It occupies the side of a hill sloping seawards, and is still, as far as the town proper is concerned, surrounded with heavy whitewashed Oriental-looking walls. The *Ḳasr al-Ribáṭ*, a square building flanked by seven bastions, was probably either a Roman or Byzantine fortress, and a Byzantine chapel is now transformed into the *Ḳahwat al-Ḳubba* or Café of the Dome. Since the French annexation the citadel, built on the highest point within the town, has been entirely restored and serves as the headquarters of the general commanding a division; and a camp of tile-roofed brick buildings has been erected in the neighborhood. The space within the walls is proving too limited for the growth of the population, and houses already extend along the shore to north and south for about a mile. Susa is the ancient seaport of Ḳairwan (45 miles inland), with which it is connected by a horse-tramway, and it has a rapidly increasing commerce. In 1864 the port was visited by about 195 vessels, in 1885 by 701, of which 532 were Italian. The exports in 1885 were valued at £1,371,510 [$6,665,538.60] (oil, to Genoa and Leghorn, £232,530 [$1,130,095.80]; grain, largely to Sicily, £397,760 [$1,933,113.60]; *sunsa* or olive refuse, to France, £13,715 [$66,654.90]; esparto, a comparatively recent article for this port, £17,935 [$87,164.10), and the imports (including building-stone from Sicily and Malta, brick, lime, marble, and timber) amounted to £660,135 [$3,208,256.10]. The population, which numbered 8000 in 1872 (2000 Jews, 1000 Christians), had increased to upwards of 10,000 in 1886.

Susa is the ancient HADRUMETUM (*q.v.*). In 1537 it was besieged by the marquis of Terra Nova, in the service of Charles V., and in 1539 was captured for the emperor by Andrea Doria. But as soon as the imperial forces were withdrawn it became again the seat of Turkish piracy. The town was attacked by the French and the Knights of St. John in 1770, and by the Venetians in 1764.

SUSANNA ("Lily"), the heroine of one of the apocryphal additions to the Greek text of the book of Daniel, the others being the *Song of the Three Children* and the story of *Bel and the Dragon*. In the English version the story of the virtuous Susanna—the false accusation brought against her by the elders and her deliverance by the judgment of Daniel—is put as a separate book. Jerome, in his *Preface* to Daniel, points out that it had been observed both by Jews and Christians that this story was certainly written by a Greek, and not translated from Hebrew, since Daniel makes a series of Greek puns on the names of trees.

Plate XI.

SUSSEX, a maritime county in the south of England, lying between 50° 43′ and 51° 9′ N. lat. and 0° 49′ E. and 0° 58′ W. long. It is 76 miles from Lady Holt Park to Kent Ditch, and 28 miles from Tunbridge Wells to Beachy Head, and adjoins Kent on the N.E., Surrey on the N., Hampshire on the W., and the English Channel on the S. Its total area is 933,269 acres or 1458 square miles.

Hills.

The range of chalk hills known as the South Downs divides the county into two districts—that of the coast and that of the Wealden—which are of unequal extent and possess very different characteristics. In the western part of the county the South Downs are about 10 miles distant from the sea; they continue eastwards for about 45 miles, and terminate in the bold headland of Beachy Head. Their average height is about 500 feet, though some of the summits reach 700 (Ditchling Beacon, 813 feet; Chanc-

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[1] The Greeks called the citadel the Μεμνόνιον (Strabo, xv. 3, 2), and supposed it to have been founded by the Ethiopian Memnon. It was strong enough to withstand Molon in his war with Antiochus the Great (Polyb., v. 48).

tonbury Ring, 783; Firle Beacon, 700; and the Devil's Dyke, 697). The Forest Ridge extends through the northern part of the county from Petworth to Crowborough, reaching the coast in Fairlight Down. The principal summits are Crowborough Beacon (796 feet), Brightling Hill (647), and Fairlight Down (528). The county has suffered greatly from incursions of the sea. The site of the ancient cathedral of Selsey is now a mile out at sea. Between 1292 and 1340 upwards of 5500 acres were submerged. In the early part of the 14th century Pagham harbor was formed by a sudden irruption of the sea, devastating 2700 acres. Recently all this land has been reclaimed and again brought under cultivation. There is considerable reason for believing that the whole coast-line of the county has been slightly raised in the last 800 years (possibly by earthquake shock), as the large estuaries at the river mouths no longer exist, and the archipelago round Pevensey (*eye* signifies "island") has only a slight elevation above the neighboring marsh land.

Rivers.

The rivers are small and unimportant. The principal are the Rother, the Cuckmere, the Ouse, the Adur, the Arun, and the Lavant. The Rother rises in the Forest Ridge, in the parish of Rotherfield, and enters the sea near Rye, its course having been diverted by a great storm on 12th October, 1250, before which date its exit was 12 miles to the east, beyond Dungeness. The Cuckmere also rises in the Forest Ridge, near Heathfield, and empties itself into the sea a little to the east of Seaford. The Ouse rises in St. Leonards Forest, to the northwest of Lindfield, and, passing through Isfield and Lewes, enters the sea at Newhaven, now the principal port in the county. The former outlet was at Seaford, but in the reign of Elizabeth the sea broke through the beach bank at some warehouses just below Bishopstone and formed what is now called the old harbor, which was in use until the Newhaven one was made a safer exit. The Adur has three sources, all in the neighborhood of St. Leonards Forest, and flows southwards, entering the sea at Southwick. The mouth of the river formerly shifted from year to year, ranging both east and west over a distance of 2 miles. The Arun rises in St. Leonards Forest, in the parish of Slinfold, flows through Amberley and Arundel, and enters the sea at Littlehampton. The Lavant has its source in Charlton Forest and encircles Chichester on all sides except the north, entering the sea through creeks in the extreme southwest corner of the county.

Forests.

The portion of the county to the north of the South Downs is called the Weald; it formerly formed part of the forest of Andredsweald; ("the wood or forest without habitations"), which was 120 miles in length and about 30 in breadth. The total area of forests in 1885 was 113,043 acres, being the greatest of any county in England. About 1660 the total was estimated at over 200,000 acres. The chief remains of the ancient forests are Tilgate, Ashdown, and St. Leonards, but the names in many parts indicate their former wooded character, as Hurstpierpoint (*hurst* meaning "wood"), Midhurst, Fernhurst, Billingshurst, Ashurst, and several others. The forests were interspersed with lagoons, and the rainfall being very great caused marshes and the large river estuaries; the rainfall, however, abated in consequence of the cutting down of the Wealden forests for fuel in the extensive ironworks that formerly existed in that district. The wood was exported in the reign of Edward VI.

Geology.

The greater portion of the county is occupied by the chalk formation, of which the South Downs are almost entirely composed. Firestone is found in the west, and Steyning is built upon it. At the base of the Downs the Greensand crops up, but is of small extent. The Wealden formations occupy nearly all the inland district of the county, and in these was found the ironstone from which iron was extracted. Sussex was at one time the centre of the English iron manufacture; before 1653 there were 42 iron-forges or mills (reduced to 18 before 1667) and 27 furnaces (reduced to 11 before 1664), which employed 50,000 men[1] and furnished the main supply of ordnance for the national defence. The last forge at Ashburnham was not extinguished until 1809. Between 1872 and 1876 boring was carried on at Netherfield, near Battle, with the object of discovering what beds were below the Wealden, and if possible of reaching the Palæozoic rocks, which at Kentish Town, Harwich, Ostend, and Calais had been found at a depth of about 1000 feet below the sea-level. Some slight hope was entertained of the occurrence of Coal-measures, as in the Boulonnais the Carboniferous limestone, where last seen, dips south. The boring was continued to a depth of 1905 feet, the Oxford Clay being reached. The chief result was the discovery of the unusual thickness of the Kimmeridge Clay, which began at 275 feet from the surface and continued to a depth of about 1469 feet. The most practical result was the finding of thick beds of gypsum (at about 160 feet), which were before unknown in the Weald and are now worked at Netherfield. From Beachy Head to Selsey Bill there lies, south of the Downs, a low and level tract belonging to the Tertiary period, of which there is no such record at any other place in England. The towns of Hove, Worthing, Littlehampton, Bognor, etc., are built on gravel, sand, and loam of the Post-Pliocene or Pleistocene series, and these superficial beds overlie the Eocene series in patches and contain a large fossil fauna. Remains of the mammoth occur in the mud deposit (or *Lutraria* clay) of this district, and the Chichester museum contains the greater portion of a fine skeleton of the *Elephas antiquus* obtained off Selsey Bill. Of the British Quaternary fossils forty-five are peculiar to Selsey, and twenty others probably find here their earliest place in British geological history. The Bracklesham beds occur at the bay of that name, and their main divisions extend from Wittering on the west to the Barn Rocks, east of Selsey Bill, a distance of 7 miles. They are full of fossil shells, particularly nummulitic.[2]

Flora and fauna.

An analysis of the flora of the county was placed before the British Association in 1872 by Mr. W. B. Hemsley (*Report*, 1872, p. 128), who stated the total number of indigenous plants to be 1000, to which 59 introduced species must be added. The most interesting features of the flora are the number of species to the county area, the species peculiar to certain formations, viz., the Chalk (56), maritime species (76), and the rare species, especially of the Atlantic and Scottish types. Amongst the rarer marsh plants are *Isnardia palustris*, *Scirpus triqueter*, *S. Carinatus*, *Pyrola media*, *Habenaria albida*, *Festuca sylvatica* of the "Scottish" type of Watson; this last is not found in adjoining counties. A prominent feature of the Wealden flora is the extent of heath land and the large size the heath attains. The fauna includes 29 species of *Mammalia*. The birds are very numerous, no less than 291 species having been recorded. There are about 76 species of general migratory visitors. Of the 216 species of marine fishes found round the British coasts 106 have been observed off Sussex, and there are also 19 freshwater fish.[3]

Climate.

The county presents two distinct climates, that of the coast district being mild, equable, and dry, whilst that of the Wealden district is continental, extreme and rainy. The coast rainfall is about 25 to 26 inches annually and that of the Weald about 33 inches; this is due partly to the South Downs, which rise up in the path of the rain-clouds, and partly to the large extent of forest. In the wet years of 1852 and 1872 the rainfall at several Wealden stations exceeded 50 inches. At Crowborough Beacon the average yearly rainfall from 1871 to 1884 was 38.16 inches; at Brighton during the same period it was only 28.87. Temperature in the Weald at Uckfield has ranged from 98° Fahr. on 14th July to —4° on 20th January, 1838. The mean daily range of temperature in the Weald is about half as much again as on the coast. The influence of the sea in modifying the temperature of the coast district is specially noticeable in the autumn months, when the temperature is higher than in the Weald and other parts of England northwards, and fashion has (perhaps unconsciously) selected the period from September to November for the Brighton season. Sea-bathing, first introduced about the middle of the 18th century, together with the fresh pure air, has turned the stream of health-seekers from Bath and Tunbridge Wells and other watering-places into Sussex. The poor but populous fishing-town of Brighthelmston developed into the fashionable town of Brighton; the new town of Worthing sprang up in Broadwater parish; and the fishing village of Eastbourne rose in importance. The Cinque Port town of Hastings afterwards developed its fashionable suburb St. Leonards, and Seaford was also resorted to; in the western part of the county the hamlet of Bognor became a fashionable place. The opening of the railway from London to Brighton in 1840, soon followed by coast lines from east to west, occasioned a great increase in the coast towns, and now almost the entire coast (except in its steep parts) presents a line of fashionable "health resorts" unequalled in any English county; these indeed form the special distinguishing feature of Sussex amongst other counties.

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[1] *Suss. Arch. Coll.*, xxxii. pp. 22-25.

[2] Address to Geological Section of British Association, 1882.

[3] Good lists of fauna and flora of certain parts of the eastern division of the county have been published by the Hastings Literary and Philosophical Society and the Eastbourne Natural History Society.

Administration.

Sussex is divided into the six rapes[1] of Hastings, Pevensey, Lewes, Bramber, Arundel, and Chichester. The only rapes which exist for practical purposes are that of Hastings, which has a separate coroner, and the last three, in which the liability to repair bridges falls as of common right upon the rape instead of the county division. The Act 19 Hen. VII. cap. 24 directed that for convenience the county court should be held at Lewes as well as at Chichester, and this apparently gave rise to the division of Sussex into east and west parts, and separate quarter sessions are now held for these two divisions. The boroughs of Hastings, Rye, Brighton, and the city of Chichester have separate commissions of the peace and courts of quarter sessions. There are eighteen petty and special sessional divisions. At the time of the Domesday survey the county contained 65 hundreds, but the modern total is 68. Of the 7 municipal boroughs which the county contains Arundel, Chichester, Hastings, and Rye existed long before the passing of the Municipal Corporations Act, 1835; Brighton was incorporated in 1854, Lewes in 1881, and Eastbourne in 1883. Winchelsea, Seaford, Pevensey, and Midhurst were unreformed corporations existing under old charters, the first being governed by a mayor and the last three by bailiffs, but all their privileges have lately been abolished. "Sussex," as Mr. Freeman observes,[2] "is no shire, no department, but a component element of England, older than England." The diocese of Chichester is nearly coextensive with the county and the old kingdom of Sussex. In the year 681 the county was converted to Christianity by St. Wilfrid (afterwards archbishop of York), who founded the see of Selsey, but in 1075 the see was transferred from Selsey to Chichester. The diocese consists of two archdeaconries, Lewes and Chicester, and five deaneries. There are 322 civil parishes, with parts of seven others.

Parliamentary representation.

Prior to the Reform Bill of 1832 Sussex returned twenty-eight members to the House of Commons, two for the county and two each for the boroughs of Arundel, Bramber, Chichester, East Grinstead, Hastings, Horsham, Lewes, Midhurst, New Shoreham (with the rape of Bramber), Rye, Seaford, Steyning, and Winchelsea. The borough of New Shoreham was in 1771 added to the rape of Bramber. In 1832 Bramber, East Grinstead, Seaford, Steyning, and Winchelsea were entirely disfranchised, the first-named being classed with the worst of the "rotten" boroughs; Arundel, Horsham, Midhurst, and Rye were each deprived of one member; the county was divided into two parts (East and West), each returning two members; and a new borough, Brighton, was created, to which two members were allotted. Chichester and Lewes were each deprived of one member in 1867, and Arundel was disfranchised in 1868. The Redistribution of Seats Act, 1885, disfranchised Chichester, Horsham, Midhurst, New Shoreham (with the rape of Bramber), and Rye, and deprived Hastings of one member. It also divided the county into six (instead of two) divisions, viz., Lewes, Southern or Eastbourne, Eastern or Rye, Southwestern or Chichester, Northern or East Grinstead, Northwestern or Horsham, each returning one member. Brighton still retains two members.

Landowners.

According to the latest owners of land *Return* (1873) there were 11 proprietors with more than 10,000 acres each; 8 of 5000 to 10,000; 1015 of 100 and less than 5000; of 10 and less than 100 acres, 1677; of 1 and less than 10, 2347; and of less than an acre, 14,675,—making a grand total of 19,733 landowners, having a gross estimated rental of £2,418,522 [$11,754,016.92]; there were in addition 23,738 acres of common or waste lands. The eleven principal landowners were: Lord Leconfield, 30,221 acres; the duke of Norfolk, 19,217; the duke of Richmond, 17,117; the earl of Chichester, 16,232; the marquis of Abergavenny, 15,364; Rev. John Goring, 14,139; the earl of Ashburnham, 14,051; the earl of Egmont, 14,021; Viscount Gage, 13,739; the Earl De la Warr, 11,165; and the duke of Devonshire, 11,062. At the time of the Domesday survey there were 15 tenants *in capite*, 534 under-tenants, and 2497 *bordarii* (or cottagers), also 765 *cotarii* (or cottars). The custom of borough-English, by which land descends to the youngest son, prevailed to an extraordinary degree in Sussex, and no less than 140 manors have been catalogued in which it was found.[3] Gavelkind tenure existed in Rye, in the large manor of Brede, and in Coustard manor (in Brede parish).

Agriculture.

The coast district has been under cultivation from the time of the Romans and is very fertile, being specially suitable for market gardens and for growing fruit trees. The fig gardens of West Tarring are celebrated. Marshall,[4] describing the Weald in 1788, says: "The townships of the Weald are in general very large, owing, as it would seem to, the fewness of sites fit for habitation. . . . A large portion of the vale lands remain in a state of commonage, particularly on the outskirts and towards the extremities of the district. . . . There is scarcely an acre of natural herbage or old grass-land"; of the coast district he observes that there is strong circumstantial evidence that the lands were not only brought to their present form but cultivated before the laying out of townships. He also mentions that in the Isle of Selsey he observed some common field land, as well as about Chichester. The South Downs afford excellent pasture for sheep, Sussex being famed for a special breed of blackfaced sheep. The total number in 1886 was 518,665,—seventh in order amongst English counties. The total area of land and water in Sussex is 933,269 acres (1881), of which in 1886 there were 682,072 under crops, bare fallow, and grass, made up of 74,518 acres of wheat, 18,667 of barley, 66,509 of oats, 399 of rye, 6307 of beans, and 9493 of pease,—the total of corn crops being 175,293 acres. The green crops were 73,315 acres in extent, including 3405 of potatoes, 28,686 of turnips and swedes, 12,152 of mangolds, 326 of carrots, 11,847 of cabbage, kohl-rabi, and rape, and 16,899 of vetches and other green crops. Clover, sainfoin, and grasses under rotation occupied 63,724 acres (47,851 for hay). Permanent pasture or grass amounted to 340,352 acres (117,956 for hay), included chiefly in the South Downs and used for sheep pasture, and the extensive pastures of Pevensey Marsh, used for fattening stock. The total area cultivated with hops was 10,391 acres, Sussex ranking next to Kent. In 1833 the total of hops was only 7701 acres. The number of horses in 1886 was 24,964, of which 20.473 were used solely for agricultural purposes. Cattle in the same year numbered 115,633, of which 40,693 were cows and heifers in milk or in calf. The total of pigs was 41,064. Poultry in 1885 included 317,712 fowls, the fattening of which for the London market forms an important industry in the northeastern part of the county, the centre being at Heathfield.

Population.

The earliest statement as to the population of Sussex is made by Bede, who describes the county as containing in the year 681 land of 7000 families; allowing ten to a family (not an unreasonable estimate at that date), the total population would be 70,000. At the time of the Domesday survey (about 400 years later the total number of tenants *in capite*, under-tenants, bordarii, cotarii, servi, villani, etc. (in fact, all able-bodied males), was 10,410.[5] Assuming each of these to represent a family of ten, the total population was then 104,100. In 1693 the county is stated[6] to have contained 21,537 houses. If seven were allowed to a house at that date, the total population would be 150,759. It is curious, therefore, to observe that in 1801 the population was only 159,311. The decline of the Sussex iron works probably accounts for the small increase of population during several centuries, although after the massacre of St. Bartholomew upwards of 1500 Huguenots landed at Rye, and in 1685 (after the revocation of the Edict of Nantes) many more refugees were added to the county. In 1881 the total population was

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[1] Probably derived from the Icelandic *hreppr*, signifying land divided by a rope. It is first mentioned in the Domesday survey.

[2] *English Towns and Districts*, p. 125.

[3] *Suss. Arch. Coll.*, vi. 164.

[4] *Rural Economy of the Southern Counties*, etc.

[5] Sir H. Ellis, *General Introduction to Domesday Book*.

[6] *Account by John Houghton, F.R.S., of Acres and Houses in each County* (King's Pamphlets, Brit. Mus.).

490,505, of whom 232,331 were male and 258,174 female. The principal towns were Brighton (population 107,546; 128,440 in parliamentary borough), Hastings (42,258; 47,738 in parliamentary borough), Chichester (8114), Lewes (10,815), and Rye (4667).

Fisheries. Bede records that St. Wilfrid, when he visited the county in 681, taught the people the art of net-fishing. At the time of the Domesday survey the fisheries were extensive, and no less than 285 salinæ (or salt-works) existed. The customs of the Brighton fishermen were reduced to writing in 1579. The census of 1851 returned 915 fishermen, but a parliamentary return in 1869 stated the number of men and boys to be 2236, and they manned 780 boats. The census of 1881 returned 1471 fishermen. The approximate value of the fish landed at Brighton yearly is about £20,000 [$97,200].

Manufactures and trade. There are now no important industries; the chief is the brick, tile, and pottery, the main centre of which is St. John's Common. The census of 1881 returned 1485 brickmakers in the county. The London, Brighton, and South Coast Railway Company have extensive works at Brighton. There is a daily service of passenger steamers from Newhaven to Dieppe in France, and large quantities of fruit, vegetables, butter, and eggs are conveyed from France to London.

History. The earliest settlers in the county were the Celtic tribes whose memorials are found in the hill-forts of Mount Caburn, Hollingbury, White Hawk, Ditchling Beacon, Devil's Dyke, Chanctonbury Hill, Cissbury, etc., the latter being a great factory for flint implements. They gave the names to the rivers. Little is, however, known respecting them beyond the fact that they had a distinct coinage some two centuries before the Roman invasion,—a coarse imitation of the Greek stater of Philip II. of Macedon. These coins have been found in various parts of Sussex. At the time of Cæsar's landing (55 B.C.) the Belgic tribe of the Regni inhabited the county and had their capital at Regnum (Chichester). Sir G. B. Airy fixed on Pevensey as the place of Cæsar's landings in 55 and 54 B.C.; this is, however much disputed, and opinion generally puts the landing near Deal. A few years after this Sussex appears to have formed part of the kingdom of Commius, a British chieftain, and upon his death seems to have been allotted to his son Tincommius. These two are the only British rulers of the county whose coins have been found. Upon the conquest of Britain under Claudius, the Romans found a ready tool in a king named Cogidubnus, who is mentioned by Tacitus, and who was created imperial legate, and may probably be identified with the king of that name mentioned in the celebrated inscription on the temple of Neptune and Minerva found at Chichester. Sussex was reduced to submission prior to the reign of Vespasian, and Major-General Pitt-Rivers suggests that the hill-fort of Mount Caburn may have been one of the twenty oppida Suetonius states to have been reduced by that emperor. Roman settlements became numerous in the county and villas sprang up, the remains of which are still occasionally found, the chief being that at Bignor, near Stane Street, the Roman road connecting Chichester with London and still partly traceable. A fortress was erected at Anderida (Pevensey), and there was another town named Mutuantonis, which is thought to be Lewes; but, having regard to the Antons in West Sussex, it may have been situated farther west than Lewes, perhaps at Littlehampton. Sussex was the first county invaded by the Saxons, who in 477 landed under Ælle at Keynor near Chichester. After fourteen years of struggle they reached the point where the South Downs abut on the sea at Beachy Head, and in 491, as the *Saxon Chronicle* grimly records, "Ælle and Cissa beset Andredes-ceaster (Anderida), and slew all that were therein, nor was there a Briton left there any more." This resulted in the formation of a distinct kingdom of South Saxons, whence its name of *Sussex*. The subjugation of the county was very complete, for it is still one of the most thoroughly Saxon counties in England, and its inhabitants, speech, place-names, customs, etc., are almost entirely Saxon. The next important event in the history of the county was the landing of William of Normandy (28th September, 1066) followed by the battle of Senlac[1] or Hastings (14th October, 1066). The conqueror erected on the battlefield a state abbey[2] dedicated to St. Martin, but it was not completed until after his death. The next chief event was the battle of Lewes, between Henry III. and the barons under Simon de Montfort in 1264, which "wiped out the stain—if stain it were—of Senlac." The only other important events have been the rebellion of Jack Cade in 1450, which received very substantial support in East Sussex, and the naval engagement fought off Beachy Head, in 1690, in which the English and Dutch fleets combined were defeated by the French. Charles II., in his flight after the battle of Worcester, escaped in 1651 from Brighton in a fishing-boat.

The foremost place amongst the illustrious natives of Sussex must be assigned to Shelley the poet. Of statesmen we have Richard Cobden and John Selden, and of eminent ecclesiastics Archbishops Frewen, John Peckham, and William Juxon, also Archdeacon Hare. Its poets include Thomas Otway, Thomas Sackville (afterwards earl of Dorset), and John Fletcher. Of antiquaries we find Sir William Burrill, John Elliot, Rev. Thomas W. Horsfield, Mark Antony Lower, Dr. Mantell (geologist), and Dr. Richard Russell (founder of modern Brighton).

Dialect.—A large number of Saxon words are still retained and pronounced in the old style; thus *gate* becomes *ge-at*. The letter *a* is very broad in all words, as if followed by *u*, and in fact converts words of one syllable into words of two, as *faüs* (face), *taüst* (taste), etc. Again, *a* before double *d* becomes *ar*, as *arder* and *larder* for *adder* and *ladder*; *oi* is like a long *i*, as *spile* (spoil), *intment* (ointment); an *e* is substituted for *a* in such words as *rag*, *flag*, etc. The French refugees in the 16th and 17th centuries introduced many words which are still in use. Thus, a Sussex woman when unprepared to receive visitors says she is in *dishabille* (déshabillé, undress); if her child is unwell, it looks *peked* (piqué),[3] if fretful, is a little *peter-grievous* (petit-grief); she cooks with a *broach* (broche, a spit), and talks of *coasts* (coste, Old French) or ribs of meat, etc. There is an excellent *Dictionary of the Sussex Dialect* by the Rev. W. D. Parrish.

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SUTHERLAND, a northern maritime county of Scotland, is bounded E. by Caithness, S.E. by Moray Firth, S. and S.W. by Ross and a part of Cromarty, and N. and W. by the Atlantic and the North Sea. The area is 1,297,846 acres, or nearly 2028 square miles. The northern and western shores are broken and irregular, in some cases deeply indented, and in the northwest, at Cape Wrath, near Durness, at Whiten Head, and farther south at the island of Handa there are ranges of wildly precipitous cliffs. Numerous islands stud the larger inlets on this coast; the only ones inhabited in 1881 were Oldney with four persons and Roan (in Kyle of Tongue) with forty-three; Handa, which had eight inhabitants in 1871, had none in 1881. On the north coast the principal sea lochs are the Kyle of Tongue, Loch Erriboll, and the Kyle of Durness, and on the west coast Loch Inchard, Loch Laxford, the various branches of Eddrachillis Bay, and Loch Inver. The eastern shore is low and comparatively regular, the only inlets being Loch Fleet and Dornoch Firth. With the exception of the narrow plain along the east coast, various stretches of low ground on the west coast, and the low grounds adjoining the rivers and inland lochs, the surface consists chiefly of a succession of irregular elevations of from 500 to over 3000 feet in height. Much of the western district adjoining the coast from Cape Wrath southwards is occupied by Archæan gneiss, forming a series of bare rounded knolls. Resting unconformably on the gneiss are deposits of grits and sandstones, generally regarded as of Cambrian age, rising into wild cliffs between Cape Wrath and the Kyle of Durness. These are succeeded unconformably by Silurian strata, specially developed in the neighborhood of Durness and Erriboll; in the former region they form a basin occupied chiefly by the limestone series, containing a remarkable collection of fossils, and at Erriboll, from which the strata at Durness are separated by a great dislocation, they present a remarkable series of horizontal displacements. Towards the east the gneiss is intermixed with granite and syenite, which cap the summits of a few of the mountains. Outliers of Old Red Sandstone also occur in this eastern mountainous region, sometimes in masses of coarse conglomerate. The highest mountain summit in Sutherland is Benmore Assynt (3273 feet), the culminating peak of a fine range of Silurian quartzites and limestone rocks lying to the southeast of Loch Assynt, while to the southwest are the picturesque conical summit of Canisp (2779 feet) and the curious Suilven (2399 feet) with its forked top. The next highest and most picturesque series of mountain groups occurs in the northeastern region, south of the Kyle of Tongue,—Ben Hope, a rounded mass with imposing precipices rising near Loch Hope to a height of 3040 feet, while to the eastward is the picturesque Ben Loyal or Laoghal (2504 feet), formed of granite, and south from it, near Loch Naver, the great bulk of Ben Klibreck (3154 feet). Numerous other summits attain a height of over 2000 feet, but the greater proportion of the mountainous region consists of elevated moorlands, bleak and uninteresting, except when the heather assumes its purple tints in autumn. In the lower region along the shores of Moray Firth the Old Red Sandstone occurs resting unconformably on the crystalline series of rocks, and is in turn succeeded by an interesting series of Jurassic strata, which, faulted against the older formations, are exposed along the coast from Golspie to Helmsdale. In this series, at Brora, some seams of coal have been worked, but the presence of iron pyrites greatly lessens its value. Limestone is wrought in various districts, and there are a number of quarries for building stone. Small quantities of gold have been found in some places.

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[1] The hill of Senlac is now occupied by the abbey and town of Battle.

[2] [William exempted the abbey domain from all "customs and domination," also from episcopal jurisdiction, and attached large privileges of intervention in criminal cases to the abbot.—AM. ED.]

[3] [Also "peaked," a word used by Shakespeare, and not uncommon in the northern parts of the United States.—AM. ED.]

Sutherland has a much greater proportion of its area occupied by water than any other large county in Scotland, the parish of Assynt being completely honeycombed with lochs and tarns. Loch Assynt, the largest of these, 10 miles in length, and narrow and irregular in outline, is entitled to rank, from its picturesque creeks and the grandeur of the adjoining mountain scenery, as the most beautiful loch in Sutherland. Loch Shin, extending 17 miles throughout nearly the whole of Lairg parish, from southeast to northwest, is towards the centre overhung by mountain masses, but otherwise is without interest to any but the angler. It is succeeded northwards by a series of lochs—Griam, Merkland, More, Stack, Garbadmore, Garbadbeg—extending through the centre of the parish of Eddrachillis. Lochs Merkland and Griam occur, like Loch Shin, in the course of the river Shin, a tributary of the Oykel, which last forms the southern boundary of the county with Ross and falls into Dornoch Firth; Lochs More and Stack are in the valley of the Laxford, running northwestward to Loch Laxford. The Dionard or Grudie flows northwards to the Kyle of Durness, and the Hope, after expanding into Loch Hope, about 10 miles in length, falls into Loch Erriboll. The Borgie, which in its course forms Loch Loyal and falls into Torresdale Bay; the Naver, which flows from the loch of that name through a fertile strath to the sea at Bettyhill of Farr; the Strathy; and the Halladale are the principal other rivers flowing northwards. Those entering Moray Firth are the Oykel; the Helmsdale, which reaches the sea at the town of that name; the Brora, which receives various tributaries before it expands into Loch Brora, 3 miles from its entrance into the Sea at Brora; and the Fleet, flowing into Loch Fleet.

Agriculture.—According to the agricultural returns of 1886 only 3110 acres out of 1,347,033 were in cultivation, less than a fortieth part of the whole area. The best land is that adjoining Moray Firth, where agriculture is in a very advanced condition. Along the river valleys there are, however, many fertile patches. At the beginning of the 19th century the crofters occupied almost every cultivable spot throughout the county; between 1811 and 1820 they were ejected from their holdings to the number of 15,000, and, according to the statement of Hugh Miller, "compressed into a wretched selvage of poverty and suffering that fringes the county on its eastern and western shores." The homes they left were, he says, "improved into a desert"; but in the opinion of those who made the alteration these mountainous parts were as "much calculated for the maintenance of stock as they were unfit for the habitation of man." The crofters in Sutherland are now (1887) chiefly confined to the western seaboard, the number of crofts, all on the estates of the duke of Sutherland, amounting, according to the *Report of the Crofters Commission*, to 1238, and representing a population of 6190. The general agricultural condition of the county has been much improved by successive dukes of Sutherland, aided by the liberality of the Government in the advancement of money for the construction of roads and bridges; and within recent years large reclamations have been made, in order to obtain a wider area for the growth of fodder and turnips. The following table gives the number and acreage of various classes of holdings in 1875, 1880, and 1885:

Year.	50 acres and under		50 to 100 acres.		100 to 300 acres.		300 to 500 acres.		500 to 1000 ac.		Above 1000 ac.		Total.	
	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Ac.	No.	Ac.	No.	Acres
1875	2505	11,994	29	2069	42	6939	9	3576	4	2212	..	..	2589	26,7[illegible]
1880	2498	12,539	34	2541	40	6661	15	5730	5	2689	..	..	2592	30,1[illegible]
1885	2512	13,232	44	3259	41	7399	14	5224	5	2899	2	8050	2618	40,0[illegible]

In 1885 of the class of holdings not exceeding 50 acres in extent 68 were between 20 and 50 acres each, 661 between 5 and 20, 1764 between 2 and 5, and 19 between ¼ and 1 acre.

Out of the 33,110 acres under tillage in 1886 there were 10,343 under corn crops, 5052 under green crops, 8861 rotation grasses, 8602 permanent pasture, and 252 fallow. The principal corn crop is oats, which occupied 8392 acres, barley occupying 1845, rye 63, pease 24, and wheat only 19. Potatoes occupied 2014 acres and turnips and swedes 2981. Cattle, chiefly West Highland, shorthorn, and crossbred, numbered in 1886 12,806, of which 5576 were cows and heifers in milk or in calf; horses, which include a large number of ponies, although Clydesdales are used on the large farms, numbered 2665, of which 2015 were used solely for purposes of agriculture; sheep, the rearing of which is the staple business of the county, the principal breed being Cheviots, numbered 211,825, of which 158,961 were two years old and above; and pigs, 1037. According to the *Report of the Crofters Commission*, there were four deer forests within the county, all belonging to the duke of Sutherland, viz.: Ben Armin and Coir-na-fearn, 35,840 acres; Dunrobin, 12,180; Glencanisp, 34,490; and Reay, 64,600; in all 157,110 acres, or more than one-ninth of the total area. There is a comparatively small area under woods,—only 12,260 acres in 1881.

According to the latest (1873) owners and heritages *Return* the land was divided among 433 proprietors possessing 1,297,253 acres at an annual value of £71,494 [$347,460.84], or 1s. 1½d. [26½ cts.] an acre all over. There were 348 proprietors who possessed each less than one acre, the total amount which they owned being only 59 acres. The bulk of the land is possessed by the duke of Sutherland, who owned 1,176,454 acres, the other proprietors possessing above 10,000 acres each being Sir Charles W. A. Ross, 55,000; E. C. Sutherland-Walker, 20,000; Sir James Matheson, 18,490;

and the executors of Gordon M'Leod, 11,000. The total valued rental of the county in 1674 was only £27,193 Scots or £2266 sterling [$11,012.76], while in 1885–86 it was £103,-979 [$505,337.94].

Communication.—The county is well supplied with roads, considering its mountainous character and its sparse population. Helmsdale affords the means of export for a considerable amount of farm produce. The Highland Railway enters the county at Invershin and after passing northwards to Lairg turns eastwards to the coast, which it skirts to Helmsdale, whence it turns northwestwards along the banks of the Helmsdale, bending afterwards eastwards at Forsinard into Caithness.

Industries.—Various textile manufactures at one time established in the county have been discontinued, the only important manufacture now remaining being that of whiskey at Clyne and Brora. Herring fishing prosecuted from Helmsdale is an important industry, and the cod, ling, and other deep-sea fishings engage a large number of boats and men. There are valuable salmon fisheries in several of the rivers.

Administration and Population.—The county contains 13 entire parishes and part of the parish of Reay, the remainder being in Caithness. The county returns one member to parliament, and one is returned for the Wick group of burghs. Dornoch, the only royal burgh, had but 497 inhabitants in 1881, while Golspie had 1548 and Helmsdale 794. The population has not varied greatly in numbers since the beginning of the 19th century. In 1801 the numbers were 23,117, and in 1881 they were 23,370, a gradual decrease having taken place since 1851, when the numbers reached 25,793. In 1881 there were 11,219 males and 12,151 females. Sutherland is the most sparsely peopled county in Scotland, there being only 12 persons to the square mile, while the average for Scotland is 125. Sutherland forms a joint sheriffdom with Ross and Cromarty, and a sheriff-substitute resides at Dornoch. Small debt circuit courts are held at Helmsdale, Tongue, Melvich, and Scourie, and justice of peace courts at Dornoch, Golspie, Brora, and Helmsdale.

History and Antiquities.—The ancient Celtic inhabitants were almost entirely expelled by the Scandinavian settlers who occupied the county after its conquest by the Norse jarl Thorfinn in 1034. The remains of Pictish towers are numerous, as are also stone circles. Of other antiquities mention may be made of the vitrified fort on Dun Creich and of the extensive remains of Dun Dornadilla in Durness parish. After the conquest of the district by the Scottish kings, Sutherland was conferred on Hugh Freskin (a descendant of Freskin of Moravia or Moray), whose son William in 1228 was created earl of Sutherland by Alexander II. The nineteenth earl of Sutherland was created duke in 1833. The seat of the ancient episcopal see of Sutherland and Caithness was at Dornoch, where a cathedral was erected by Gilbert of Moravia (1222–1245), of which the ancient tower, attached to the modern parish church, still remains.

See Sir Robert Gordon's *History of the Earldom of Sutherland*, 1813; Hugh Miller's *Sutherland as it is*, 1843; and C. W. G. St John's *Tour in Sutherlandshire*, 1849. (T. F. H.)

SUTTEE, the name given by English writers to the rite of burning a widow on the funeral pyre of her husband as practiced among certain Hindu castes, and especially among the Rajputs. The word *satí* (as it should rather be written) properly denotes the wife who so sacrifices herself, not the rite itself, and means "a good woman," "a faithful wife." The sacrifice was not actually forced on a wife, but it was strongly recommended by public opinion as a means to her own happiness and that of her husband in the future state, and the alternative was a life of degraded and miserable widowhood. The practice was current in India when the Macedonians first touched that country (Diod. Sic., xix. 33), and it lasted into the 19th century, having been tolerated even by English rulers till 1829. (See INDIA, vol. xii. pp. 845–6.) The subject is illustrated by copious quotations from ancient and modern authorities in Yule's *Anglo-Indian Glossary*, p. 666 *sq.*, and by comparison of similar rites among other nations in Tylor's *Primitive Culture*, ch. xi. It has its root in the primitive view of the future life, which regards the dead as having similar needs to the living. The wife is sent into the world of shades with her husband, just as arms, clothing, or treasure are buried in his tomb, or slaves are slain to attend their master in the underworld. The Indian custom is not, therefore, properly a part of Brahmanism; but it was adopted by the ministers of that religion, who strained their sacred texts to find support for it.

SUTTON COLDFIELD, an ancient market town and municipal borough of Warwickshire, England, is situated on the London and North-Western Railway, 8 miles south of Lichfield and 7 northeast of Birmingham. The town has been greatly increased of late years by the erection of villas for persons having their business offices in Birmingham, Walsall, and other towns. The church of the Holy Trinity—early English and late Perpendicular, restored in 1874 and enlarged in 1879—contains a fine Norman font and the tomb of Bishop Vesey. He obtained from Henry VIII. the grant of the park and manorial rights for the benefit of the town, the annual value (now about £2000 [$9720]) being expended in charities and education. On the picturesque park near the town, 2400 acres in extent, the inhabitants have the right of grazing horses and cattle at a small fee. A town hall was erected in 1859; in it there is a good library. The corporation formerly consisted of a warden and 24 members, but in 1885 Sutton obtained a municipal charter, by which it is divided into six wards, with an alderman and three councillors for each ward. The population of the township in 1871 was 5936, and in 1881 it was 7737.

Sutton was at one time a royal manor and an apanage of the earls of Warwick. It owes much of its prosperity to the gifts of John Vesey (Voysey), bishop of Exeter in the 16th century, who was a native of the place. In its charter of incorporation, 20th Henry VIII., it is called the royal town of Sutton Coldfield.

SUTTON-IN-ASHFIELD, a town of Nottinghamshire, England, is situated on an eminence on the Nottingham and Worksop and the Erewash Valley Railways, 3 miles west-southwest of Mansfield. The church of St. Mary Magdalene of the 12th century was restored in 1868. In the churchyard is a yew tree reputed to be 700 years old. There are a number of collieries and limeworks in the vicinity. Cotton hosiery and thread are the principal manufactures. The duke of Portland is lord of the manor. The population of the urban sanitary district (area, 4855 acres) in 1871 was 7574, and in 1881 it was 8523.

SUWAŁKI, a government of Russian Poland, occupies the northeast corner of the kingdom, extending to the north between East Prussia and the Russian governments of Kovno, Vilna, and Grodno. Its area is 4846 square miles. It covers the east of the low swelling, studded with lakes, which skirts the south coast of the Baltic (see POLAND), its highest parts reaching 800 to 1000 feet above the sea. Its northern slopes descend to the valley of the lower Niemen, while in the south it falls away gently to the marshy tract of the Bebrz. The rivers flow there in deep gorges and valleys, diversifying the surface. Suwałki is watered by the Niemen, which forms its eastern and its northern boundary and is largely used as a channel of communication; it has many affluents from both slopes of the swelling. The Augustowo Canal connects the navigable Hancza, tributary of the Niemen, with a tributary of the Bebrz, which belongs to the basin of the Vistula, and an active traffic is carried on on this canal. The population was 606,573 in 1883, the increase being 3400 during the year. It has a most varied composition, embracing Lithuanians (the prevailing element), who number about four-tenths of the whole (Zhmuds, 31.5 per cent.; Lithuanians proper, 10.3), Poles (28.4, of whom 5.3 are Mazurs), Jews (17.2), Germans (6.8, but they are rapidly increasing), and White Russians (4.6). In religion the Catholics are predominant (449,476 in 1883); the Jews come next (98,743); there are also 38,610 Protestants, 13,-275 Orthodox Greeks, and 6246 Raskolniks.

Tertiary and Chalk deposits are widely spread in Suwałki, and the entire surface is covered with Post-Tertiary deposits. The bottom moraine of the great ice-sheet of North

Germany, containing scratched boulders and furrowed by depressions having a direction north-northeast to south-southwest,[1] covers immense tracts of the ridge of the lake-districts and its slopes, while limited spaces are covered with well-washed glacial sands and gravel. On the northern slopes of the coast-ridge, the boulder-clay being covered with lacustrine deposits, there are at many places layers of fertile soil; and in the southern parts of the province the boulder-clay is very stony, and sometimes covered with gravel. Still, nearly nine-tenths of the surface are considered suitable for cultivation. Agriculture is the chief occupation, and potatoes are extensively grown for export to Prussia, where they are used for the manufacture of spirits, which are smuggled into the province. The manufactures are unimportant (600 workmen; annual produce valued at £124,000 [$602,640], one-half being due to distilleries). All manufactured wares are imported, mostly from Prussia; and all trade is in the hands of Jews. The educational institutions include two gymnasia for boys, one for girls, one seminary for teachers (at Weiwery), one Catholic seminary, and 196 lower grade schools, having altogether an aggregate of 13,193 scholars in 1884. Suwałki is divided into seven districts, the chief towns of which with their populations in 1882 were—Suwałki (see below), Augustowo (11,100), Kalwarya (10,600), Mariampol (5610), Seiny (4035), Wilkowiszki (6700), and Władisławow (9300). Wierzbolowo (3550), an important custom-house, situated on the railway from St. Petersburg to Berlin, also has municipal institutions.

SUWAŁKI, capital of the above government, is situated at the source of the Hancza, tributary of the Niemen, 75 miles northwest of Grodno. In the 15th century it was but a small village, lost amidst forests, and peopled by Lithuanians. In the end of the 18th century it became the capital of the Augustowo government, but never had any importance, except as the seat of the local authorities. Since 1834 it has been the capital of the government of Suwałki. Its population was 18,640 in 1882.

SUWAROFF, or Suvoroff, Alexander Vasilievich (1729–1800), Russian general, was born at Moscow on 24th November, 1729, the descendant of a Swede named Suvor who emigrated to Russia in 1622. Suwaroff entered the army at an early age and first distinguished himself at the battle of Kunersdorf in 1759, where he acted as aide-de-camp to General Fermor. Throughout the Seven Years' War he was conspicuous for his bravery and military skill. He next took part in the battles between the Russians and Poles at the period of the first dismemberment of Poland. Being afterwards transferred to the banks of the Danube (1773), he there in the campaigns against the Turks laid the foundation of his reputation as a military commander. It 1775 he put an end to the formidable revolt of Pugatcheff, who was brought in chains to Moscow and there decapitated. In 1789 Suwaroff defeated the Turks at Fokshani (Moldavia), and again in the same year on the Rimnik. In 1790 he took by assault the town of Ismail, on which occasion he sent his well-known couplet to the empress.[2] On the termination of this war Suwaroff was summoned to another campaign against the Poles. After the defeat of Kosciusko by Fersen at Macicowice in Siedlce (1794) he marched on Warsaw, and captured its suburb Praga, where 15,000 Poles were massacred. Upon this the city capitulated, and the Russian general was made field-marshal. He remained in Poland till 1795 and was received in triumph on his return to St. Petersburg. In November, 1796, the empress Catherine, his firm friend and admirer, died. On the accession of Paul, who always labored to undo his mother's work, Suwaroff fell into disgrace and was banished to his country-seat at Kontchanskoe in the government of Novgorod. There he remained some time in retirement. He unsparingly criticised the new military tactics and dress introduced by the emperor, and some of his caustic verses reached the ears of Paul. His conduct was therefore watched and his correspondence with his wife, who had remained at Moscow—for his marriage relations had not been happy—was tampered with. On Sundays he tolled the bell for church and sang among the rustics in the village choir. On week days he worked among them in a smock frock. But in February, 1799, he was summoned by the emperor to assist in the campaign with the Austrians against the French. Suwaroff took command of the combined forces at Verona. He attacked Moreau, the French general, at Cassano, the ford of the Adda, and completely defeated him, taking about 3000 prisoners; he then made a triumphal entry into Milan. He next defeated Macdonald on the Trebbia in a sanguinary engagement which lasted three days, from the 17th to the 19th of June (1799). Soon afterwards Joubert was defeated and slain at Novi (15th August). But the importance of these successes was neutralized by the constant squabbles between Suwaroff and the Austrian commanders. The Russian general now received orders to join Korsakoff in Switzerland and to assist him in driving the French from that country. He accordingly crossed the Alps, suffering severe losses, but on his arrival learned that Korsakoff had been previously defeated by Masséna. It only remained for him to effect a retreat with the shattered remains of his army. He finally reached his winter quarters, between the rivers Iller and Lech, and thence directed his homeward march to Russia. The emperor Paul, who soon after this time entirely changed his policy and made an alliance with Bonaparte, recalled Suwaroff in disgrace, and on his return refused to see him. The veteran retired to his country-seat, where he died on the 18th of May, 1800. Lord Whitworth, the English ambassador, was the only person of distinction present at the funeral of this remarkable man. He lies buried in the church of the Annunciation in the Alexandro-Nevskii monastery, the simple inscription on his grave being, according to his own direction, "Here lies Suwaroff."

Among the Russians the memory of Suwaroff is cherished as that of a great and successful general, but he hardly enjoys such a reputation among foreigners, who generally look upon his victories as due rather to the huge masses of men under his control than to military genius. His tactics seem to have been somewhat Oriental. He formed no general plans for his campaigns, but trusted to celerity of movement and blows rapidly struck. He was terribly reckless of human life, neither sparing his own soldiers nor showing mercy to the conquered. And yet we find him the subject of exaggerated eulogy among English writers in the early part of the 19th century. He was a man of great simplicity of manners, and while on a campaign lived as a common soldier, sleeping on straw and contenting himself with the humblest fare. But he had himself passed through all the gradations of military service, and had been for many years a private soldier; moreover, his education had been of the rudest kind. He affected the habits of a humorist, and his gibes procured him many enemies. He had all the natural contempt of a man of ability and action for ignorant favorites and ornamental carpet-knights. Droll stories, in keeping with the well-known eccentricity of his character, are told of his manner of life in camp.[3]

SVEABORG, an important fortress of Finland, built by Count Ehrensvärd in 1749 on seven small islands off the harbor of Helsingfors (*q.v.*). It is the seat of a great naval harbor and arsenal.

SWABIA, Suabia, or Suevia (Germ. *Schwaben*), is the name of an ancient duchy in the southwest part of Germany, afterwards transferred to one of the ten great circles into which the empire was divided in the reign of Maximilian I. (1493–1519). At present the official use of the name is confined to a province of Bavaria (capital, Augsburg), comprising a mere fragment of the former Swabia, but in common use it is still applied to the districts included in the old duchy. The duchy of Swabia was bounded on the N. by the Rhenish Palatinate, on the E. by the Lech (separating it from the duchy of Bavaria), on the S. by Switzerland, the lake of Constance, and Vorarlberg, and on the W. by the Rhine. It corresponds roughly to the modern Würtemberg, Baden, and Hohenzollern, with part of Bavaria. The circle of Swabia coincided more nearly than most with the duchy from which it was named, but was rather more extensive. It was bounded by Switzerland, France (after the cession of Alsace), and the circles of the Upper and Lower Rhine, Franconia, Bavaria, and Austria. Its area was about 13,500 square miles. The Swabian circle contained more independent states of the empire than any other, including the countship (afterwards duchy) of Würtemberg, the margraviate of Baden, the principalities of Hohenzollern and Liechtenstein, a whole series of smaller secular and ecclesiastical principalities, and upwards of thirty free imperial towns (Augsburg, Ulm, etc.). Swabia is intersected from west to east by the Danube, and is one of the most mountainous (Black Forest, Swabian Jura) and picturesque parts of the German empire. It is also very fertile. The Swabians are a strong, big-framed, and good-humored race, and, though in several popular legends the "Schwab" plays the part of a "wise man of Gotham," he is probably no denser than his neighbors.

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[1] Hedroits, in *Proc. Russ. Geol. Committee*, iii., 1884.

[2] [For this couplet see vol. xix. p. 615.—Am. Ed.]

[3] [For an account of this extraordinary career see Rambaud's *History of Russia*. Gen. J. W. De Peyster published in 1883 (Phila.) a laudatory military criticism of Suwaroff.—Am. Ed.]

The use of the name of Swabia in connection with the southwest part of Germany, previously called Alemannia (see ALEMANNI), begins with the 5th century of our era, when the Suevi poured into the country and amalgamated with the Alemanni. It was not, however, till the 8th century, when the dukedom of Alemannia was abolished and Rhætia and Alsace separated from it, that Swabia became the recognized name of the district, henceforth administered by nuncii cameræ, as representatives of the Frankish emperors. One of these nuncii, who usurped the ancient title of duke of Alemannia, was executed in 917, but two years later Henry I. yielded to the popular will in allowing Count Burkhard I. to style himself duke of Swabia. The dukedom thus founded, which lasted for more than three centuries, repeatedly changed hands, and was generally conferred by the emperors and kings of the Saxon and Franconian lines on members of their own families. In 1079 it passed into the hands of Frederick I. of Hohenstaufen, the progenitor of a line of German monarchs, and under his successors Swabia had the reputation of being the most civilised and prosperous part of Germany. As, however, the Hohenstaufen line gradually lost strength in its hopeless struggle with the papacy, the Swabian nobles increased in power at the expense of the dukes, and several of them became "immediate." No duke of Swabia was appointed after the death of Conradin, the last of the Hohenstaufen, in 1268, and his place was henceforth filled in some degree by the count of Würtemberg as *primus inter pares*. For the next 250 years or so the history of Swabia consists of an endless series of feuds between the different members of the duchy, mingled with more or less abortive attempts of the German emperors and others to restore peace. The lesser nobles fought with the greater nobles, the towns banded themselves together against both, and alliances and counter-alliances were formed and dissolved with bewildering rapidity. The "Schleglerkrieg" is the name given to a bloody contest between the counts of Würtemberg and the lesser noblesse in 1367. The most important of the various leagues formed by the towns was the "Schwäbischer Städtebund" of 1376, the point of which was directed against Würtemberg. In 1488 the Swabian estates,—nobles, prelates, and towns,—weary of constant dissension, joined in the Great Swabian Confederation, the object of which was to maintain peace throughout the country. This league possessed a carefully drawn up constitution and exercised executive and judicial functions throughout the whole of Swabia, maintaining a standing army to give force to its decrees. Though not successful in completely abolishing war within Swabia, the confederation was by no means a failure. It was, for instance, the general of the confederation that put an end to the calamitous Peasants' War of 1525. The Reformation found ready acceptance in Swabia. Würtemberg, Ulm, and some of the other estates even joined in the Schmalkald League; but for this they afterwards had to pay large fines to the emperor, while the towns lost their democratic constitution, and with it most of their political importance. The outstanding feature of Swabian history for some time afterwards may be said to be the struggle for supremacy between the Protestant Würtemberg and the Roman Catholic Austria. In 1512, when all Germany was divided into ten circles, one of them was named the Schwäbischer Kreis, or Swabian Circle (see above). The circle received its complete organization in 1563, and retained it practically unchanged till the dissolution of the empire in 1806. Swabia suffered severely in the Thirty Years' War, and it was also one of the scenes of the struggles consequent on the French Revolution. But its modern history must be sought for under such headings as WÜRTEMBERG and BADEN.

SWAHILI (*Wa-Swahili*, *i.e.*, "Coast People," from the Arabic *sáḥil*, coast), a term now commonly applied to the inhabitants of Zanzibar and of the opposite mainland between the parallels of 2° and 9° S., who are subjects of the sultan of Zanzibar, and whose mother-tongue is the Ki-Swahili language. According to present local usage no person would be called a Swahili unless he verified these two conditions. The Swahili are essentially a mixed people, in whom the Bantu and Arab elements are mingled in the proportion of about three to one; and the same is true of their speech, which of all the Bantu dialects has been most affected by Arab and other influences. The interest attaching to the Swahili people, who have figured so largely in the history of African enterprise during the last half century, is thus of a social rather than of a strictly scientific character. The energy and intelligence derived from a large infusion of Semitic blood has enabled them to take a leading part in the development of trade and the industries, as shown in the wide diffusion of their language, which, like the Hindustani in India and the Guarani in South America, has become the principal medium of intercommunication throughout most of the continent south of the equator. During his journey from the Indian Ocean to the Atlantic Commander Cameron found that a knowledge of this language enabled him everywhere to dispense with the aid of an interpreter, as it was understood by one or more persons in all the tribes along the route. Owing to this circumstance the intelligent and enterprising natives of Zanzibar have been found indispensable assistants in every expedition penetrating from the eastern seaboard to the interior since they began to be employed by Speke and Burton as porters and escorts. Missionary enterprise has been at work amongst the Swahili, who are all Mohammedans, but with poor results. The language, however, has been carefully studied, and is now better known than perhaps any other member of the Bantu family. There are several varieties, of which the chief are—the archaic Ki-Ngozi in the north about the river Tana, mostly free from foreign elements; the Ki-Mvita of the Mombasa district, reduced to writing by Krapf; and the Maneno Unguya of Zanzibar, which is most affected by Arabic, Persian, Indian, and other foreign influences, but which, nevertheless, is now the literary standard; of it complete grammatical treatises have been published, and into it portions of the Bible have been translated by Bishop Steere.[1]

SWALLOW (A.-S. *Swalewe*, Icel. *Svala*, Dutch *Zwaluw*, Germ. *Schwalbe*), the bird which of all others is recognized as the harbinger of summer in the northern hemisphere; for, though some slight differences, varying according to the meridian, are constantly presented by the birds which have their home in Europe, in Northern Asia, and in North America respectively, it is difficult to allow to them a specific value; and consequently a zoologist of wide views, while not overlooking this local variation, will regard the Swallow of all these tracts as forming a single species, the *Hirundo rustica* of Linnæus.[2] Returning, usually already paired, to its summer-haunts, after its winter-sojourn in southern lands, and generally reaching England about the first week in April, it at once repairs to its old quarters, nearly always around the abodes of men; and, about a month later, the site of the nest is chosen, resort being had in most cases to the very spot that has formerly served the same purpose—the old structure, if still remaining, being restored and refurnished. So trustful is the bird that it commonly establishes itself in any of men's works that will supply the necessary accommodation, and a shed, a barn, or any building with an open roof, a chimney[1] that affords a support for the nest, or even the room of an inhabited house—if chance should give free access thereto,—to say nothing of extraordinary positions, may be the place of its choice. Wheresoever placed, the nest is formed of small lumps of moist earth, which, carried to the spot in the bird's bill, are dully arranged and modelled, with the aid of short straws or slender sticks, into the required shape. This is generally that of a half-saucer, but it varies according to the exigencies of the site. The materials dry quickly into a hard crust, which is lined with soft feathers, and therein are laid from four to six white eggs, blotched and speckled with gray and orange-brown deepening into black. Two broods are usually reared in the season, and the young on leaving the nest soon make their way to some leafless bough, whence they try their powers of flight, at first accompanying their parents in short excursions on the wing, receiving from them the food themselves are as yet unable to capture, until able to shift for themselves. They collect in flocks, often of many hundreds, and finally leave the country about the end of August or early in September, to be followed, after a few weeks, by their progenitors. The Swallows of Europe doubtless pass into Africa far beyond the equator,[2] and those of Northern Asia, though many stop in India or Burmah, even further to the southward, occasionally reaching Australia, while those of North America extend their winter-wanderings to southern Brazil; but, whithersoever they then resort, they during that season moult their feathers, and this fact affords one of the strongest arguments against the popular belief (which, curious to say, is still partly if not fully entertained by many who should know better) of their becoming torpid in winter, for a state of torpidity would suspend all animal action.[3] The chestnut forehead and throat, the shining steel-blue upper plumage, and the dusky-white—in some cases reddening so as almost to vie with the frontal and gular patches—of the lower parts are well known to every person of observation, as is the markedly forked tail, which is become proverbial of this bird.

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[1] The language was first reduced to writing by the Arabs, who still use the Arabic character. But the European missionaries have wisely replaced this by the Roman system, which is far more suited for the transliteration of most African, and especially of the Bantu, tongues.

[2] Dr. Stejneger (one of the chief leaders in the recent American movement, the results though not the intention of which would be the subversion of much of the nomenclature of birds hitherto thought in Europe to have been established on tolerably firm

Taking the word Swallow in a more extended sense, it is used for all the members of the Family *Hirundinidæ*,[4] excepting a few to which the name MARTIN (vol. xv. p. 587) has been applied, and this Family includes from 80 to 100 species, which have been placed in many different genera. The true Swallow has very many affines, some of which range almost as widely as itself does, while others seem to have curiously restricted limits, and much the same may be said of several of its more distant relatives. But altogether the Family forms one of the most circumscribed and therefore one of the most natural groups of *Oscines*, having no near allies; for, though in outward appearance and in some habits the Swallows bear a considerable resemblance to SWIFTS (*q.v.*), the latter belong to a very different Order, and are not Passerine birds at all, as their structure, both internal and external, proves. It has been sometimes stated that the *Hirundinidæ* have their nearest relations in the FLYCATCHERS (vol. ix. p. 307); but the assertion is very questionable, and the supposition that they are allied to the *Ampelidæ* (*cf.* WAXWING), though possibly better founded, has not as yet been confirmed by any anatomical investigation. An affinity to the Indian and Australian *Artamus* (the species of which genus are often known as Wood-Swallows, or Swallow-Shrikes) has also been suggested; and it may turn out that this genus, with its neighbors, may be the direct and less modified descendants of a generalized type, whence the *Hirundinidæ* have diverged; but at present it would seem as if the suggestion originated only in the similarity of certain habits, such as swift flight and the capacity of uninterruptedly taking and swallowing insect-food on the wing.

Swallows are nearly cosmopolitan birds, inhabiting every considerable country except New Zealand, wherein only a stray example, presumably from Australia, occasionally occurs. (A. N.)

SWAMMERDAM, JOHN (1637-1680), may be ranked almost with Leeuwenhoek as one of the most eminent Dutch naturalists of the 17th century. Born at Amsterdam in 1637, the son of an apothecary and naturalist, he was destined for the church; but he insisted on passing over to the profession of medicine, meanwhile passionately devoting himself to the study of insects. Having necessarily to interest himself in human anatomy, he devoted much attention to the preservation and better demonstration of the various structures, and he devised the method of studying the circulatory system by means of injections, so doing the greatest service to practical anatomy. The fame of his collection soon became European; thus the grand-duke of Tuscany offered him 12,000 florins [$4680] for his collection, on condition of his coming to Florence to continue it. His *General History of Insects* and other kindred works lie at the foundation of modern entomology, and include many important discoveries. Thus he cleared up the subject of the metamorphosis of insects, and in this and other ways laid the beginnings of their natural classification, while his researches on the anatomy of mayflies and bees were also of fundamental importance. His devotion to science led to his neglect of practice; his father greatly resented this, and stopped all supplies; and thus Swammerdam experienced a period of considerable privation, which had the most unfortunate consequences to his health, both bodily and mental. In 1675 he published his *History of the Ephemera*, and in the same year his father died, leaving him an adequate fortune, but the mischief was irreparable. He became a hypochondriac and mystic, joined the followers of Antoinette Bourignon, and died at Amsterdam in 1680.

SWAN (A.-S. *Swan* and *Swon*, Icel. *Svanr*, Dutch *Zwaan*, Germ. *Schwan*), a large swimming-bird, well known from being kept in a half-domesticated condition throughout many parts of Europe, whence it has been carried to other countries. In England it was far more abundant formerly than at present, the young, or Cygnets,[5] being highly esteemed for the table, and it was under especial enactments for its preservation, and regarded as a "Bird Royal" that no subject could possess without license from the crown.

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principles) would apply to the Swallow the generic term of *Chelidon*, generally accepted for the MARTIN (vol. xv. p. 587), and to the latter *Hirundo*. Herein he is technically incorrect, for one of the first principles of zoological nomenclature has always been that a generic term, to be valid, must be defined. In the absence of definition such a term may be, by courtesy, occasionally accepted; but this courtesy has never been, nor except in America is likely to be, extended to the misapplication here in question.

[1] Hence the common English name of "Chimney-Swallow." In North America it is usually the "Barn-Swallow."

[2] It must be noted that the Swallow has been observed in England in every month of the year; but its presence from the beginning of December to the middle of March is an extremely rare occurrence.

[3] See John Hunter's *Essays and Observations in Natural History*, edited by Sir R. Owen in 1861 (ii. p. 280). An excellent bibliography of the Swallow-torpidity controversy, up to 1878, is given by Prof. Coues (*Birds of the Colorado Valley*, pp. 378-390), who seems still to hanker after the ancient faith in "hibernation."

[4] An enormous amount of labor has been bestowed upon the *Hirundinidæ* by Mr. Sharpe (*Cat. B. Br. Museum*, x. pp. 85-210), only commensurate, perhaps, with that required for an understanding of the results at which he has arrived. Nothing can better show the difficulty of unravelling the many puzzles which the Family offers than this; and it is to be hoped that in his finely-illustrated *Monograph* which is now in course of publication he will succeed in clearing up some of them.

[5] Here, as in so many other cases, we have what may be called the "table-name" of an animal derived from the Norman-French, while that which it bore when alive was of Teutonic origin.

the granting of which license was accompanied by the condition that every bird in a "game" (to use the old legal term) of Swans should bear a distinguishing mark of ownership (*cygninota*) on the bill. Originally this privilege was conferred on the larger freeholders only, but it was gradually extended, so that in the reign of Elizabeth upwards of 900 distinct Swan-marks, being those of private persons or corporations, were recognized by the royal Swanherd, whose jurisdiction extended over the whole kingdom. It is impossible here to enter into further details on this subject, interesting as it is from various points of view.[1] It is enough to remark that all the legal protection afforded to the Swan points out that it was not indigenous to the British Islands, and indeed it is stated (though on uncertain authority) to have been introduced to England in the reign of Richard Cœur de Lion; but it is now so perfectly naturalized that birds having the full power of flight remain in the country. There is no evidence to show that its numbers are ever increased by immigration from abroad, though it is known to breed as a wild bird not further from our shores than the extreme south of Sweden and possibly in Denmark, whence it may be traced, but with considerable vacuities, in a southeasterly direction to the valley of the Danube and the western part of Central Asia. In Europe, however, no definite limits can be assigned for its natural range, since birds more or less reclaimed and at liberty consort with those that are truly wild, and either induce them to settle in localities beyond its boundary, or of themselves occupy such localities, so that no difference is observable between them and their untamed brethren. From its breeding-grounds, whether they be in Turkestan, in south-eastern Europe, or Scania, the Swan migrates southward towards winter, and at that season may be found in northwestern India (though rarely), in Egypt, and on the shores of the Mediterranean.

The Swan just spoken of is by some naturalists named the Mute or Tame Swan, to distinguish it from one to be presently mentioned, but it is the Swan simply of the English language and literature. Scientifically it is usually known as *Cygnus olor* or *C. mansuetus*. It needs little description; its large size, its spotless white plumage, its red bill, surmounted by a black knob (technically the "berry") larger in the male than in the female, its black legs and stately appearance on the water are familiar, either from figures innumerable or from direct observation, to almost every one. When left to itself its nest is a large mass of aquatic plants, often piled to the height of a couple of feet and possibly some six feet in diameter. In the midst of this is a hollow which contains the eggs, generally from five to nine in number, of a grayish-olive color. The period of incubation is between five and six weeks, and the young when hatched are clothed in sooty-gray down, which is succeeded by feathers of dark sooty-brown. This suit is gradually replaced by white, but the young birds are more than a twelvemonth old before they lose all trace of coloring and become wholly white.

It was, however, noticed by Plot (*N. H. Staffordshire*, p. 228) 200 years and more ago that certain Swans on the Trent had white Cygnets; and it was subsequently observed of such birds that both parents and progeny had legs of a paler color, while the young had not the "blue bill" of ordinary Swans at the same age that has in some parts of the country given them a name, besides offering a few other minor differences. These being examined by Yarrell led him to announce (*Proc. Zool. Society*, 1838, p. 19) the birds presenting them as forming a distinct species, *C. immutabilis*, to which the English name of "Polish" Swan had already been attached by the London poulterers.[2] There is no question so far as to the facts; the doubt exists as to their bearing in regard to the validity of the so-called "species." Though apparently wild birds, answering fairly to the description, occasionally occur in hard winters in Britain and some parts of the European Continent,[3] their mother country has not yet been ascertained,—for the epithet "Polish" is but fanciful,—and most of the information respecting them is derived only from reclaimed examples, which are by no means common. Those examined by Yarrell are said to have been distinctly smaller than common Swans, but those recognized of late years are as distinctly larger. The matter requires much more investigation, and it may be remarked that occasionally Swans, so far as is known of the ordinary stock, will produce one or more Cygnets differing from the rest of the brood exactly in the characters which have been assigned to the so-called Polish Swans as specific namely, their white plumage slightly tinged with buff, their pale legs, and flesh-colored bill. It may be that here we have a case of far greater interest than the mere question of specific distinction,[4] in some degree analogous, but yet in an opposite direction, to that of the so-called *Pavo nigripennis* before mentioned (PEACOCK, vol. xviii. p. 454).

Thus much having been said of the bird which is nowadays commonly called Swan, and of its allied form, we must turn to other species, and first to one that anciently must have been the exclusive bearer in England of the name. This is the Whooper, Whistling, or Wild Swan[5] of modern usage, the *Cygnus musicus* or *C. ferus* of most authors, which was doubtless always a winter-visitant to this country, and, though nearly as bulky and quite as purely white in its adult plumage, is at once recognizable from the species which has been half domesticated by its wholly different but equally graceful carriage, and its bill—which is black at the tip and lemon-yellow for a great part of its base. This entirely distinct species is a native of Iceland, eastern Lapland, and northern Russia, whence it wanders southward in autumn, and the musical tones it utters (contrasting with the silence that has caused its relative to be often called the Mute Swan) have been celebrated from the time of Homer to our own. Otherwise in a general way there is little difference between the habits of the two, and very closely allied to the Whooper is a much smaller species, with very well marked characteristics, known as Bewick's Swan, *C. bewicki*. This was first indicated as a variety of the last by Pallas, but its specific validity is now fully established. Apart from size, it may be externally distinguished from the Whooper by the bill having only a small patch of yellow, which inclines to an orange rather than a lemon tint; while internally the difference of the vocal organs is well marked, and its cry, though melodious enough, is unlike. It has a more easterly home in the north than the Whooper, but in winter not unfrequently occurs in Britain.

Both the species last mentioned have their representatives in North America, and in each case the trans-Atlantic bird is considerably larger than that of the Old World. The first is the Trumpeter-Swan, *C. buccinator*, which has the bill wholly black, and the second the *C. columbianus* or *americanus*[6]—greatly resembling Bewick's Swan, but with the colored patches on the bill of less extent and deepening almost into scarlet. South America produces two very distinct birds commonly regarded as Swans,—the Black-necked Swan and that which is called *Cascaroba* or *Coscaroba*. This last, which inhabits the southern extremity of the continent to Chili and the Argentine territory, and visits the Falkland Islands, is the smallest species known,—pure white in color except the tip of its primaries, but having a red bill and red feet.[1] The former, *C. melanocorypha* or *nigricollis*, if not discovered by earlier navigators, was observed by Narborough 2d August, 1670, in the Strait of Magellan, as announced in 1694 in the first edition of his *Voyage* (p. 52). It was subsequently found on the Falkland Islands during the French settlement there in 1764-65, as stated by Pernetty (*Voyage*, ed. 2, ii. pp. 26, 99), and was first technically described in 1782 by Molina (*Saggio sulla Stor. Nat. del Chile*, pp. 234, 344). Its range seems to be much the same as that of the Cascaroba, except that it comes further to the northward, to the coast of southern Brazil on the east, and perhaps into Bolivia on the west. It is a very handsome bird, of large size, with a bright red nasal knob, a black neck, and the rest of its plumage pure white. It has been introduced into Europe, and breeds freely in confinement.

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[1] At the present time the Queen and the Companies of Dyers and Vintners still maintain their Swans on the Thames, and a yearly expedition is made in the month of August to take up the young birds—thence called "Swan-upping" and corruptly "Swan-hopping"—and mark them. The largest Swannery in England, indeed the only one worthy of the name, is that belonging to Lord Ilchester, on the water called the Fleet, lying inside the Chesil Bank on the coast of Dorset, where from 700 to double that number of birds may be kept—a stock doubtless too great for the area, but very small when compared with the numbers that used to be retained on various rivers in the country. The Swanpit at Norwich seems to be the only place now existing for fattening the Cygnets for the table—an expensive process, but one fully appreciated by those who have tasted the results. The English Swan-laws and regulations have been concisely but admirably treated by the late Serjeant Manning (*Penny Cyclopædia*, xxiii. pp. 271, 272), and the subject of Swan-marks, elucidated by unpublished materials in the British Museum and other libraries, is one of which a compendious account, from an antiquarian and historical point of view, would be very desirable.

[2] M. Gerbe, in his edition of Degland's *Ornithologie Européenne* (ii. p. 477), makes the amusing mistake of attributing this name to the "*fourreurs*" (furriers) of London, and of reading it "*Cygne des pôle*" (polar, and not Polish, Swan).

[3] Chiefly in the northwest, but Lord Lilford has recorded (*Ibis*, 1860, p. 351) his having met with them in Corfu and Epirus.

[4] The most recent authorities on the Polish Swan are Stevenson, in separately-printed advance sheets (1874) of his *Birds of Norfolk* (vol. iii.), and Southwell (*Trans. Norf. & Norw. Nat. Society*, ii. pp. 258–260), as well, of course, as Dresser (*B. Europe*, vi. pp. 429–433, pl. 419, Figs. 1, 2).

[5] In some districts it is called by wild-fowlers "Elk," which perhaps may be cognate with the Icelandic *Alft* and the Old German *Elbs* or *Elps* (*cf.* Gesner, *Ornithologia*, pp. 358, 359), though by modern Germans *Elb-schwan* seems to be used for the preceding species.

[6] Examples of both these species have been recorded as occurring in Britain, and there can be little doubt that the first has made its way hither. Concerning the second more precise details are required.

A greater interest than attaches to the South-American birds last mentioned is that which invests the Black Swan of Australia. Considered for so many centuries to be an impossibility, the knowledge of its existence seems to have impressed (more perhaps than anything else) the popular mind with the notion of the extreme divergence—not to say the contrariety—of the organic products of that country. By a singular stroke of fortune we are able to name the precise day on which this unexpected discovery was made. The Dutch navigator Willem de Vlaming, visiting the west coast of Zuidland (Southland), sent two of his boats on the 6th of January, 1697, to explore an estuary he had found. There their crews saw at first two and then more Black Swans, of which they caught four, taking two of them alive to Batavia; and Valentyn, who several years later recounted this voyage, gives in his work[2] a plate representing the ship, boats, and birds, at the mouth of what is now known from this circumstance as Swan River, the most important stream of the thriving colony of West Australia, which has adopted this very bird as its armorial symbol. Valentyn, however, was not the first to publish this interesting discovery. News of it soon reached Amsterdam, and the burgomaster of that city, Witsen by name, himself a fellow of the Royal Society, lost no time in communicating the chief facts ascertained, and among them the finding of the Black Swans, to Martin Lister, by whom they were laid before that society in October, 1698, and printed in its *Philosophical Transactions* (xx. p. 361). Subsequent voyagers, Cook and others, found that the range of the species extended over the greater part of Australia, in many districts of which it was abundant. It has since rapidly decreased in numbers, and will most likely soon cease to exist as a wild bird, but its singular and ornamental appearance will probably preserve it as a modified captive in most civilized countries, and perhaps even now there are more Black Swans in a reclaimed condition in other lands than are at large in their mother country. The species scarcely needs description: the sooty black of its general plumage is relieved by the snowy white of its flight-feathers and its coral-like bill banded with ivory.

The *Cygninæ* admittedly form a well-defined group of the Family *Anatidæ*, and there is now no doubt as to its limits, except in the case of the Cascaroba above mentioned. This bird would seem to be, as is so often found in members of the South American fauna, a more generalized form, presenting several characteristics of the *Anatinæ*, while the rest, even its Black-necked compatriot and the almost wholly Black Swan of Australia, have a higher morphological rank. Excluding from consideration the little-known *C. davidi*, of the five or six[3] species of the Northern hemisphere, four present the curious character, somewhat analogous to that found in certain CRANES (vol. vi. p. 484), of the penetration of the sternum by the trachea nearly to the posterior end of the keel, whence it returns forward and upward again to revert and enter the lungs; but in the two larger of these species, when adult, the loop of the trachea between the walls of the keel takes a vertical direction, while in the two smaller the bend is horizontal, thus affording an easy mode of recognizing the respective species of each.[4] Fossil remains of more than one species of Swan have been found. The most remarkable is *C. falconeri*, which was nearly a third larger than the Mute Swan, and was described from a Maltese cave by Prof. Parker in the Zoological *Transactions* (vi. pp. 119–124, pl. 30). (A. N.)

SWANSEA, a municipal and parliamentary borough and large seaport of Glamorganshire, South Wales, is finely situated in an angle between lofty hills, on the river Tawe, near its mouth in the beautiful Swansea Bay, a recess of the Bristol Channel, and on the Great Western, London and North-Western, Midland, and Rhondda and Swansea Bay railway lines, 45 miles west-northwest of Cardiff. Being for the most part of comparatively modern growth, the streets are laid out with great regularity. Swansea retains few traces of antiquity, and some of its more picturesque features have been destroyed to make room for the construction of docks. Of the old castle, originally founded in 1099 by Henry Beauchamp, earl of Warwick, to secure possession of his lands in the province of Gower, the principal remains are the keep, built by Bishop Gower of St. David's after the castle had been for some time in ruins, a range of arched dungeons lit by loopholes, and the hall, now fitted up for use as a volunteer drill hall. There are fragments of a wall with a Gothic window of the hospital of St. David, founded by Bishop Gower in 1331. The church of St. Mary's, founded by the same bishop, was rebuilt in 1739, with the exception of the tower and chancel. The modern public buildings include the guildhall, in the Italian style with Corinthian pillars and pilasters, erected in 1846, and comprehending the municipal offices, the crown and *nisi prius* courts, the council chamber, and the library of the Swansea and Neath Incorporated Law Society; the royal institution of South Wales, established 1835, a building in the Ionic style, and embracing a library, a lecture hall, and a museum of geology, mineralogy, natural history, and antiquities; the free public library, schools of art, and art gallery, a fine new building with about 30,000 volumes (including the library of the Rev. Rowland Williams, one of the authors of *Essays and Reviews*) and a large number of beautiful engravings; the grammar school, founded by Hugh Gore, bishop of Waterford, in 1682; the market (1830), the cattle market (1864); the Albert hall for concerts (1864), with a smaller hall erected in 1881; the agricultural hall; the working men's club (1875); the Prince of Wales hall (1882); and two theatres. The benevolent institutions include the general hospital, founded in 1817, and rebuilt with the addition of two wings in 1878; the Cambrian institution for the deaf and dumb, founded in 1847, and several times extended; the Swansea and South Wales institute for the blind (1865); the nursing institution (1853); the provident dispensary (1876); the eye hospital (1878); the industrial home (1859); and the sailors' home (1864). Swansea is specially well supplied with parks and recreation grounds. They include Brynmill grounds between Parkwern and Singleton (1872), 9 acres in extent, and containing a beautiful reservoir and ornamental lawns; Cwmdonkin ark, on the uplands, 13 acres, and commanding fine iews; the new recreation ground, formed in 1883, 11 cres, situated between Brynmill and the Oystermouth oad; Park Llewelyn, to the north of Swansea, 40 cres; and the St. Helen's field, near the beach, about 0 acres, now being laid out. The population of the municipal borough (area 4363 acres) in 1871 was 51,702, and in 1881 it was 65,597. The population of the parliamentary borough in 1881 was 73,971. Its area then was 4777 acres, but in 1885, when Swansea received independent representation, the area was diminished, the population of this smaller area being 50,043 in 1881.

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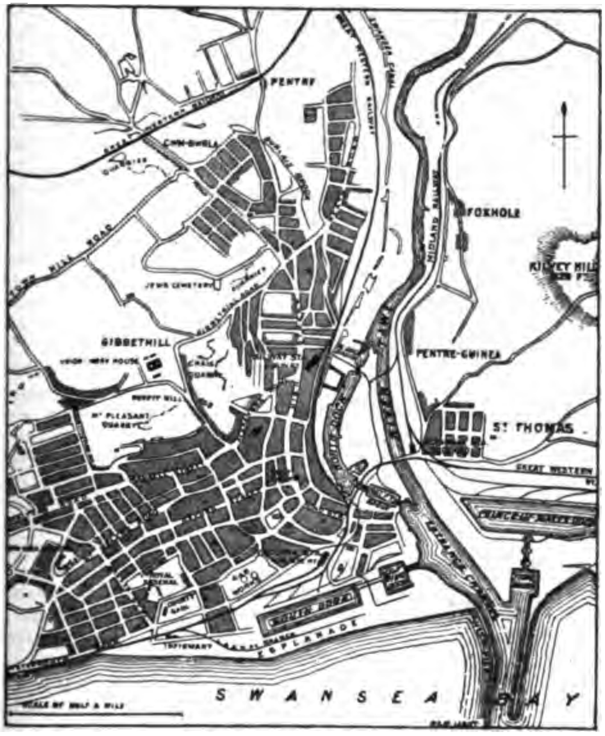
[1] Dr. Stejneger (*Proc. U. S. Nat. Museum*, 1882, pp. 177–179) has been at much pains to show that this is no Swan at all, but merely a large Anatine form. Further research may prove that his views are well founded, and that this, with another very imperfectly known species, *C. davidi*, described by Swinhoe (*Proc. Zool. Society*, 1870, p. 430) from a single specimen in the Museum of Peking, should be removed from the Sub-Family *Cygninæ*. Of *C. coscoroba* Mr. Gibson remarks (*Ibis*, 1880, pp. 36, 37) that its "note is a loud trumpet-call," and that it swims with "the neck curved and the wings raised after the true Swan model."

[2] Commonly quoted as *Oud en Nieuw Oost Indien* (Amsterdam, 1726). The incidents of the voyage are related in Deel iii. Hoofdst. iv. (which has for its title Description of Banda) pp. 68–71.

[3] The *C. unwini* doubtfully described by Mr. Hume (*Ibis*, 1871, pp. 412, 413) from India, though recognized by Dr. Stejneger (*ut supra*), seems to be only the immature of the Mute Swan.

[4] The correct scientific nomenclature of the Swans is a matter that offers many difficulties, but they are of a kind far too technical to have any interest for the general reader. Dr. Stejneger, in his learned "Outlines of a Monograph" of the group (*ut supra*), has employed much research on the subject, with the result (which can only be deemed unhappy) of upsetting nearly all other views hitherto existing, and propounding some which few ornithologists outside of his adopted country are likely to accept, since the principles on which he has gone are not those commonly received, nor (it may perhaps be added) are based on common sense. In the text, as above written, care has been taken to use names which will cause little if any misunderstanding, and this probably is all that can be said in the present state of confusion.



Plan of Swansea.

Swansea owes its prosperity to its situation in the neighborhood of extensive collieries and to its possession of great natural advantages as a harbor. With some exaggeration it has been called the "metallurgical centre of the world," but the title must at least be allowed in reference to copper, which is imported to be smelted from all parts of the world. The smelting of copper, which has been carried on in the district from the time of Elizabeth, is the distinctive and most important industry of the town, the others including tinplate manufacture, lead smelting, spelter and zinc manufacture, the extraction and manufacture of silver, nickel, and cobalt, iron smelting, Siemens steel manufacture, the manufacture of chemicals, of agricultural manure, and of patent fuel, and the construction of railway carriages and wagons. In Swansea Bay there are valuable oyster fisheries. The earliest harbor works on a large scale were those of the South Dock Company, begun in 1847 and opened in 1859. This dock, which has an area of about 13 acres, with a half-tide basin of 4 acres and a lock 300 feet long by 60 feet wide, is used principally for the export of coal. The north dock, completed in 1882, has an area of about 10¼ acres, in addition to several other smaller docks. An important addition was made by the completion of the Prince of Wales Dock in October, 1881, with an area of 23 acres; and as yet this additional accomodation is more than sufficient for the trade of the port. In 1876 the number of sailing and steam vessels that entered with cargoes and in ballast from foreign countries, British possessions, and coastwise was 7799, of 1,068,062 tons; the number that cleared being 7549, of 1,041,078 tons. In 1885 the entrances were 7447, of 1,461,248 tons, the clearances 7051, of 1,366,117 tons. The total average value of the imports of foreign and colonial produce during the five years ending 1885 was about £2,400,000 [$11,664,000], but has been decreasing; and the total average value of the exports of the produce of the United Kingdom was about £1,500,000 [$7,290,000], but has been steadily increasing, and has reached over £2,000,000 [$9,720,000]. There is a large trade with France, Portugal, Spain, and the Mediterranean ports. There is also considerable trade with South Africa, and the trade is greater with South than with North America. The exports consist chiefly of the various manufactures of the town, especially tin plates, the direct trade in which between Swansea and American ports has within the last two years attained great importance; and the imports include chiefly metallic ores, timber, and various kind of provisions. Shipbuilding and ship-repairing are carried on, but the industry is of minor importance.

Swansea owes its origin to the erection of the castle in 1099 by Henry Beauchamp, earl of Warwick, who introduced into it a garrison of English and Flemish colonists. The fortress was frequently assaulted in the 12th and 13th centuries, and in 1260 was burned down by Llewelyn ab Grwfydd, last prince of North Wales. During the insurrection of Owen Glendower against Henry IV. it was again destroyed. Swansea was created a borough by a charter of King John, which is said to be preserved among the records of the Tower of London. The earliest charter in possession of the corporation is that granted by Henry III. in 1234, conferring upon it freedom from toll pontage and other customs. Its privileges were confirmed by Edward II. and Edward III. The town was during the Civil War alternately in the hands of both parties, but in 1647 the castle was dismantled by the Parliamentarians, after which Oliver Cromwell was made lord of Swansea of the signiory of Gower, and of the manor of Kelvey. The corporation now consists of a mayor, 6 aldermen, and 18 councillors, and the borough has a commission of the peace. From the reign of Henry VIII. it contributed along with other boroughs to return a member to parliament. In 1658 it received a charter from Cromwell permitting it to return a member for itself, but after the Restoration it resumed its character as contributory. In 1832 it became the head of a new district of boroughs, and in 1885 it received separate representation while a portion of its area was also included in a district of boroughs to which it gives the name. In the reign of Edward IV. the castle came by marriage to the Somerset family, and it is held by the duke of Beaufort, whose title of Baron Herbert of Gower dates from 1506.

SWARTZ, Olof (1760–1818), a celebrated Swedish botanist, was born in 1760. He commenced his botanical studies in Upsala, under Linnæus and Thunberg, and began early to make excursions. He made a voyage to America in 1783, visited England in 1788, returned to Sweden in 1789, and was made professor of natural history in Stockholm. He was the author of many systematic works, and largely extended our knowledge of both flowering plants and cryptogams. He died in 1818.

See Sachs, *Geschichte d. Botanik.*

SWATOW (also, less frequently, Swartow and Shantow), a port of China, in the province of Kwangtung, opened to foreign trade in 1869. It is situated at the mouth of the main branch of the river Han, which 30 miles inland flows past the great city of Chow-chu or Tai-chu (Tie-chu), and the surrounding country is more populous and full of towns and villages than any other part of the province. English merchants settled on Double Island in the river as early as 1856; but the city, which is built on ground but recently recovered from the sea, was formerly a mere fishing village. The trade of the port has rapidly increased. In 1869 718 vessels of all nations entered or cleared (of 310,500 tons burden), in 1884 1387 vessels (1,282,936 tons)—the total value of the trade being respectively £4,800,000 [$23,328,000] and £5,519,772 [$26,826,091.92]. The surrounding country is a great sugar-cane district producing annually about 2,000,000 piculs (picul = 133⅓ ℔) of sugar, and there is an extensive refinery in the town employing upwards of 600 workmen and possessing a reservoir for 7,000,000 gallons of water. Next in value comes the manufacture of bean-cake, which is also imported in large quantities from New-chwang, Chefoo, Shanghai, Amoy and Hong-Kong (total import in 1874, 1,408,384 piculs [187,784,533⅓ ℔]; in 1884, 2,539,710 [338,628,000 ℔]). Among the leading exports are tea (since about 1872); grass-cloth, manufactured at Swatow from so-called Taiwan hemp (the fibre of the *Bœhmeria nivea* from Formosa); pine-apple cloth, manufactured in the villages about Kieh-Yang (a town 22 miles distant); oranges, for which the district is famous; cheap fans; and pewter, iron, and tin wares. Swatow is also a great emigration port. In 1870 about 22,000 Chinese embarked there for Singapore, Bangkok, and Saigon; and the number of emigrants has since increased so that British vessels alone carry 50,000 to 53,000 per annum. Of the whole foreign trade of the port upwards of 83 per cent. is in British bottoms, the trade with Hong-Kong being of especial importance. The population of Swatow is upwards of 30,000. In 1874 the foreign residents numbered 147 (63 British), including Double Island.

About 1865 the whole Swatow district was still divided into a number of "independent townships, each ruled by its own headmen," and the population was described in the official gazetteer as "generally rebellious and wicked in the highest degree." Mr. Forrest, British consular agent, relates that in that year he was witness to the preparations for a fight between the people living on the opposite sides of the estuary, which was only prevented by an English war-vessel. The Taipings swept over the country, and by their ravages and plundering did much to tame the independence of the clans. The punishment inflicted in 1869 by Commander Jones on the inhabitants of Otingpui (Outing-pei), about 8 miles from Swatow, for the attack they had made on the boats of H.M.S. "Cockchafer," showed the Chinese authorities that such piratical villages were not so strong as had been supposed. General Fang (a native of Chow-chu-fu) was sent to reduce the district to order, and he carried out his instructions with remorseless rigor.

SWEAT. See NUTRITION, vol. xvii. p. 704.

SWEATING-SICKNESS. A remarkable form of disease, not known in England before, attracted attention at the very beginning of the reign of Henry VII. It was known indeed a few days after the landing of Henry at Milford Haven on August 7, 1485, as there is clear evidence of its being spoken of before the battle of Bosworth on August 22. Soon after the arrival of Henry in London on August 28 it broke out in the capital, and caused great mortality. Two lord mayors successively and six aldermen, beside numerous other persons, died in one week. At the end of October, however, the epidemic in London suddenly ceased. In Oxford it had already begun at the end of August, and lasted with great mortality for six weeks. In the course of the autumn it attacked various places, and by the end of December had spread over all England. Then the epidemic disappeared as suddenly as it came. This alarming malady soon became known as the sweating-sickness. It was regarded as being quite distinct from the plague, the pestilential fever, or other epidemics previously known, not only by the special symptom which gave it its name, but also by its extremely rapid and fatal course and by other characters to be noted presently.

From 1485 nothing more was heard of it till 1507, when the second outbreak occurred, which was much less fatal than the first (it is said because the treatment was better understood) and attracted less notice. In 1517 was a third and much more severe epidemic. It began in London in July, and lasted till the middle of December. Many distinguished persons died, including Lord Clinton, Lord Grey of Wilton, Andrea Ammonio, the king's secretary, and others, with an immense number of the common people. In Oxford and Cambridge it was also very fatal, as well as in other towns, where in some cases half the population are said to have perished. There is evidence of the disease having spread to Calais and Antwerp, but with these exceptions it was confined to England.

In 1528 the disease recurred for the fourth time, and with great severity. It first showed itself in London at the end of May, and speedily spread over the whole of England, though not into Scotland or Ireland. In London the mortality was very great; the court was broken up, and Henry VIII. left London, frequently changing his residence. When the epidemic ceased cannot be accurately stated, nor have we any precise estimate of the mortality. The most remarkable fact about this epidemic is that for the first and last time it spread over the Continent. On the 25th July, 1528 (English style) or 1529 (Roman style), when it was beginning to decline in London, it suddenly appeared at Hamburg. The story went that the infection was brought by a ship returning from England, the sailors of which were suffering from the disease. However this may have been, the disease spread rapidly, so that in a few weeks more than a thousand persons died. In less than a week it had spread to Lübeck, and thus was the terrible sweating-sickness started on a destructive course, during which it caused fearful mortality throughout eastern Europe. France, Italy, and the southern countries were spared. It spread much in the same way as cholera, passing in one direction, from north to south, arriving at Switzerland in December, in another northwards to Denmark, Sweden and Norway, also eastwards to Lithuania, Poland, and Russia, and westwards to Flanders and Holland, unless indeed the epidemic, which declared itself simultaneously at Antwerp and Amsterdam on the morning of September 27, came from England direct. In each place which it affected it prevailed for a short time only,—generally not more than a fortnight. By the end of the year it had entirely disappeared, except in eastern Switzerland, where it lingered into the next year;[1] and the terrible "English sweat" has never appeared again, at least in the same form, on the Continent.

England was, however, destined to suffer from one more outbreak of the disease, which occurred in 1551, and with regard to this we have the great advantage of an account by an eye-witness, John Kaye or Caius, the eminent physician. It first appeared at Shrewsbury on April 13, and after spreading to other towns in Wales and in the midland counties, broke out in London, causing in one week the death of seven hundred and sixty-one persons. At the end of July it ceased in London, but it went through the east of England to the north, until the end of August, when it began to diminish. At the end of September it ceased altogether, without affecting Scotland or Ireland. Nor did it apparently widely affect the Continent, though Caius mentions its occurrence at Calais, and Brasavolus (*De Morbo Gallico*) speaks of the English sweating-sickness as raging in Flanders in the year 1551, in which he wrote, causing the death of several thousand persons, and lasting at least till September.

Symptoms.—The symptoms as described by Caius and others were as follows: The disease began very suddenly with a sense of apprehension, followed by cold shivers (sometimes very violent), giddiness, headache, and severe pains in the neck, shoulders, and limbs, with great prostration,—in short, the usual symptoms of an acute febrile attack. In some cases the stomach was affected, and there was vomiting, but according to Caius this happened only in those who were full of food. The breathing was deep and frequent, the voice like a moan. After the cold stage, which might last from half an hour to three hours, followed the stage of heat and sweating. The characteristic sweat broke out suddenly, and, as it seemed to those unaccustomed to the disease, without any obvious cause. In some cases it was much more copious than in others, these differences depending, according to Caius, mainly on age, clothing, food, and other external circumstances, and also on the season, sweating being more profuse in hot weather. With the sweat, or after that was poured out, came a sense of heat, and with this headache and delirium, rapid pulse, and intense thirst. Palpitation and pain in the heart were frequent symptoms. No eruption of any kind on the skin was generally observed; Caius makes no allusion to such a symptom. In the later stages there was either general prostration and collapse, or an irresistible tendency to sleep, which was thought to be fatal if the patient were permitted to give way to it. The malady was remarkably rapid in its course, being sometimes fatal even in two or three hours, and some patients died in less than that time. More commonly it was protracted to a period of twelve to twenty-four hours, beyond which it rarely lasted. Those who survived for twenty-four hours were considered safe.

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[1] Guggenbühl, *Der englische Schweiss in der Schweiz*, Lichtensteig, 1838.

The disease, unlike the plague, was not especially fatal to the poor, but rather, as Caius affirms, attacked the richer sort and those who were free livers according to the custom of England in those days. "They which had this sweat sore with peril or death were either men of wealth, ease, or welfare, or of the poorer sort, such as were idle persons, good ale drinkers, and taverne haunters."

Relapses were not uncommon; but the statements sometimes made about the disease attacking the same person several times seem to rest on a misunderstanding of the original authorities. What is meant is that they had several, even twelve, successive attacks of sweating. The disease was not thought to be transmitted by contagion from one person to another. Nevertheless, in its spread, it appears, like cholera, to have followed the main lines of human travel and traffic,—passing with Richmond's army to Bosworth, thence to London, and so on. It would be difficult otherwise to explain why Calais should have been affected and not the adjacent parts of France. Even the very circumstantial story of the disease having been brought to Hamburg by a ship from England seems by no means incredible, though it is doubted by some.

Causes.—Some attributed the disease to the English climate, its moisture and its fogs, a view which was thought to be supported by the occurrence of unusual rainfall and atmospheric moisture in the years of the sweating-sickness. But it is plain that the English climate was much the same before and after, and can hardly be regarded even as a predisposing cause, certainly not as an explanation. Nor is there much evidence that the epidemic years were distinguished for their humidity.

In 1485, 1507, and 1517 the seasons were in no way remarkable. The year 1528 (1529 in Continental reckoning) was, however, certainly notable for excessive moisture. In England eight weeks continuous rain began in April, and the harvest was spoiled. In Germany the copious rainfall, and the cold fogs which endured through the summer, gave the impression that the air of England had been carried over to the Continent. In 1551 the outbreak of the sickness in Shrewsbury is described as having been preceded by dense and stinking fogs, which arose from the valley of the Severn and spread over other parts of England. The summer was everywhere very hot, and in England moist as well. In Amsterdam a similar fog announced the outbreak of the sickness in 1528. But we cannot attribute much importance to these circumstances, since in other epidemics they were wanting, and similar conditions have often occurred without any pestilence resulting.

It was again attributed by some to the intemperate habits of the English people, and to the frightful want of cleanliness in their houses and surroundings which is noticed by Erasmus in a well-known passage, and about which Caius is equally explicit. But causes such as these cannot, any more than climate, account for the incidence in time of an epidemic, even if they do something towards explaining its geographical range. Nor is there much evidence that the English were worse in these respects than most European nations, though the native country of Erasmus may have set an early example of cleanliness.

Caius and some of the chroniclers make out that this special liability of Englishmen to the sweating-sickness followed them even into foreign parts, so that in Calais, Brabant, and Spain it affected the English only and not the natives. This is puzzling and improbable, except so far that the English abroad may have belonged to the same classes who mainly suffered at home. But a careful examination of those statements shows that they referred either to Englishmen who had left England while the disease was raging there and carried the infection with them, or to merchants and others who were in direct communication with home. This disease, like others introduced into a foreign country, did not always take root there. But it did so sometimes, as, according to contemporary evidence, was the case in Flanders in 1551. The statement also made that foreigners in England were not affected likewise requires qualification, since we know several instances of foreigners in London who died of it. On the whole, no great importance can be attached to this supposed special liability of the English physical constitution.

From all this we must conclude that climate, season, and manner of life were not adequate, either separately or collectively, to produce the disease, though each may have acted sometimes as a predisposing cause. The sweating-sickness was in fact, to use modern language, a specific infective disease, in the same sense as plague, typhus, scarlatina, or ague. The origin of such diseases is not explained by causes such as those above enumerated. We can only suppose that they come into being by laws similar to those which have determined the evolution of species of animals and plants. But when once their specific distinctness is established they "breed true" and always present the same characters.

Probable Identity with Miliary Fever.—The important question, however, arises—Did this specific disease exist before or has it existed after the sixty-six years of its recognized history? or is it identical with any other known disease called by another name? It is very unlikely that any epidemic of so striking a disease should have existed before without having been noticed, and there is certainly no record since of any outbreak precisely similar. The only disease of modern times which bears any resemblance to the sweating-sickness is that known as miliary fever ("Schweiss-friesel," "suette miliaire," or "the Picardy sweat"), a malady which has been repeatedly observed in France, Italy, and Southern Germany, but not in the United Kingdom. It is characterized by intense sweating, and occurs in limited epidemics, not lasting in each place more than a week or two (at least in an intense form). On the other hand, the attack lasts longer than the sweating-sickness did, is always accompanied by an eruption of vesicles, and is not usually fatal. It is therefore evidently not the same as the English disease, though allied to it. The first clearly described epidemic was in 1718 (though probably it existed before), and the last in 1861. Between these dates some one hundred and seventy-five epidemics have been counted in France alone. A single epidemic of a disease which had a striking resemblance to the sweating-sickness was observed in 1802 at Rottingen, a village in the district of Würzburg, Germany. Its access was sudden; it affected chiefly robust persons; it was accompanied by profuse perspiration, rheumatic pains, etc., without any constant eruption. If death resulted it was usually in twenty-four hours. The epidemic lasted some ten days, and then entirely vanished. It may be considered as an extremely severe form of miliary fever. Finally, Hirsch has drawn attention to certain cases of a choleraic affection, observed first by Dr. Murray in India (1839–40), which has been described as a sweating-sickness. It has, however, more resemblance to miliary fever than to the English sweat. A similar form of disease has been described by some French physicians as "choléra cutané ou sudoral." On a review of the whole evidence, it would appear that the only disease which the sweating-sickness much resembled was the miliary fever, of which it may conceivably have been, like the Rottingen epidemic, a highly malignant form.

Where did it Originate?—Whether it really originated in England is a question difficult to answer. Its appearance certainly coincided with the arrival of a foreign army, consisting, as we know, largely of foreign mercenaries, men of foul habits and irregular lives (whom the French king was thought to have done his country a service by getting rid of), and crowded into small vessels. Among such men any infective disease which arose would, by want of cleanliness and overcrowding, be likely to be fostered into great intensity. It is in accordance with the history of many epidemics to suppose that an ordinary and not very fatal disease might under such circumstances assume a malignant form.[1] Now, supposing that the French soldiers brought with them their native "Picardy sweat," a malady local and not severe in its French home, might not this have become developed into the formidable English sweating-sickness? If so, its great destructiveness in England would also be in great measure explained by its affecting a new population. For we find that any exported epidemic disease is generally more fatal in a country which receives it for the first time, among a population which offers a virgin soil to the disease, than it was in the country where it was endemic, and where men were inured to the infection. The notable exemption of northern France from the true sweating-sickness would then have depended upon the popul[illegible] already inured to a milder form of the same disease. As to southern France and other countries of the south, they were evidently not adapted by climate to receive the infection. If this be true, we need hardly expect to see the sweating-sickness again. The sweat of Picardy may continue from time to time to produce its comparatively slight epidemics; but the conditions which launched the English sweat on its rapid career of destruction are unlikely to occur a second time. The example of the Rottingen epidemic, which on a small scale was scarcely less remarkable, may show, however, that such an event is not quite impossible.

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[1] This is the case even with the Oriental plague itself. See PLAGUE.

Authorities.—For history see Bacon's *Life of Henry VII.*, and the chronicles of Grafton, Holinshed, Baker, Fabyan, etc. The only English medical account is that of John Caius, who wrote in English *A Boke or Counseill Against the Disease commonly called the Sweate, or Sweating Sicknesse* (London, 1552), and in Latin *De Ephemera Britannica* (Louvain, 1556; reprinted London, 1721). The English tract is reprinted in Babington's translation of Hecker's *Epidemics of the Middle Ages*, Syd. Soc., 1844. This also contains Hecker's valuable treatise on the English sweat, published in German, 1834, and also printed in his *Volkskrankheiten des Mittelalters*, edited by Hirsch, Berlin, 1865. Grüner's *Scriptores de Sudore Anglico*, Jena, 1847, contains nearly all the original documents, including the two treatises of Caius. See also Hirsch, *Handbook of Geographical and Historical Pathology*, transl. by Creighton, New Syd. Soc., 1885. (J. F. P.)

SWEDEN.

Part I.—Geography and Statistics.

SWEDEN comprises the eastern and southern divisions of the Scandinavian peninsula. Its northern extremity, Kuokimodka, is situated in 69° 3′ 21″ and the southern in 55° 20′ 18″ N. lat. The western extremity (on the Cattegat) lies in 11° 6′ 29″ and the eastern (on the frontier of Finland) in 24° 10′ E. long. The greatest length of the country from north to south is 986 miles and its greatest breadth 286 miles, and the area is 170,713 square miles. The length of the coast-line is 1603 miles, the length of the boundary line towards Norway 1019 miles, and that of the boundary line towards Finland 305 miles.

For map see vol. xvii. Plate XX.

Sweden is divided into three chief parts,—the southern being called Götaland, the middle part Svealand or Sweden proper, and the northern Norrland. The north and northwest parts of Norrland are called Lapland.

The frontier towards Norway, from 69° to 63° N. lat., is formed by a continuous mountain range called Kölen (the keel). The snow peaks of Sulitelma (6178 feet), east of Saltenfjord, on the frontier between Sweden and Norway, were long supposed to mark the highest elevation of this mountain chain, but the geodetical survey now in progress in western Lapland has already shown that there are at least two peaks whose height exceeds that of Sulitelma, viz., Kebnekaise (7008 feet) and Sarjektjåkko (6988 feet).

Mountain and river systems.

In this mountain range (Kölen), rise a great number of rivers and streams, which flow in a southeasterly direction to the Gulf of Bothnia. The immense quantity of fresh water that is thus carried into the gulf makes its water scarcely more salt than that of a lake (0.25 to 0.40 per cent. of salt). Between the upper courses of the rivers the watersheds consist of mountain ridges, which gradually diminish in height. The intermediate valleys are for the most part filled with the water of the rivers, and thus form a number of lakes at a considerable elevation above the sea-level. Issuing from these lakes, the rivers form great cataracts, and afterwards flow through the level plain that forms the coast-region of the Gulf of Bothnia for a distance of many miles from the shore.

The boundary between Sweden and Finland is formed by (1) Muonio Elf, and afterwards by (2) Torneå Elf, into which it flows; Torneå Elf rises in Torneå Träsk, at an elevation of 1132 feet above the sea. Then come, in order along the coast, the following rivers: (3) Kalix Elf, which in its upper course forms the lakes of Paitas Jaur and Kalas Järvi;[1] (4) Stora Luleå Elf (242 miles), which forms Stora Luleå Jaur (1214 feet) and receives on the right (5) Lilla Luleå Elf, which forms the lakes of Saggat Träsk and Skalka Jaur (984 feet); (6) Piteå Elf, with the lake of Tjäggelvas; (7) Skellefteå Elf, forming a number of great lakes, such as Hornafvan (1391 feet), Uddjaur (1375 feet), Storafvan (1371 feet); (8) Umeå Elf (261 miles), with a great number of lakes, of which the largest is Stor-Uman, receives on the left a tributary of almost equal size, viz., (9) Vindel Elf; (10) Ångerman Elf (211 miles), which receives the water of a whole system of streams and lakes, the largest of the latter being Ströms Vattudal, in the south of Lapland; (11) Indals Elf, which receives the Ammerå, with its tributaries and the numerous emissary lakes, as Hotagen (1017 feet), Kallsjön and Storsjön ("Storsa Lake" on the map) (958 feet, area 173 sq. miles). Close to the railway from Trondhjem to Östersund, between Kallsjön and Storsjön, rises the peak of Åreskutan (4652 feet), which is ascended every year by a great number of tourists, and in the vicinity many sanatoria are situated. Farther south flow three large rivers: (12) Ljungan (193 miles), with Holmsjön (656 feet); (13) Ljusnan (249 miles); and (14) Dal Elf (286 miles), which passes through Särnasjön (1450 feet) and Siljan (541 feet, 110 sq. miles), and receives on the right (15) West Dal Elf. The last-named four rivers rise in a mountainous region with many high summits, which are the eastern outposts of the high range of Dovrefjeld, which traverses Norway from west to east between the parallels of 67° and 63° N. lat. Among these summits, situated on the frontier or in Sweden, are to be observed the Syltoppar (5865 feet), Son Fjell (4190 feet), Helags Fjell (5900 feet), and Städjan (3860 feet) on the north shore of Särnasjön.

In Norway, not far from the sources of Dal Elf, lies the lake of Fämundsjö, which gives rise to (16) Klar Elf, which flows southwards to Lake Vener, the largest lake in Sweden (144 feet, area 2150 square miles). The outlet of Vener is (17) Göta Elf, which falls into the Cattegat, near Gothenburg. The watershed between Dal Elf and Klar Elf is a wooded range of hills without high peaks, sloping to the southeast. The southeastern part of Svealand comprises the water systems of the large lakes of Hjelmar (75 feet, area 185 square miles) and Mälar (area 449 square miles). Lake Mälar discharges into the Baltic at Stockholm by two outlets—(18) Norrström and Söderström. They are, however, almost to be regarded as channels or sounds, rather than as streams, the difference of level between Lake Mälar and the Baltic being so small that occasionally, when the water is low in Mälar and high in the Baltic, the current sets from the latter into the former. Lake Mälar may thus be considered a fjord of the Baltic. Still its waters are kept fresh by the great number of small streams that discharge into it, the most important of these being (19) Fyris Elf, which passes Upsala.

The boundary between Svealand and Götaland consists of wooded heights. Between Lake Vetter and the northern shore of Bråviken Bay stretches the forest of Kolmorden, and between the northern extremity of Lake Vetter and Lake Vener lies that of Tiveden. Lake Vetter (290 feet, area 733 square miles) discharges itself into Bråviken by (20) Motala Ström, the falls of which are utilized for the mills in the town of Norrköping, near the mouth of the river.

The central part of Götaland consists of an extensive tableland or plateau, of which the highest part, at an elevation of 1237 feet, lies somewhat to the south of

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[1] The word for "lake," which is *sjö* or *träsk* in Swedish, is *jaur* in Lapponian, and *järvi* in Finnish. "River" is *elf* in Swedish.

Vetter. On the north this plateau descends rather abruptly towards the fertile plains of Östergötland (drained by Motala Ström) and Skaraborg län, between Vetter and Vener. Near the southeastern shore of Vetter, a little to the north of Jönköping, lies Mount Omberg (863 feet), and near the southern shore of Vener, close by Lidköping, lies Kinnekulle (915 feet), both hills remarkable for their beauty. The great plateau descends less abruptly towards east, south and west. A great number of lesser streams flow down its slopes. The principal are—(21) Emmån, which falls into Calmar Sound; (22) Lyckebyån, (23) Mörrumsån, and (24) Helgaån, which flows in a southerly direction; and (25) Lagan, (26) Nissan, (27) Ätran, and (28) Viskan, which fall into the Cattegat. On this great plateau and its slopes lie also many lakes. In the northern part, east of Vetter, lies Sommen (479 feet), and farther north Boren, Roxen, and Glan. Between Vetter and Vener lies Unden (384 feet). On the summit of the plateau lies Ekelsjö (1132 feet), and on its southern slope Helgasjö (535 feet), Bolmen (466 feet), Möckeln (446 feet), and Åsnen.

The southmost part of Sweden, Skåne, consists for the most part of a low fertile country. Only in the northern part, Christianstad län, occur two low stretches of hills, called Linderödsåsen and Söderåsen.

Waterfalls.

Waterfalls.—The largest waterfalls are—(1) Njuommelsaska (Harspånget), in Stora Luleå Elf, with a breadth of 60–70 feet, consisting of two cataracts of 103 feet at the upper end and a fall of 150 feet more in the course of 1⅜ miles,—the largest waterfall in Europe; (2) Ådna-Muorki-Kortje ("The great fall of the lake"), on the same river as the former, higher up, between the two lakes Jäntajaur and Kaskajaur, has a fall of 130 feet, of which 100 feet are one perpendicular cataract; (3) Tännforsen, 12 miles west of Åreskutan in Jemtland, between Tännsjön and Noren, has a breadth of 160 and a perpendicular fall of 84 feet; (4) Trollhättan, in Göta Elf, consists of three successive falls having a total height of 100 feet.

Character of surface.

It will be seen that, with the exception of the northwest part along the Norwegian frontier, Sweden is not a mountainous country. On the other hand, fertile plains are not frequent. The most extensive are the northwest shore of the Gulf of Bothnia, where, however, the severe climate precludes any successful agriculture, the water districts of Lake Mälar and Lake Hjelmar, the rich agricultural district of Östergötland between Vetter and the Baltic, Vestergötland, or the whole country between the two great lakes as far as Gothenburg, and, as has been just mentioned, the southmost part, or Skåne, which comprises Christianstad and Malmöhus län. The greatest part of the country consists of low hills of granite or gneiss, clothed with forests of pine and fir. The valleys are generally in great part filled with water, and the shores of their lakes or wide rivers are covered with forests of deciduous trees, chiefly birch, or consist of arable soil. With the exception of Finland there is no country so full of lakes as Sweden. Nearly one-twelfth of the whole surface of the country, or about 13,900 square miles are covered with water.

Coast.

The "skärgård."

Coast.—The coast of Sweden is not broken by so many or so deep fjords as that of Norway. The most considerable indentation is the above-mentioned Bråviken Bay. On the other hand, the Swedish coast is, perhaps in a still greater degree than the Norwegian, fringed by innumerable little islets. Except on the coast round Skåne, in the south, the mainland does not come into direct contact with the sea, girdled as it is by a belt of islands, holms, and skerries, more or less thickly set, which forms the so-called "skärgård" fence of skerries or outer coast. Between this wall of islets and the mainland, therefore, extends a connected series of sounds of the greatest importance for coastal navigation, since they admit of the employment of vessels of less size and strength. This skärgård forms, besides, a most valuable natural defence; for, while some sounds are deep, navigation in the vicinity of the coasts is, as a rule, practically impossible without the help of pilots.

The broadest part of this skärgård is that off Stockholm, which stretches many miles out into the Baltic. It consists of a few large and well-peopled islands, surrounded by many hundreds of islets, for the most part uninhabited. The outer islands are bare gray rocks of gneiss, but the inner ones are mostly covered with fir and birch trees. The entrance to Stockholm through this archipelago is of its kind one of the most curious and picturesque in the world. The largest of these islands are Ljusterö, Vermdö, Ingarö, Vindö, Runmarö, Ornö, and Utö (with rich iron mines). As mentioned above, Lake Mälar is to be considered as a fjord of the Baltic. The skärgård also extends into Mälar, which is filled with islands. The most remarkable is Björkö, where the old town of Birka was situated. The archæological researches on this spot have been of the greatest importance for our knowledge of life in Sweden in the times of the vikings. The part of the skärgård next in breadth is that off Carlskrona, where the islands of Sturkö, Tjurkö, Aspö, and Hasslö are situated.

The Cattegat skärgård, which extends from the fjord of Svinesund at the southern extremity of the Norwegian frontier as far as Halmstad, has a different aspect from that of the Baltic. In the Cattegat all the islands, as well as the rocks of the mainland, are almost bare of vegetation. Trees are quite absent in most places, and generally the gray rocks are not even covered with grass or moss. They look as if they were polished by the sea. Between these bare rocks there is, however, in many places even on the larger islands arable soil of great fertility. In the northern part of the skärgård near Strömstad lie the larger islands of Sandö, Ödö, Tjernö, Rösö, etc. Farther seawards lie the Koster Islands and the Väder Islands with their lighthouses. A little more to the south, in the vicinity of Lysekil, are three narrow fjords—Åbyfjord, Gullmarfjord, and Koljefjord. Off the first-named lies Malmö,[1] remarkable for its quarry, where the fine granite of which the island consists is wrought. Next come, in succession, Kornö, Skaftö, Flatö, Hermanö, and Lyrö, the last two situated off the two largest islands on this coast, Oroust and Tjörn. All the islands now enumerated are surrounded by innumerable islets and rocks. South of Tjörn there are no considerable islands except Marstrand (with a small town and much-frequented sea-bathing quarters), Koö, and Klöfverö, all situated immediately to the south of Tjörn. On the coast of Halland we find only Särö, off the fjord of Kungsbacka, and the Väderö of Halland, off Torekow, between Laholm Bay and Skelder Bay, the only islands on the whole coast that are covered with a rich vegetation of trees. On the extreme point of the cape between the latter fjord and the Sound, lies the isolated Mount Kullen with its lighthouse. In the Sound off Landskrona lies the islet of Hven, where Tycho Brahe had his observatory, Uranienborg, in the end of the 16th century (1576–1597).

Large islands.

In the Baltic lie the two great islands of Gotland and Öland, of which the former is itself a county and a bishopric. These islands are quite different from the Swedish mainland. They are formed of Silurian limestone. On the western coast of Gotland the limestone rocks descend precipitously into the sea, and the island forms a comparatively smooth plateau, which slopes gradually to the east. The limestone soil is very fertile, and trees and plants thrive on it that do not otherwise grow in the climate of Sweden, such as walnuts, ivy, etc. The case is the same in Öland. This island somewhat resembles a house-top. A sterile limestone plain (Alvaren) stretches the whole length of the island from north to south, and from this the country slopes both towards Calmar Sound on the west and towards the Baltic on the east. The slopes, especially the western are very fertile.

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[1] Not to be confounded with the town of Malmö in Skåne.

Depths of surrounding sea.

Sea-Bed.—The seas that surround Sweden are remarkably shallow. Round the south part of Norway runs a depression in the sea-bed, called the Norwegian Channel (see NORWEGIAN SEA). It stretches along the west and south coasts of Norway southward and eastward almost to Christiania Fjord and the Cattegat. The deepest part of this channel, upwards of 400 fathoms, extends through the Skagerack between Arendal in Norway and the Scaw. In the Cattegat the depth diminishes abruptly, and between Gothenburg, and the Scaw the greatest depth is between 33 and 55 fathoms. The greatest part of the southern half of the Cattegat has a depth of less than 30 fathoms. The depth of the sound generally is even less than 12 fathoms. The whole southern part of the Baltic between Sweden and Germany is very shallow. West of Bornholm the depth nowhere reaches 30 fathoms. East of Bornholm the sea is somewhat deeper, and a small area of a depth of 50 to 60 fathoms is found a little east of that island. The whole of that part of the Baltic which lies between Sweden and Russia is divided into two separate basins by a submarine bank. From the southern extremity of Gotland (Hoburg) there extends a nearly uninterrupted bank to the southwest as far as the Prussian coast. The depth on this bank nowhere reaches 30 fathoms. The shallowest parts are Hoburg Bank south of Gotland, Mittel Bank southeast of Öland, and Stolpe Bank off the Prussian coast. Between Färö off the north coast of Gotland and the Gottska Sandö there extends a similar bank, which continues with a somewhat greater depth of about 30 fathoms as far north as Stockholm. The deepest part of the Baltic between these banks is situated in the north part between Landsort and the Gottska Sandö, the maximum depth being about 160 fathoms. Ålends Haf, the channel between the Swedish coast and the Åland Islands, is tolerably deep (100 to 160 fathoms).

The Gulf of Bothnia is divided into two basins by the channel of Qvarken; the southern is the deeper (about 50 fathoms), and the depth increases towards the northwest, where, over a small area off the island of Ulfö near the Swedish coast, it reaches 160 fathoms). The channel of Qvarken is very shallow (8 to 16 fathoms). The basin on the north side is also shallow. Only over a small area off Bjurö Cape does the depth exceed 160 fathoms.

Climate.

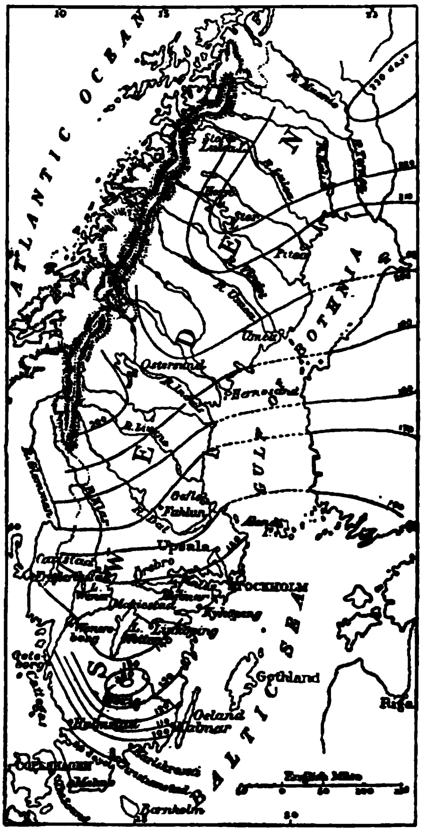
Climate.—**Sweden is situated between two countries of very different climatological conditions. On the west there is the maritime climate of the Norwegian coast, and on the east the continental climate of Russia. It may be said that Sweden alternates between the two. Cold winters alternate with mild ones, and warm and dry summers with cool and rainy ones. But different parts of Sweden have also in this respect a greatly differing climate, of which we readily see the reason if we only recollect the character and the general features of the configuration of the country. Lapland and the western part of the country along the Norwegian frontier have a pronounced continental climate, and so has the high plateau to the south of Lake Vetter. On the other hand, the climate is more maritime the more we approach the coasts of the Baltic, and on the coast of the Cattegat and in Skåne the maritime climate distinctly predominates.**

Station.	An'al.	Jan.	July.	Station.	An'al.	Jan.	July.
	°	°	°		°	°	°
Lund	44.9	31.3	61.7	Örebro	41.6	25.8	62.6
Carlshamn	44.4	31.1	61.7	Stockholm	41.4	26.1	61.4
Calmar	44.2	30.2	62.1	Carlstad	41.6	24.9	62.9
Halmstad	44.8	30.5	62.7	Vesterås	41.0	24.7	62.6
Vexiö	42.3	27.5	61.2	Upsala	40.4	24.5	61.5
Visby	43.4	30.7	60.3	Falun	38.7	20.8	61.2
Gothenburg	44.4	29.8	62.1	Gefle	40.0	24.5	61.0
Vestervik	42.8	28.1	61.4	Hernösand	37.1	20.0	58.9
Jönköping	42.7	28.6	61.0	Östersund	35.0	15.3	56.4
Venersborg	42.3	27.5	61.1	Umeå	34.4	15.8	58.8
Skara	41.5	26.0	60.3	Stensele	31.7	9.5	57.7
Linköping	43.4	27.8	63.9	Piteå	33.8	11.2	60.6
Nyköping	41.5	26.6	61.4	Haparanda	31.9	10.1	59.4
Askersund	41.0	25.1	61.2	Jockmock	29.1	3.1	58.0

Temperature.

The preceding table gives the mean annual temperatures (Fahr.) at twenty-eight meteorological stations in Sweden, together with the means for January and July.

From these figures it appears that, as mentioned above, the climate is most continental in the northern and interior parts of the country, especially at the two stations of Lapland, Stensele and Jockmock, while it is more maritime on the coasts. For this reason the isotherms for January on the Scandinavian peninsula are linguiform. The warm sea off Norway causes the peculiarity that the western parts of Lapland, although situated at the greatest elevation above the sea, have not so cold winters as the interior parts round the great lakes. Still farther to the east the temperature increases again towards the coast of the Gulf of Bothnia. Thus, for example, the isotherm of 10° F. enters Lapland from the northeast at about 68° N. lat., runs towards the southwest over the great lakes as far as about 64½°, south of Lake Stor-Uman, makes there an abrupt bend towards the east, and runs in a northeasterly direction to Haparanda at the northern extremity of the Gulf of Bothnia. The isotherm of 23° F. runs from the great lake of Mjösen in Norway, north of Christiania, to the southern shore of Lake Siljan, or almost straight east, curves there to the northeast, and reaches the shore of the Gulf of Bothnia a little north of the mouth of Ljusnan. Finally, the isotherm of 30° runs from Gothenburg towards the southeast to the lake of Åsnen, curves towards the northeast, and passes Calmar and the northern parts of the islands Öland and Gotland. On the summit of the plateau south of Vetter the mean temperature is, of course, lower than both north and south of the plateau. In July the temperature is almost constant all over the country. With the exception of the interior of Lapland the mean temperature varies generally between 59° and 62°. The warmest point is Lin-



Map of Equal Ice Periods.

köping on the plain of Östergötland, between Lake Vetter and the Baltic. The most temperate and most agreeable climate of the whole country is that of the Cattegat coast round Halmstad.

Equiglacial lines.

A good indication of the climate, especially that of the winter, is the time during which the freshwater lakes remain frozen. We have seen that nearly one-twelfth of the whole surface of Sweden is covered with water, and in Finland the number of the lakes is still greater. In both countries the times of freezing and breaking up of a great many lakes have been observed for many years. From these data we can calculate the length of the ice periods. If these periods are entered on a diagram, we can draw out the lines of equal ice periods, or the equiglacial lines. The accompanying map shows these lines for Sweden and Finland. From it we see that the glacial period in the southern part of the country is 90 days, while in the northern part of Lapland it has a duration of no less than 230 of the 365 days of the year. The western lakes of Lapland, though the higher in situation, have a somewhat shorter ice period than the eastern. The ice period is considerably lengthened on the great plateau south of Lake Vetter.

Variations of temperature.

We have said above that in certain years the climate of Sweden is more maritime, in others more continental. Thus, for instance, the annual mean temperature of Upsala has varied during the last 30 years between 43.2° (1859) and 35.0° (1867). The mean temperature of particular months varies of course in a still higher degree, especially during the winter; thus the mean temperature of January, 1873, was 34.3°, but of January, 1875, only 12.2°.

The difference between the means of the warmest month and the coldest is the so-called yearly range of temperature. In Sweden July is generally the warmest and February the coldest month. The difference between the January and July temperatures, however, as given in the foregoing table, will show the yearly range approximately. It will be seen that this increases towards the north. For the same latitude, it is greater in the interior of the country than on the coasts.

As is easily understood, the periodic daily range of temperature is least during the darkest part of the year, during December and January, especially in the north part of the country round the polar line, and still farther north, where it is almost nil. The mean range for the whole country is in December only 2°. The maximum occurs in June or July at all stations except those of western Sweden, where it occurs as early as May. The mean of June is 13°. A curious fact is that in Norrland, especially in the interior, a secondary maximum occurs in March, which sometimes even exceeds the summer maximum.

The non-periodic daily range of temperature, or the difference between the monthly means of daily maximum and minimum of temperature, is as usual considerably greater than the periodic. The difference is almost constant for all stations, especially during the warmer part of the year. We have, for the whole country:

	Non-periodic.	Periodic.	Difference.
Winter	10.0°	3.0°	7.0°
Spring	16.0°	11.2°	4.8°
Summer	19.1°	13.0°	6.1°
Autumn	11.7°	6.3°	5.4°

Winds.

Barometer.

The mean direction of the winds shows little variation during different seasons. During the summer it is west or west-southwest in the south of Sweden, changes to southwest in the middle part of the country, and due south along the coast of the Gulf of Bothnia. In winter north-northeast winds become comparatively frequent in the north part of the country. This is explained by the difference in barometric pressure in summer and in winter. In July the mean height of the barometer indicates a gradual fall along the coast of the Baltic, from 29.828 inches in Calmar to 29.675 in Haparanda. In January, on the other hand, there is a gradual fall from 29.853 in Calmar to 29.718 in Hernösand, but thereafter a gradual rise to 29.834 in Haparanda. Unfortunately the isobarometric lines for Sweden have not yet been calculated with due precision.

Rainfall.

The rainfall is greatest on the coast of the Cattegat. The annual amount is greatest at Gothenburg, where it is 32.56 inches. At Halmstad it is 28.26, and at Venersborg, where Göta Elf issues from Lake Vener, it is 30.33. These are the rainiest stations of Sweden. Generally speaking, the amount of rain diminishes afterwards as well towards north and northwest as towards southeast. The least rain falls on the one hand in northern Lapland, where the annual amount is only 15.52 inches, and on the other hand in the southeastern corner of Sweden, where (at Calmar) we have the lowest known rainfall for the whole country (12.75 inches). Between these two tracts there runs a belt of greater precipitation from Gothenburg towards the northeast to Upsala, where the annual amount is 23.28. Even along this belt the amount of rainfall diminishes towards the northeast, but at every point the amount is greater than to the northwest and southeast of it. The greatest amount of rain falls in July and August and the least in February and March. Thus, for instance, there fall in Upsala during August 2.86 inches and during March 0.99 inch. As the temperature varies, so does the rainfall for different years.

Thunderstorms.

The number of thunderstorms is small in Sweden compared with the countries of the south. Their number diminishes as does the precipitation from southwest towards north and east. From 1871 to 1880 the mean annual number of thunderstorms at each station was 9.5 in Götaland, 8.4 in Svealand, and only 6.3 in Norrland. In the south their number diminishes rapidly from west to east, from 11 on the coast of the Cattegat to 8.3 on the coast of the Baltic, and only 6.6 on the isle of Gotland. The thunderstorms have a distinctly marked annual and daily period. They occur almost always during the warmest time of the year and of the day. During the above-mentioned ten years the least number occurred during the month of February, only 3, whereas there occurred in May 1194, in June 3724, in July 4419, in August 3306, and in September 1461. As regards the daily period, the least number, 147, occurred between 1 and 2 A. M., and the greatest, 1704, between 3 and 4 P. M. In Götaland and Svealand most of the thunderstorms come with a southwesterly wind, in Norrland with a southerly; for the whole country, the least number come with a northerly wind.

Hail.

If the number of thunderstorms is small in Sweden, the same is in a still higher degree to be said of their intensity. Hail, which on the Continent causes such immense damage to the growing crops, is rare in Sweden, and often quite harmless. In the south of Germany about 2 per cent. of the crops are annually destroyed by hail. At Magdeburg the damage is 0.9 per cent., at Berlin 0.6 to 0.7 per cent., but in Sweden only 0.06 per cent. (H. H. H.)

Geology.

Geology.—The fundamental rocks of Sweden belong to the Azoic or Pre-Cambrian formation, and consist of crystalline rocks. Three great divisions of this formation may be distinguished,—the gray gneiss, the red iron gneiss, and the granulite.

The gray gneiss rules in the northern and western parts of the country, from West Norrland down to the province of Calmar. The rock has a prevalent gray color, and contains as characteristic minerals garnet and in some parts graphite.

The red iron gneiss prevails in western Sweden in the provinces of Vermland, Skaraborg, Elfsborg, and down to the province of Christianstad. The formation is very uniform in its character, the gneiss having a red color and containing small granules of magnetite, but, nevertheless, not a single iron-mine belongs to this region. The red gneiss contains in many places beds or masses of hyperite.

The granulite, also called eurite and hälleflinta, is the most important of the Pre-Cambrian formation, as it contains all the metalliferous deposits of Sweden. It prevails in the middle part of the country, in the provinces of Vermland, Kopparberg, Vestmanland, and Upsala. It occurs also in some parts of the provinces of Östergötland, Calmar, and Kronoberg. The main rock in this region consists of hälleflinta, a kind of very compact and fine-grained mixture of feldspar, quartz, and mica, often graduating to mica schists, quartzite, and gneiss. With these rocks are often associated limestones, dolomites, and marbles containing serpentine (Kolmården). The metalliferous deposits have generally the form of beds or layers between the strata of granulite and limestones. They are often highly contorted and dislocated.

The iron-mines occur imbedded in more or less fine-grained gneiss or granulite (Gellivaara, Grängesberg, Norberg, Striberg), or separated from the granulite by masses of augitic and amphibolous minerals (*grönskarn*) as in Persberg and Nordmark. Sometimes they are surrounded by hälleflinta and limestone, as at Dannemora, Långban, Pajsberg, and then carry manganiferous minerals. Argentiferous galena occurs at Sala in limestone, surrounded by granulite, and at Guldsmedshytta (province of Örebro) in dark hälleflinta. Copper pyrites occurs at Falun in mica-schists, surrounded by hälleflinta. Zinc blende occurs in large masses at Ammeberg, near the northern end of Lake Vetter. The cobalt ore consists of cobalt-glance (Tunaberg in the province of Södermanland) and of linneite (at Gladhammar, near Vestervik). The nickel ore of Sweden is magnetic pyrites, containing only a very small percentage of nickel. The magnetic pyrites occurs generally imbedded in diorite and greenstones. In the evidently most recent division of the granulite occurs clay-slate (at Grythytta in the province of Örebro).

Large masses of granite are found in many parts of Sweden, and form extensive massifs as in the provinces of Kronoberg, Örebro, Göteborg, Stockholm, etc. Sometimes the granite graduates into gneiss; sometimes (as north of Stockholm) it incloses large angular pieces of gneiss. In many parts of Sweden occur greenstones, as hyperite, gabbro (anorthite-gabbro at Rådmansö in the province of Stockholm), and diorite, the last often forming beds between the strata of the gneiss.

The Cambrian formation occurs generally associated with the Lower Silurian, and consists of many divisions. The oldest is a sandstone, in which are found traces of worms, impressions of *Medusæ*, and shells of *Lingula*. The upper divisions consist of bituminous limestones, clay-slates, alum-slate, and contain numerous species of trilobites of the genera *Paradoxides*, *Conocoryphe*, *Agnostus*, *Sphærophthalmus*, *Peltura*, etc. In Öland and north of Siljan are found beds with *Obolus*.

The Lower Silurian consists of the following divisions: (1) beds with *Ceratopyge;* (2) schists with Graptolites; (3) large beds of red and gray limestone (200 feet in thickness) containing *Megalaspis* and *Orthoceratites*. This limestone is largely used as building material; (4) slates with *Trinucleus;* (5) slates with Brachiopods; (6) slates with Graptolites. The Cambrian and Lower Silurian strata occur scattered in several places from Vesterbotten down to Jemtland (around Storsjön), and in the provinces of Skaraborg, Elfsborg, Örebro, Östergötland, and Christianstad. The whole of the island of Öland consists of these strata. The strata are in most places very little disturbed, and form horizontal or slightly inclined layers. They are, south of Lake Vener, capped by thick beds of eruptive diabase (called *trapp*). North of Lake Siljan (province of Kopparberg) occur Lower Silurian but not Cambrian strata, which have been very much dislocated. The Upper Silurian has in Sweden almost the same character as the Wenlock and Ludlow formation of England. The island of Gotland consists entirely of this formation, which occurs also in some parts of the province of Christianstad. In the western part of the province of Kopparberg are extensive deposits of sandstone, separated by beds of diabase, and seemingly of the same age,—the Middle Silurian,—but no fossils have been found in them. In the vicinity of this sandstone region are large beds and massifs of porphyries. There are still two sets of stratified, not fossiliferous, deposits, viz., in the province of Elfsborg (formation of Dalsland) and around Lake Vetter (formation of Visingsö). The Dalsland formation, which attains the thickness of 6000 to 7000 feet, consists of conglomerates, chlorite schists, quartzites, and mica schists. The Visingsö formation, 800 to 1000 feet in thickness, consists of sandstones, clay-slate, etc. In the western and northern alpine part of Sweden, near the boundaries of Norway, the Silurian strata are covered by crystalline rocks, mica schists, quartzites, etc., of an enormous thickness. These rocks form the mass of the high mountain of Åreskutan, etc.

The Triassic formation (Rhætic division) occurs in the northern part of the province of Malmöhus. This formation consists partly of sandstones with impressions of plants (cycads, ferns, etc.), and partly of clay-beds with coal.

The Cretaceous formation occurs in the provinces of Malmöhus and Christianstad. Also some spots of this formation are found in the province of Blekinge. The Cretaceous beds of Sweden belong to the most recent division of the Cretaceous formation (chalk and danien). In many parts it has all the characteristics of a coast-deposit.

The most recent deposits of Sweden date from the Glacial and Post-Glacial periods. At the beginning of the Glacial period the height of Scandinavia above the level of the sea was greater than at present, Sweden being then connected with Denmark and Germany and also across the middle of the Baltic with Russia. On the west the North Sea and Cattegat were also dry land. On the elevated parts of this large continent glaciers were formed, which, proceeding downwards to the lower levels, gave origin to large streams and rivers, the abundant deposits of which formed the diluvial sand and the diluvial clay. In most parts of Sweden these deposits were swept away when the ice advanced, but in Skåne they often form still, as in northern Germany, very thick beds. At its maximum the inland ice not only covered Scandinavia but also passed over the present boundaries of Russia and Germany. When the climate became less severe the ice slowly receded, leaving its moraines, called in Sweden *krosstenslera* and *krosstensgrus*. Swedish geologists distinguish between *bottengrus* (bottom-gravel, bottom moraine) and ordinary *krossgrus* (terminal and side moraine.) The former generally consists of a hard and compact mass of rounded, scratched, and sometimes polished stones, firmly imbedded in a powder of crushed rock. The latter is less compact and contains angular boulders, often of a considerable size, but no powder. Of later origin than the krosstensgrus is the *rullstensgrus* (gravel of rolled stones), which often forms narrow ranges of hills, many miles in length, called *åsar*, running generally, independent of the relief of the country, in a north-and-south direction or towards the southeast. They are of the same nature as the kames and eskers in Ireland and Scotland, and consist of rolled pebbles and sand. It is very probable that these åsar were formed on the bottoms of rivers which cut their way in the inland ice. During the disappearance of the great inland ice large masses of mud and sand were carried by the rivers and deposited in the sea. These deposits known as glacial sand and glacial clay cover most parts of Sweden south of the provinces of Kopparberg and Vermland, the more elevated portions of the provinces of Elfsborg and Kronoberg excepted. In the glacial clay shells of *Yoldia arctica* have been met with in many places (*e.g.*, near Stockholm). At this epoch the North Sea and the Baltic were connected along the line of Vener, Vetter, Hjelmar, and Mälar. On the other side the White Sea was connected by Lakes Onega and Ladoga with the Gulf of Finland and the Baltic. In the depths of the Baltic and of Lakes Vener and Vetter there actually exist animals which belong to the arctic fauna and are remnants of the ancient ice-sea. The glacial clay consists generally of their darker and lighter colored layers, which give it a striped appearance, for which reason it has often been called *hvarfvig lera* (striped clay). The glacial clay of the Silurian regions is generally rich in lime and is thus a marl of great fertility. The deposits of glacial sand and clay are found in the southern part of Sweden at a height ranging from 70 to 150 feet above the level of the sea, but in the interior of the country at a height of 400 feet above the sea.

On the coasts of the ancient ice-sea, in which the glacial clay was deposited, there were heaped up masses of shells which belong to species still extant around Spitzbergen and Greenland. Most renowned among these shell-deposits are the Kapellbackarne near Uddevalla. With the melting of the great ice-sheet the climate became milder, and the southern part of Sweden was covered with shrubs and plants now found only in the northern and alpine parts of the country (*Salix polaris*, *Dryas octopetala*, *Betula nana*, etc). The sea fauna also gradually changed, the arctic species migrating northward and being succeeded by the species existing on the coasts of Sweden. The Post-Glacial period now began. Sands (*mosand*) and clays (*åkerlera* and *fucuslera*) continued to be deposited on the lower parts of the country. They are generally of insignificant thickness. In the shallow lakes and inclosed bays of the sea there began to be formed and still is in course of formation a deposit known by the name *gyttja*, characterized by the diatomaceous shells it contains. Sometimes the gyttja consists mainly of diatoms, and is then called *bergmjöl*. The gyttja of the lakes is generally covered over by peat of a later date. In many of the lakes of Sweden there is still in progress the formation of an iron-ore, called *sjömalm*, ferric hydroxide, deposited in forms resembling peas, coins, etc., and used for the manufacture of iron.[1] (P. T. C.)

Flora.

Flora.—Of the whole area of Sweden about 132,000 square miles are covered with wild vegetation. This may be broadly divided into five different sorts, viz., the forest, bush, marsh, heath, and prairie vegetations, of which the first-mentioned covers by far the largest area, or upwards of 40 per cent. of the whole surface of Sweden. In the northern part of the country the fir (*Pinus sylvestris*) and the pine (*Pinus Abies*) are the predominating trees; south of Dal Elf the oak (*Quercus pedunculata*), and in the southern and southwestern provinces the beech (*Fagus sylvatica*), are, together with the fir and pine, the forest-forming trees. Besides these, there are two species of birch (*Betula verrucosa* and *B. odorata*), which form considerable forests. The bush vegetation derives its character from various species of *Salix*, *Rubus*, and *Rosa*, from *Prunus spinosa* and several other species. The marsh vegetation is composed of some low bushes, of *Cyperaceæ*, *Gramineæ*, and a small number of dicotyledonous and large-flowered monocotyledonous plants. The heath vegetation consists principally of social *Ericaceæ*, especially heather (*Calluna vulgaris*), and the prairie vegetation of a considerable variety of plants.

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[1] The geology of Sweden has been worked out principally by Hisinger, Forselles, Erdmann, Törnebohm, and others. A systematic geological survey of Sweden was set on foot by the Government in 1858. The geology of the fossiliferous strata of Sweden has been elaborated chiefly by Nilsson, Angelin, Linnarsson, Lindström, Nathorst, and others, and that of the Glacial and Post-Glacial periods by Sefström, Von Post, Torell, and others.

The Swedish phanerogamic flora is chiefly angiospermous with about thrice as many dicotyledonous as monocotyledonous plants. The gymnosperms are only about 0.25 per cent. of the species of the flora. Its largest families are (in the order of number of species)—*Compositæ*, *Gramineæ*, *Cyperaceæ*, *Cruciferæ*, *Papilionaceæ*, *Rosaceæ*, *Personatæ*, *Ranunculaceæ*, *Umbelliferæ*, *Alsinaceæ*, *Labiatæ*, and *Orchideæ*, the first-named being represented by 160, the last-named by 38 species. The number of families represented amounts to 99. The largest genus of the flora is *Carex*, with 88 species. More than 250 genera are represented by only one species each. The whole number of phanerogamic species now known in Sweden is 1475. Of these only a very small number can be supposed to have originated in the country; the greatest number have immigrated from the south or east after the Glacial period, or have been introduced in one way or another by man. Among the immigrated species about 400 are more or less generally spread over the polar countries of the present period, or are to be found in southern countries as alpine plants. The great mass of these Glacial plants, the earliest inhabitants of the country, are confined to the northern part of Sweden; a smaller number are also to be found, or are only to be found, in the south and in particular localities; a larger number—about 70 species—are abundantly distributed over the whole country.

The Glacial plants were followed and superseded partly by subarctic or subglacial species. Of these the Swedish flora has about 300, of which 50 are abundantly spread over the country, and 80 are pretty generally and abundantly distributed. The principal mass of the remaining species of the flora have immigrated in the same period as the oak, and have spread over the country south of Dal Elf, or also to the provinces immediately to the north of this river; some are outlying steppe-plants; some have entered with the beech, the last immigrated forest-tree of Sweden; and a small number of species, now limited to the west of the country, have possibly entered during a period before that of the beech, when the climate was warmer and moister than at present. (F. K.)

Fauna.

Fauna.—After the close of the Glacial period a twofold immigration of animals occurred,—from the southwest through Denmark, and from the northeast through Finland. Of the existing fauna, many species are widely spread. Especially in the north we find boreal circumpolar forms (wild reindeer, glutton, arctic fox, ptarmigan, several birds of prey, *Grallæ*, and aquatic birds). Others such as the bear, the wolf, the fox, the magpie, etc., are to be found only in the Old World, but are represented in America by forms resembling them so much as to be regarded by many as only local varieties. Many of the commonest species, *e.g.*, the squirrel, the woodpeckers, the crow, most of the singing-birds, etc., though wanting in the New World, are distributed over Europe and parts of northern Asia.

Besides these we find also specially eastern, southern, and western forms, which have immigrated from widely separated regions. Thus the northern hare, *Lepus timidus*, properly an inhabitant of Russia and Siberia, but also to be found in the mountainous tracts of central Europe, is common in most parts of Sweden, while the European hare, *Lepus europæus*, which is spread over central and western Europe, and is also to be found in Denmark, is wanting. Most of the field-mice, and many birds which have an exclusively eastern range, have immigrated from Siberia. Among mammals, which nearly all belong to Europe, may be mentioned the roe-deer and the red-deer, the dormouse and the hedgehog; the last-named is common in central and southern Sweden. The elk is considered to have immigrated from the south.

Not very long ago the bear, lynx, and wolf were common in all the forests of northern and central Sweden, but their number has rapidly decreased during the last fifty years. The bear is now confined to the wildest mountain and forest regions of Norrland and Kopparberg län. The wolf was formerly common throughout the country, and between 500 and 600 were killed annually fifty years ago. Now the number is only 30 to 40, and it is to be found almost exclusively in the mountain regions of Norrland. The lynx is also being exterminated; it is still found in the greater part of northern and central Sweden, at least as far south as Lake Vener. On the other hand, foxes have of late increased, at least in certain parts of the country, and are common everywhere. The glutton also is by no means rare in the mountain regions of Lapland. The destruction of cattle caused by beasts of prey, especially in the north is not inconsiderable, the loss being estimated at about 2500 reindeer and from 9000 to 10,000 sheep and goats annually.

Not without influence on the number of the smaller beasts of prey are the singular migrations of the mountain LEMMING (*q.v.*), which has its home on the higher mountains above the tree-limit, whence in certain years it migrates in countless numbers to the lower forest regions and lowlands, doing great damage to the vegetation wherever it goes. After the last migration in 1883 the number of the foxes was found to have increased in the regions through which the lemmings had passed.

Of eatable game the elk holds the first place. It has increased in numbers and range of late years, and is pretty common in the forest tracts of central Sweden. The roe-deer, which has its proper home in the southmost parts of Sweden, has also increased of late, and has been seen as far north as Örebro län and Vestmanland. Hares occur in great abundance. Seals are found round the coast; they are hunted chiefly in the Baltic and the Gulf of Bothnia. Besides the larger beasts of prey, martens, weasels, otters, and squirrels are hunted for the sake of their skins, but not to any great extent. The beaver is now probably extinct. Some of the mammals (the bat, hedgehog, dormouse, badger, bear) hibernate; most of the other animals are in winter covered with a thicker coat of hair, and some change their color to white or gray.

The wood-grouse is the most valued winged game. Its favorite haunt is the great lone forests. Although it has been obliged to retreat before advancing cultivation, it is still pretty common in suitable places. More numerous and almost as much liked is the black grouse, which has somewhat the same distribution as the wood-grouse, but is less particular in the choice of its abode. In the forests of central and especially of northern Sweden the hazel-grouse is numerous in many places, and on the mountains above the tree-limit the ptarmigan is common everywhere. In the birch and willow regions we find the willow-ptarmigan, which above the snow-line is superseded by the common ptarmigan. In winter a great deal of game is exported from Norrland to the southern provinces. The partridge, probably introduced about 1500, with difficulty endures the rude climate of Sweden, and great numbers often perish in winter for want of food. Still it is distributed all over southern and central Sweden as far north as Jemtland, and of late its numbers have increased. The number of woodcock and snipe is, like that of *Grallæ* in general, decreasing. Numerous sea-fowl are found on all the coasts. Some are killed and eaten, but as a rule they are not much relished. Their eggs are collected for food by the inhabitants of the seaboard. The eider-duck is common on both coasts. Among the birds of prey the hawk is the most destructive and the most hunted. The gyrfalcon and the golden eagle are found in Norrland and Lapland, and the sea-eagle throughout the country, especially on the coasts. Some kinds of falcons and owls are very common, the latter especially in northern Sweden. In the interior the most characteristic birds are swallows, sparrows, the birds of the crow family, and the singing-birds, among which the lark, the chaffinch, the thrushes, and the many species of *Sylvia* are most noticeable. The northern nightingale is rare in southern Sweden. The cuckoo is heard everywhere, especially in the forest regions. The mute swan is found in great numbers in a few places in southern and central Sweden. The whooper swan frequents the marshes and lakes of Lapland. The white stork is found in Skåne and Halland, and herons are found in great numbers here and there in Skåne and Blekinge. Cranes are distributed all over the country. Characteristic of the wild forest tracts of Lapland is the Siberian jay. Upwards of 250 species of birds may be considered as belonging to the Swedish fauna, most of them birds of passage, scarcely 40 remaining over winter in their summer resorts. In spring and autumn Sweden is visited by great flocks of the birds of passage of the extreme north, especially geese and snipe.

The reptiles and amphibians are few (3 snakes, 3 lizards, 11 batrachians).

Fisheries.

The Swedish rivers and lakes are generally well stocked with fish. The objects of capture are chiefly salmon, eel, pike, different species of perch, burbot, and several species of the *Salmonidæ* and *Cyprinidæ*. The annual income from the fisheries in the lakes and rivers amounts to upwards of £135,800 [$659,988], of which the salmon fisheries alone yield £42,000 [$204,120]. Of still greater importance, of course, are the sea-fisheries. In the end of last century the herring fishery in the "skärgård" of the west coast was the most important in Europe, and it is estimated that in one year 1500 millions of herrings were taken. Somewhat, later, however, the great shoals disappeared for a long time. In 1877 a new era began in the history of the west-coast fisheries, the take that year being 1,230,000 cubic feet. Since then the herring has returned every year in greater or smaller numbers. There are also captured on the same coast flat-fishes and codfish, mackerel, and sprats. The annual produce of the sea-fishery of the south and west coasts is valued at about £111,000 [$539,460]. A smaller variety of the herring is found in great abundance on the east coast. In the Sound it is still 11 inches in length, in the Baltic only 6 or 8 inches. This variety is called "strömming," and is the object of an important fishery, annually bringing in more than £175,000 [$850,500]. About 140 kinds of fishes are constantly found in Sweden or along its coast. Of these nearly 100 belong exclusively to the sea, and upwards of 10 are to be found both in salt and fresh water. The remainder are properly freshwater fishes, but many are found in the brackish water of the Baltic coasts. Here we find perch, pike, etc., by the side of purely saltwater fishes, as the "strömming," the flat-fish, etc.

The species of Scandinavian insects number at least 15,000. Notorious among these are the Lapland gnats. The "skärgård" of the west coast has a rich fauna of lower marine animals, partly forms of boreal and arctic descent, partly immigrants from the south. The Royal Academy of Science has here a zoological station, Kristineberg, for the purpose of scientifically examining the marine fauna.

Compared with the fauna of the west coast, that of the Baltic is extremely poor. It consists partly of European boreal forms, which have immigrated from the west, partly of freshwater forms, which have been able to live in the brackish water. But other types also occur, which, though sparingly represented, are of the greatest interest to the naturalist,—namely, certain dwarfed forms,—two or three species of fish, some crustaceans and other lower marine animals, belonging to a purely arctic fauna, which have immigrated when the Baltic during a part of the Glacial period communicated with the White Sea. They are wanting on the south and west coasts of Sweden, but are found in the Arctic Ocean. Some of them, the four-horned cottus and some crustaceans, are found in Lake Vetter and some other lakes of central Sweden, whither they had come when these lakes formed part of the arctic sea; they have since been shut in and have survived both the climate and the altered composition of the water. The arctic "vikare" seal (*Phoca fœtida*), which is common in the north part of the Baltic but is not found on the west coast, and which is also found in Lake Ladoga, Lake Onega, and some lakes of Finland, is also considered as a survival of the fauna of the Glacial period. On the west coast lobster and oyster fisheries are carried on, the former being very productive. The common mussel is abundant, but in Sweden is only used as bait for fish. The crayfish is common in many places in central and southern Sweden. Pearls are sometimes found in the freshwater mussel *Margaritana margaritifera*, which is met with all over the country. (A. WI.)

Area and population.

Extent and Population.—Sweden takes rank among the larger countries of Europe. It contains 170,712.60 English square miles, of which area 3,517.29 square miles are occupied by the large lakes Vener, Vetter, Mälar, and Hjelmar, leaving 167,195.31 square miles distributed among the counties as shown in the following table, which gives the areas and the estimated population in 1885 of the different administrative divisions (the capital Stockholm and the twenty-four "län" or counties) into which the kingdom is divided:

The population has long been steadily increasing. In 1750 it amounted to 1,763,368, in 1800 to 2,347,303, and in 1850 to 3,482,541. The census of December 31, 1880, returned the number as 4,565,668 (2,215,243 males, 2,350,425 females), and at the end of 1885 the population was estimated at 4,682,769 (2,273,861 males, 2,408,908 females).

It will be seen that Sweden is sparsely peopled (the average for the whole country being only 28 inhabitants to the square mile), and that the population is very unevenly distributed,—Malmöhus län, which lies farthest south, counting 193 persons to the square mile, whereas Norrbotten, farthest to the north, and by far the largest county, has only 2.4.

The urban population as late as 1884 amounted to only 777,857 (the rural amounting to 3,866,591). The towns are in general small. Except Stockholm (215,688 inhabitants in 1885), only five towns—Gothenburg (91,033), Malmö (44,532), Norrköping (28,503), Gefle (20,753), and Upsala (20,202)—had in 1885 more than 20,000 inhabitants.

Vital statistics.

The average number of marriages per 1000 inhabitants was for each of the years 1751-60 9.09; this proportion has gradually diminished since, having been 7.60 in 1851-60 and 6.81 in 1871-80. The yearly average of living children born from 1871-80 was 133,730, and the yearly average of deaths 80,140. The yearly average of deaths to 100 inhabitants for 1751-1815 was 2.71; this number has since been almost constantly decreasing, the average for 1851-60 being 2.17, and for 1871-80 1.82. Immigration and emigration till comparatively recent times had little influence on the numbers of population, but the latter years of the decennial period, 1860-70, caused a change in this respect. The number of emigrants, which as late as 1867 amounted to little more than 9000, increased during 1868 to 27,000 and during 1869 to 39,000. During the years that followed there was a considerable decrease, but towards 1880 the number of emigrants again rapidly increased, and in 1882 this amounted to upwards of 50,000. The figure for 1884 was 23,560. Immigration, on the contrary, continues to be insignificant. The annual average of immigrants for 1875-84 was 3333.

Län.	Square Miles.	Population.
Stockholm (city)	12.65	215,688
Stockholm (rural)	3,008.45	148,841
Upsala	2,052.75	116,406
Södermanland	2,630.64	150,032
Östergötland	4,272.88	267,842
Jönköping	4,440.51	197,392
Kronoberg	3,841.51	166,881
Calmar	4,439.06	240,507
Gotland	1,202.97	52,570
Blekinge	1,164.09	140,071
Christianstad	2,506.97	226,787
Malmöhus	1,847.02	358,178
Halland	1,899.45	136,973
Göteborg (Gothenburg)	1,952.51	281,001
Elfsborg	4,948.15	282,335
Skaraborg	3,283.13	253,467
Vermland	7,345.73	259,958
Örebro	3,502.88	182,513
Vestmanland (Vesterås)	2,623.14	132,056
Kopparberg	11,420.8	194,291
Gefleborg	7,418.70	191,223
Vesternorrland	9,519.92	184,884
Jemtland	19,603.5	93,091
Vesterbotten	21,942.4	113,541
Norrbotten	40,315.5	96,241

Race.

The inhabitants of Sweden belong almost exclusively to the Scandinavian race. The principal exceptions are the Finns (in 1880 about 17,000), who chiefly inhabit the northeastern part of the county of Norrbotten, the Lapps (in 1880 about 6400), spread over an area of about 44,000 square miles in Lapland and Jemtland, and the Jews (in 1880 about 3000).

Agriculture.

Agriculture.—Agriculture is the principal industry in Sweden. The number of persons gaining their livelihood by this occupation and those immediately depending on it was 2,342,000 in 1880, and the value of the harvest in 1884 was estimated at about £25,500,000 sterling [$123,930,000], of which the grain-harvest made £14,800,000 [$71,928,000]. From 1840 to 1880 the export of grain (including meal, etc.) exceeded the import; but this has not been the case since 1881, while, on the other hand, the export of dairy produce has meanwhile increased.

Mines.

Mines.—Sweden is rich in minerals, especially iron-ores, and the Swedish iron is celebrated for its good quality. In 1884 526 iron-mines were worked, the joint produce of which amounted to 922,310 tons. The manufacture of cast-iron amounted to 416,956 tons, that of bar-iron to 267,534 tons, of steel to 66,329 tons, and of hardware to 43,226 tons. The copper during the same year amounted to 650 tons, and the silver to rather more than 4000 lb. Pit-coal has been found only in Malmöhus län, and even there in small quantity compared to the consumption of the country. The produce of the coal-mines was in 1884 not more than 7,277,000 cubic feet, whereas the import of coal amounted to 52,650,000 cubic feet.

Forests.

Forests.—A great part of Sweden is, as was above mentioned, covered with forests. Most of these are the property of private persons or joint-stock companies, but the Government also possesses large forests, the value of which was in 1884 estimated at about £2,400,000 [$11,664,000]. The forest produce ranks among the principal articles of export from Sweden.

Manufactures.—It was not till 1854 that Sweden completely

Manufactures.

broke with the pre-existing protectionist system and adopted the principles of free trade. Since 1860 there has been no prohibition, and import duty is in general low. The value of the manufactures, which as late as 1850 was estimated at only £2,000,000 [$9,720,000], was for 1883 computed at more than £10,600,000 [$51,516,000].

Commerce.

Commerce.—The united value of the exports and imports of Sweden was estimated for 1850 at little more than £4,000,000 [$19,440,000], whereas in 1884 it was something over £31.000,000 [$150,660,000] (imports about £18,000,000 [$87,480,000], exports about £13,000,000 [$63,180,000]). The principal articles of export were—timber and wooden wares, £5,747,000 [$27,930,420]; metals and hardware goods, £2,667,000 [$12,961,620]; grain (including meal, etc.), £1,307,000 [$6,352,020]; animal food, £1,081,000 [$5,253,660]; live animals, £652,000 [$3,168,720]; paper and stationery, £584,000 [$2,838,240]. The principal articles of import during the same year were—cotton and woollen manufactured goods, £3,012,000 [$14,638,320]; colonial products (coffee, sugar, etc.), £2,309,000 [$11,221,740]; grain and meal, £2,258,000 [$10,973,880]; minerals (principally coal), £1,479,000 [$7,187,940]; metals and hardware goods, £1,308,000 [$6,356,880]; cotton, wool, etc., £1,125,000 [$5,467,500]; animal food, £1,036,000 [$5,034,960]; ships, carriages, machines, instruments, etc., £807,000 [$3,922,020]; hair, hides, bones, horns, and other animal substances, £784,000 [$3,810,240]; tallow, oils, tar, gums, and similar substances, £782,000 [$3,800,520]. The aggregate burden of vessels entering from and clearing to foreign ports was 858,827 tons in 1850, 5,388,065 tons in 1884. The estimated value of the exports to the United Kingdom during 1884 was £6,229,000 [$30,272,940], to Denmark £1,848,000 [$8,981,280], to France £1,073,000 [$5,214,780], to Germany £1,008,000 [$4,898,880], and to Norway £604,000 [$2,935,440]; while the imports from Great Britain and Ireland reached £4,952,000 [$24,066,720], from Germany £4,947,000 [$24,042,420], from Denmark £2,932,000 [$14,249,520], from Russia and Finland £1,881,000 [$9,141,660], and from Norway £1,225,000 [$5,953,500].

Railways.

Post-office.

Telegraphs.

Railways, Posts, and Telegraphs.—The length of the railways in Sweden is very great in proportion to the population. In 1884 the total length was 4194 miles, of which 1437 miles belonged to the Government and 2657 to 76 private companies. The postal system is remarkably well organized. In 1884 the number of post-offices was 1965, through which 46,533,627 inland letters, post-cards, post-office orders, newspaper and book packets, etc., were forwarded, and 5,507,770 to and 6,511,248 from foreign countries. The telegraph system is also in a very flourishing condition. The total length of the telegraph wires in 1884 was 12,969 miles, and the number of messages forwarded was 1,178,959.

Education.

Education.—With regard to education Sweden occupies a very prominent place. Primary education is compulsory for all the children of the country, and this principle is so strictly applied that in 1884 out of 733,329 children of school-age only 15,143 were not under tuition. To supply this primary instruction there are 9925 national schools of different kinds, with 5216 male teachers and 6832 female teachers (1884). For higher educational purposes there are 96 public schools (1885), of three grades, with 14,617 pupils, and two universities (Upsala with 1821 and Lund with 827 students). In Stockholm there is, besides, a medical faculty, the Royal Caroline Medico-Chirurgical Institution. A free university is in course of formation, for which large sums have been given by private persons. There are a large number of Government schools for the military and naval services, for the technical sciences, for metallurgy, agriculture, nautical science, and for the blind and the deaf and dumb. All instruction at the national schools, the public schools, and the universities is free.

Religion.

Religion.—Christianity was introduced into Sweden about the ninth century, and was generally professed by the twelfth. The country adopted the doctrines of the Reformation during the reign of Gustavus Vasa. The national church, established by the resolution passed at Upsala in 1593 (*Upsala möte*), is Lutheran. The country is divided into 12 bishoprics (*stift*). The bishop of Upsala is archbishop of Sweden. In 1880 the number of dissenters was 21,234, of whom 14,627 were Baptists, 2993 Jews, 1591 Methodists, and 810 Roman Catholics.

Army.

Army and Navy.—The land defences consist partly of a standing army, partly of a militia. The former is for the most part founded on the so-called "indelningsverk," an institution dating from the time of Sweden's greatness, which makes the soldier a settled farmer. This force comprises about 40,000 men. The militia comprises (since 1885) all males between twenty-one and thirty-two years of age. The time of drill for the militia is only forty-two days, extending over two years.

Navy.

The navy, with a permanent personnel (also for the most part founded on the "indelningsverk") of rather more than 7000 men, consists principally of coasting vessels, both ironclad and unarmored.

Constitution.—Sweden is a limited monarchy. Its constitution, like that of England, rests on an historical development of several centuries. From the earliest times the people governed themselves through elected trustees, made laws and levied taxes, while the king was little more than their leader in war. By and by the power of the king was extended, and alongside of it there arose a class of great men, who certainly lessened the legal rights of the lower orders, but who never succeeded in completely subduing them. Through Engelbrecht the burghers and yeomen regained their influence on the development of the state, and their deputies were summoned to the riksdag (1435). Gustavus Vasa and his son Charles IX. stripped the nobility of the high authority they had exercised during the latter part of the mediæval period, and which had been dangerous both to the power of the king and to the people, and so saved the work of Engelbrecht. The right of the lower classes to be members of the riksdag was confirmed by the first "Riksdagsordning" ("law for regulating the riksdag or parliament") of Sweden (1617), which for the first time legally regulated the system of four houses formerly adopted. In the 16th century the nobility, having been endowed with extensive domains by the crown, again won an ascendency that was very dangerous to the lower classes, but it was crushed when Charles XI., by the diminution of their property (1680), forever put an end to the supremacy of the nobility and the council in the state. By this act the power of the king was greatly strengthened, so much so as to endanger even the most essential rights of the riksdag,—those of giving laws and levying taxes. But after the death of Charles XII. the despotic system was abolished, and all power was lodged in the hands of the riksdag by the constitutions of 1719 and 1720. During the following period, which is called "the time of liberty," it was the riksdag that had the function of appointing and dismissing the councillors of state, and by this means was able to dominate the administration so completely as to make the power of the king of little more significance than an empty word. Different political parties defeated each other, and sold their services to foreign states without any regard to the interests of their own country. This state of affairs, which might eventually have proved exceedingly disastrous, was altered by a revolution effected by Gustavus III. (1772), which restored to the king his former power. In the new constitution, however, neither the authority of the king nor that of the people was clearly limited, and this soon led to collisions by which the king succeeded in considerably increasing his ascendency (1789), though he cannot be said to have gained despotic power. Gustavus IV., however, abused his great authority, so that he was dethroned by a revolution. New constitutional laws were now made, in which, guided by the experience of former times, an effort was made clearly to define the respective powers of the king and the representatives of the people, to prevent encroachment from either side. The effort was crowned with success, and the new constitution of June 6, 1809, is still in great measure in force. The old division, however, into four houses has been abolished, and the influence of the representatives of the people has been increased by the new Riksdagsordning of 1866. The other constitutional laws are the "Successionsordning" ("law of succession") of 1810 and the "Tryckfrihetsordning" ("law regulating the liberty of the press") of 1812.

The executive power is vested in the king alone. The legislative power he shares with the riksdag, both parties having the rights of initiative and veto. The king has, besides, a legislative power, not precisely defined, in certain economic matters. The right of levying taxes belongs to the riksdag alone; but the king may in certain cases (as, for example, through his right of lowering the custom duties) exercise a certain influence. He can declare war and make peace, and has the supreme command of the army.

The king is irresponsible, but all his resolutions must be taken in the presence of responsible councillors ("statsråd"). These, who form the council of state, are ten in number, of whom seven are also the heads of departments of the administration (justice, foreign affairs, army, navy, internal affairs, finance, and ecclesiastical affairs, including both church and schools). For the advice they give the councillors of state are responsible to the riksdag, which revises the record of their proceedings through an annually appointed board, which has power also to indict the councillors before a special tribunal, the "riksrätt," formed for the occasion, of which certain high functionaries have to be members. One of the councillors of state is, as prime minister, the head of the administration.

The riksdag meets every year on January 15, and consists of two houses. The members of the first house, one for every 30,000 inhabitants (143 in 1887), are elected by the "landsting" in the counties, or by the municipal councils of the larger towns, for a period of nine years. They receive no payment. Any Swede is eligible who is at least thirty-five years of age, who possesses, and for three years before the election has possessed, real property to the value of 80,000 crowns [$21,600], or who, during the same period, has paid taxes on an annual income of 4000 crowns [$1080]. The members of the second house (one or two for every district of judicature in the country, according as the population exceeds or falls short of 40,000, and one for every 10,000 inhabitants in the towns) receive a salary of 1200 crowns [$324], and are elected for a period of three years by electors, or directly, according to the resolution of the electoral district. If a member retires during that period, his successor is elected for the remainder of the three years, and thus the house is wholly renewed at regular intervals, which is not the case with the first house. The franchise is possessed by every one who owns landed property to the value of 1000 crowns [$270], or who has farmed for at least five years lands worth 6000 crowns [$1620], or pays taxes on an annual income of 800 crowns [$216]. All electors are eligible. The number of electors is about 6.5 per cent. of the population. The towns elect their representatives separately. Both houses have in theory equal power. Before bills are discussed they are prepared by boards, whose members are elected by half of each house. When the houses differ on budget questions, the matter is settled by a common vote of both houses, which arrangement gives the second house a certain advantage from the greater number of its members. By revisers elected annually the riksdag controls the finances of the kingdom, and by an official ("justitieombudsman") elected in the same way the administration of justice is controlled; he can indict any functionary of the state who has abused his power. The bank of the kingdom is superintended by trustees elected by the riksdag, and in the same way the public debt is administered through an office ("Riksgäldskontoret"), the leader of which is appointed by the riksdag.

Administration, Law, and Justice.—The administration consists partly of a centralized civil service, arranged under different departments, partly of local authorities. Each of the twenty-four counties has a governor (landshöfding") who presides over the local offices (the "landskansli," the "landskontor"), and is assisted by subordinate local officers ("kronofogdar," "häradsskrifvare," "länsmän"). There is, moreover, in each county a representation (the "landsting"), elected by the people, that deliberates on the affairs of the county, and has a right to levy taxes. Each county is divided into parishes, which, like the towns, have a very strong communal self-government. The law of Sweden dates from 1736, but it has of course undergone a great many alterations and additions, the most important being the new penal law of 1864. Justice is administered by tribunals of three instances: (1) the "häradsrätter" in the country, consisting of a judge and seven to twelve assessors elected by the people, who, if they are unanimously of an opinion different from that of the judge, can outvote him, and the "rådhusrätter" (boards of magistrates) in the towns; (2) three "hofrätter" (higher courts) in Stockholm, Jönköping, and Christianstad; and (3) the royal supreme court, which passes sentence in the name of the king, and two members of which are present in the council of state when law questions are to be settled; this tribunal has, moreover, to give its opinion upon all proposed changes of the law. A jury is never summoned in Sweden except in cases affecting the liberty of the press.

Union with Norway.—Sweden has been united to Norway since 1814. The union is regulated by the "Riksakt" of 1815, according to which each country is free and independent, though both are governed by the same king. The connections of both countries with foreign states are regulated by the Swedish minister for foreign affairs, but when the king has to settle matters concerning foreign states which also are of importance to Norway a Norwegian councillor of state has to be present. Both countries have the same ambassadors and consuls abroad, and share the expenses of their support, Sweden bearing the larger part of this outlay. In war the two countries are bound to assist each other. Thus the union is what is called a "unio realis." (J. F. N.)

PART II.—HISTORY.

From the earliest times of which we have any authentic information there were in Sweden two more or less distinct peoples,—the Göta or Goths in the south, and the Svea or Swedes in the north. They spoke similar languages, were of the same Teutonic stock, and had like customs, institutions, and religious beliefs; but these facts did not prevent them from regarding one another with jealousy and dislike. The most powerful king among these peoples was the king at Upsala. There were other chiefs or kings, called in later times smaa-kongar, but they recognized the superiority of the Upsala king, whose peculiar position was due to the fact that there was at Upsala a great temple of Wodan, which was held in equal reverence by the Swedes and the Goths. Upsala was in the territory of the Swedes, and we can account for the feeling of the Goths with regard to it only by supposing that they were an offshoot from the Swedes, and that the worship of Wodan was in some special way associated with Upsala before the separation took place. Of the two peoples, the Goths seem to have been most active and open to new ideas. They spread along the southern coasts of Sweden and among the islands of the Baltic, and there can be little doubt that the Goths in Germany and Russia, who played so great a part in the disruption of the Roman empire, sprang from the Swedish Goths.

Slavery was not unknown in ancient Sweden, but it did not form an important element in social life. The vast majority of the people were free. They were divided into two classes, jarls and bondar, corresponding to the Anglo-Saxon eorls and ceorls. The bondar were the landed freemen, while the jarls were of noble blood. In some remote age the land may have been held in common by village communities, but in historic times there has always been in Sweden private property in land as well as in movable,—the jarls having wider lands than the bondar, and some bondar being better off than other members of their class. The kings were treated with much respect, for they belonged to families which were believed to be descended from the gods; but their power was far from being absolute. When a king died, his authority did not necessarily pass to one of his sons; the freemen chose as his successor the member of the royal family who seemed to them best fitted for the duties of the office. The king's power was limited not only by the fact that he was elected but by the rights of the freemen in all matters concerning life and land. At regular times moots were held for legal, legislative, and political purposes; and without the sanction of the Great Thing, as the tribal assembly was called, no law was valid and no judgment good.

Besides the Great Thing, of which all freemen were members, there were local things, each attended by the freemen of the district to which it belonged. The chief function of these local assemblies was to settle disputes between freemen, their decisions being given in accordance with rules based on ancient customs. Very often their judgments could not be enforced; and here, as in other Teutonic lands, the impotence of the local popular courts was one of the causes which led to the growth of the king's authority. He was bound to go round his land in regular progress, doing and enforcing justice among his subjects; and in course of time men felt more and more strongly that the best way of obtaining redress for serious grievances was to appeal directly to him.

As far back as we can go in Swedish history we find that the principal aim of the Upsala kings was to get rid of the smaa-kongar, and to put royal officers in their place. These officers ruled in the king's name in association with the local things, but their tendency, especially in times of great civil commotion, was to make themselves as independent as possible. The king himself was always attended by some of the leading magnates, who formed a sort of council of state, and with their aid he prepared the plans which were afterwards submitted to the Great Thing. Although the Great Thing never ceased to be in theory an assembly of the nation, it gradually lost its primitive character, the political rights of the common freemen being usurped by the nobles, who sought also to hamper the exercise of the royal authority.

According to the *Ynglinga Saga*, in which bits of old Swedish legends are preserved, the first Upsala kings were Ynglingar, sprung from Yngve Frey, the grandson of Wodan. We are told that the last representative of this dynasty was Ingjald Illrede, that he slew six of the smaa-kongar, and that he afterwards killed himself when he heard that the son of one of the murdered chiefs was advancing against him. It is said that the Ynglingar were succeeded by the Skioldungar, who claimed to be descended from Skiold, Wodan's son; and the traditional account is that this line began with Ivar Widfadme, and that he not only became king at Upsala but conquered Denmark, a part of Saxony, and the fifth part of England. Another of the Skioldungar, Eric Edmundsson, is said to have been an even greater king than the founder of the dynasty. During this legendary period, kings in Sweden were often at war with kings in Norway and Denmark, and Swedish adventurers undertook many warlike enterprises against the Finns and the Wends. While Danes and Norwegians were founding states in the British Islands and France, the Swedes were accomplishing like results on the eastern shores of the Baltic.

At this early period Sweden did not take in all the territory which now belongs to it. Scania, one of the most fruitful and prosperous districts of modern Sweden, had been from time immemorial an independent and comparatively powerful Gothic state. In the 9th century it was annexed to Denmark by King Guthrun; and, although in later times it was often a subject of bitter dispute between Denmark and Sweden, its connection with the former country was not finally severed until the 17th century. Lund, the principal town in Scania, was for many generations the see of the primate of the Danish church.

The scattered notices of Adam of Bremen, Saxo, and certain saints' lives, with a few allusions elsewhere, are our direct written sources for this early period. They may be eked out by study of the laws and of local nomenclature. Later the rich runic remains of Sweden give us some fuller help. After the end of the 10th century the evidence gradually becomes clearer and more trustworthy. There was then at Upsala a powerful king called Eric the Victory-Blest. He defeated a band of vikings in a great battle at Fyrisval, and, according to Adam of Bremen, had for some time complete control over Denmark. He was succeeded in 993 by his son Olaf (993–1024), who was called the Lap-King because he was a child when his reign began. Olaf was baptized about the year 1000, and was the first Christian king of the Swedes. In the 9th century St. Ansgar had labored for some time as a missionary in Sweden, but without much success. Even Olaf, who was supported in his efforts by Siegfred, the devoted English missionary from whom he had received instruction in Christian doctrine, found that it was impossible to convert the majority of his subjects. He was allowed to build churches in West Gothland, but in the rest of his dominions the people clung obstinately to paganism. During his reign there was war between Sweden and Norway, and Olaf seems to have been in favor of carrying on the struggle with vigor. His people, however, desired peace, and it is related that at the Great Thing at Upsala they threatened to take his life if he did not give Olaf, the Norwegian king, his daughter in marriage. He consented to do as they wished, but broke his promise; and he would probably have been set aside had it not been for the mutual jealousy of the Swedes and the Goths.

Olaf.

The Lap-King was succeeded, one after the other, by his sons Anund and Edmund the Elder; and under their rule the church lost much of the ground which it had gained through the efforts of Olaf. After Edmund the Elder's death the Goths resolved that Stenkil, the Christian jarl of West Gothland, should be made king. This decision was resisted by the Swedes, but the result of the civil war which broke out was that Stenkil was able to maintain his claim. He reigned from 1056 to 1066, and effectually protected the church without attempting to do violence to the convictions of the pagan population. His reign was followed by a period of much confusion, during which the Goths and the Swedes treated each other as enemies,—the latter upholding paganism, the former contending for Christianity. Under Inge the Elder, who reigned from 1080 to 1112, the temple at Upsala was burned, and from this time there could be no doubt as to the ultimate triumph of the church, which was served with heroic courage by many zealous foreign missionaries. So much progress was made that Swerker Karlsson, who reigned from about 1135 to 1155, begged the pope to give the Swedish people bishops and a primate. Nicholas Breakspear, the English cardinal who was afterwards raised to the papacy as Adrian IV., was sent to make the necessary arrangements. He found that the Swedes and the Goths could not agree as to a place for the see of a primate; but at a synod which met at Linköping in 1152 it was decided that the Swedish clergy should accept the law of celibacy, and that Sweden should pay a yearly tax to the pope. For a long time many pagan ideas and customs survived, but Sweden was now, at least nominally, a Christian country.

Eric Edwardsson.

When Swerker was murdered in 1155 the Goths wished to make his son king, but the Swedes chose Eric Edwardsson, and he reigned until 1160. Eric was so good a king that after his death he was canonized by the popular voice, as was then the way in the north. Upsala was made by him a primate's see, and he began the series of efforts which led to the annexation of Finland to Sweden. Finnish pirates had often desolated the Swedish coasts, and it had become absolutely necessary that their country should be subdued. Eric not only overcame the Finns, but did what he could to compel them to accept Christianity.

For about a century after Eric's death the Goths and the Swedes were almost constantly at war with one another, each people choosing its own king. The Goths preferred the descendants of Swerker, while the Swedes were loyal to the descendants of Eric, who were known as the yeomen-kings, because Eric had originally belonged to the class of bondar or yeomen. The Danish kings often aided one or other of the contending parties, and as a rule they seem to have done far more harm than good by their interference. To some extent the church maintained among the people a sense of national unity, but it was not powerful enough to give much protection to the poorer members of the community against the despotism of local magnates. In the end, when the church itself became rich, the higher clergy were quite as tyrannical as the secular nobles.

Waldemar.

John Swerkerson, the last king of the Swerker dynasty, died in 1222; Eric the Halt, the last of the yeomen-kings, in 1250. In the latter year the crown was given to Waldemar, whose mother was a sister of King Eric the Halt. Waldemar belonged to the Folkungar family, which had acquired great estates and risen to a position of high importance in the state. Under this dynasty the Goths and the Swedes gradually ceased to be jealous of one another, and became a thoroughly united people. From this time civil troubles in Sweden sprang, not from the antagonism of rival peoples, but chiefly from the increasing power of the great landowners, who strove incessantly to limit the rights of the free peasantry, and were often strong enough to defy the crown.

Magnus.

At the time of the death of Eric the Halt, Birger Brosa, Waldemar's father, was in Finland, where he conquered Tavastland and strengthened the hold of the Swedish crown over those tribes which had been already subdued. On his return to Sweden he was indignant to find that he had not himself been elected to the throne. He accepted what had been done, however, and devoted his energies to the promotion of his son's interests. Until his death Birger was the real ruler of Sweden, and the nation had never been governed by a man of stronger will or more upright character. If he did not actually found Stockholm, it was he who made it the strongest fortress in the country,—a service for which the Swedish people had good reason to be grateful to him, for it enabled them to put an end to the depredations of Finnish pirates. After the death of Birger great evils were brought upon the country by the folly and incompetence of Waldemar, who was at last driven from the throne and imprisoned by his brother Magnus, who succeeded him. Magnus (1279–1290) was a lover of pomp and splendor, and formed a more brilliant court than the Swedes had ever seen. He granted immunity from taxation to those landowners who should give the crown *ross-djenst* or horse-service, that is, serve the king in war at the head of a body of horsemen. His intention in adopting this plan was to secure for the crown a powerful body of loyal and attached supporters, but as the measure added to the wealth, dignity, and influence of the nobles, its ultimate effect was to weaken the royal authority. Although he increased the importance of the aristocracy, Magnus was not unmindful of the interests of the common freemen. He is known as Ladu-laas or Barn-Lock, because he issued a law requiring persons of noble birth to pay for the straw and corn with which, when travelling, they might be supplied by peasants. Magnus was also a munificent benefactor of the clergy. He endowed a large number of churches and built five monasteries.

Birger.

Magnus.

Magnus was succeeded by his son Birger (1290–1319). Birger was only nine years old when his father died, and for a long time the power of the crown was wielded by his guardian, Torkel Knutsson, a wise and vigorous statesman. Knutsson drew up a code of laws which was accepted by the Great Thing in 1295; and in Finland he not only put down rebellion but annexed Savolax and Carelia. In 1306, misled by his brothers Eric and Waldemar, Birger caused this faithful and able counsellor to be beheaded, and the result was civil war, in which the weak king found it hard to make way against his restless and ambitious brothers. At last he got them into his power by treachery, and threw them into a dungeon of the castle of Nyköping, where they died of starvation. Soon afterwards Birger himself died, despised and hated by his subjects. He was succeeded by his nephew Magnus, his brother Eric's son, a child of about three years of age. Magnus's guardian, Mats Ketilmundsson, was a man of strong and noble character, and as long as his supremacy lasted the Swedish people were more prosperous than they had ever been before. Taking advantage of the troubled condition of Denmark, he joined Scania and the neighboring districts of Halland and Blekinge to the Swedish kingdom; and had his prudent system of government been maintained these provinces might have been kept, for the inhabitants seem to have preferred Swedish to Danish rule. But, when he died, in 1336, the king fell under the influence of unworthy favorites. Scania, Halland, and Blekinge were restored to Denmark, and Sweden was soon in a state of the greatest confusion. In 1363 a number of nobles who had given Magnus much trouble, and whom he had expelled from the country, went to his sister's son Albert, count of Mecklenburg, and offered him the crown. The offer was accepted, and afterwards Albert was formally elected by the Great Thing. Magnus resisted, but was defeated and made prisoner in a battle at Enköping in 1365. In 1371 he was released, and the rest of his days he spent in Norway, where he was not unpopular. From his mother he had inherited the Norwegian crown, but before the misfortunes of his later years it had been transferred to his son Haco.

Albert.

The nobles and the hierarchy of Sweden were now so powerful that only a king of the highest political genius could have hoped to control them. Albert of Mecklenburg proved to be utterly unfit for the task he had undertaken. He tried to protect himself by giving many of the great offices of state to Germans, but he was warned that he would be dethroned if he continued to show so much favor to foreigners. In 1371 he accepted as his chief counsellor a great Swedish noble called Bo Jonsson, to whom about a third of the kingdom is said to have belonged. Bo Jonsson gave much more heed to his own interests than to those of his country, and did hardly anything to mitigate the hardships inflicted on the common people at this time by the turbulence of the well-off classes. After Bo Jonsson's death Albert attempted to regain some of the authority which he had been forced to delegate to his powerful minister; but the nobles refused to obey him, and invited Margaret of Denmark and Norway to take his place.

Margaret.

Margaret, one of the most remarkable figures in Scandinavian history, was the daughter of Waldemar IV. of Denmark, and at an early age she had become the wife of Haco of Norway, son of the Swedish king whom Albert had supplanted. The offspring of this marriage was an only son, Olaf, who succeeded his grandfather in Denmark in 1375 and his father in Norway in 1380. Both countries were ruled firmly and wisely by Margaret in her son's name; and after his death in 1387 the Danes and the Norwegians begged her to retain supreme power. To this request she assented; and, when the Swedish nobles asked her to undertake the government of Sweden also, she at once expressed her willingness to attack Albert, who had irritated her by claiming the Danish crown. An army was soon despatched to Sweden, and in 1389 Albert was defeated and taken prisoner at Falköping. Stockholm, which was held by German mercenaries, refused to admit the conqueror, and for several years it was besieged without success by Danish troops. At last the difficulty had to be settled by negotiation. In 1395 it was arranged that Albert should be set at liberty on condition that within three years he should pay a ransom of 60,000 marks [Hamburg marks, $17,430]. If at the end of that period the money was not paid, he was either to give up Stockholm or to return to captivity. The result was that in 1398 Stockholm was surrendered by the Hanseatic League, which had become security for the fulfilment of Albert's engagement.

Meanwhile Margaret had persuaded the Danes, the Norwegians, and the Swedes to accept her grand-nephew Eric of Pomerania as her successor, and in 1397 he was crowned at Calmar. Margaret was eager that the union of the Scandinavian countries under a single sovereign should be made permanent, and delegates from the councils of state of the three kingdoms met at Calmar to discuss her proposals. On the 20th of July, 1397, these delegates concluded what was called the union of Calmar. Sweden, Norway, and Denmark, while retaining their local laws and customs, were in all future time to be ruled by one king. When a king died he was to be succeeded by his eldest son; but if he was childless his successor was to be freely elected. In foreign affairs Scandinavia was always to act as a united country. Margaret had excellent intentions in devising this bold scheme, but the time was not ripe for so vast a change. It was inevitable that when popular movements were no longer held in check by her strong will, formidable difficulties should spring from the jealousies of the three nationalities.

Eric XIII.

Even after Eric's coronation Margaret remained the real sovereign, and she was powerful enough to make the union something more than a mere name. But even during her lifetime the Swedish people showed that they resented the idea of being taxed for objects in which they were only indirectly interested, and when she died (in 1412) it soon became evident that Eric would be unable to retain their allegiance. In 1386 Margaret had formally recognized the claim of Gerhard VI., count of Holstein, to be feudal lord of the duchy of Schleswig. Gerhard died in 1404, leaving three young sons. Margaret and Eric then tried to recover the rights of the Danish crown in the duchy; and in 1413, soon after Margaret's death, Eric caused Schleswig to be declared a forfeited fief. The result was a war which lasted about twenty years. The Swedes had to bear heavy burdens to enable Eric to carry on the conflict, and he made no attempt to allay their discontent. He seldom visited their country, and his officers often treated them with reckless cruelty. In the province of Dalecarlia the royal bailiff acted so tyrannically that in 1434 the people rebelled. They were led by a brave and patriotic miner, Engelbrecht Engelbrechtsson, and under his influence the movement spread rapidly among the peasantry of other districts. The Swedish council of state, alarmed by the enthusiasm he had excited, agreed in 1436 to declare the king deposed. The nobles were more afraid of the peasants than of Eric, and soon placed him on the throne again; but he never fully recovered his authority. He was obliged to make Charles Knutsson his viceroy in Sweden; and Knutsson was as anxious as Engelbrechtsson that Swedish independence should be restored. The two patriotic leaders became jealous of one another, and Engelbrechtsson was murdered by a member of Knutsson's party. But the popular agitation lost none of its original force, and in 1439 Eric was dethroned by all his kingdoms. He fled to the island of Gotland, where he lived for some years by piracy; and afterwards he was compelled to seek for refuge in Pomerania.

Christopher.

Christopher of Bavaria, Eric's nephew, was elected to the Danish throne, and he was soon acknowledged also in Norway and Sweden. He was a man of good intentions, but was not strong enough to overcome the prejudice created against him by the fact of his being a foreigner. When he died in 1448 the Danes chose Christian, count of Oldenburg, as his successor, and the Norwegians by and by followed their example. Had the decision in Sweden rested only with the nobles and the clergy, Christian would at once have received the Swedish crown, for under the nominal rule of a foreign king these classes were able to tyrannize as they pleased over their poorer neighbors. But the Swedish people generally so strongly disliked the union, and stood so urgently in need of the protection of a native sovereign, that Charles Knutsson was made king.

Charles VIII.

He mounted the throne as Charles VIII. The aristocracy, both spiritual and temporal, detested him; and in 1457 he found in Archbishop Jöns Bengtsson so formidable an enemy that he had to make his escape to Dantzic. Christian I. of Denmark and Norway then became king of Sweden, but he was unable to assert supremacy over the country as a whole, and in 1464 Charles VIII. again secured the throne. In the following year Charles was displaced a second time, but soon afterwards he was recalled, and he retained the crown until his death in 1470.

Sten Sture regent.

Charles was succeeded, not as king but as regent, by his nephew Sten Sture, under whose firm rule Sweden became prosperous and contented. Sten Sture was a far-seeing statesman, and sided resolutely with the peasants against the nobles. He took great pains also to promote the intellectual culture of the people. The university of Upsala was founded by him, and he introduced into Sweden the art of printing, and invited to the country many foreign scholars. He was not able wholly to destroy the union, for in 1496 he was defeated by King Hans of Denmark and Norway, who afterwards received the Swedish crown. Nevertheless Sten Sture remained the real master of Sweden, and after the defeat of the Danes by the Ditmarshers in 1500 his power was almost absolute. He died in 1503, when his authority passed to his nephew Svante Nilsson Sture, whom King Hans and the Swedish clergy and nobles in vain attempted to put down. Svante Nilsson Sture was succeeded by his son, Sten Sture the younger in 1512, and for some time this brave and patriotic regent vigorously held his own both against his enemies at home and against Christian II., king of Denmark and Norway. In 1520, however, he was mortally wounded in a battle with the Danes at Bogesund, after which Christian II. became king of Sweden.

Christian II.

This sovereign had some enlightened ideas, but he was a man of ferocious passions, and he had no sooner restored the union than he made the maintenance of it impossible by an act of almost unparalleled cruelty. Under the pretence of upholding the honor of the church he ordered at Stockholm the execution of ninety persons accused of having taken part in the deposition of his friend and supporter Archbishop Gustavus Trolle, who had been the late regent's bitterest enemy. Most of the condemned men were nobles, and Christian hoped that by killing them he would secure the allegiance of the peasantry. The whole Swedish nation, however, was shocked by so horrible a massacre, and resolved to shake off forever the hated Danish yoke.

The movement for national independence was headed by Gustavus Ericsson, known afterwards as Gustavus Vasa. This young noble had been one of a group of Swedish hostages whom Christian II. had sent to Denmark, treating them as if they had been prisoners of war. In 1519 he escaped from prison, and after a short stay in Lübeck found his way to Dalecarlia, where he went about in disguise among the peasantry, urging them to combine against the common enemy. At first they were afraid to act with him, but their hesitation vanished when they heard of the blood-bath in Stockholm,—a crime by which Gustavus himself was more than ever embittered against the Danes, for his father was one of Christian II.'s victims. A force raised by Archbishop Trolle having been defeated, Gustavus led his troops beyond the limits of Dalecarlia and took Vesterås and Upsala, and laid siege to Stockholm and Calmar. These fortresses were bravely defended, but in 1523, with the help of a fleet sent to him by Lübeck, he succeeded in capturing them. In 1521 he had been declared regent, and in 1523, before the conquest of Stockholm and Calmar, he summoned at Strengnås a diet which elected him to the throne. Soon afterwards he made himself master of Finland, and he annexed Scania, Halland, and Blekinge. The union had now been brought to an end, and from this time Sweden was always ruled by her own kings. Denmark and Norway, however remained subject to one crown until the beginning of the 19th century.

Gustavus Vasa.

Gustavus Vasa was by far the greatest sovereign who had up to this time ruled the Swedish people. Before he was made king the doctrines of Luther had been proclaimed in Sweden by the brothers Olaus and Laurentius Petri; and Gustavus, who listened attentively to their teaching, became one of the most enthusiastic adherents of the Reformation. He acted cautiously, however, and resolutely opposed violent agitators. The majority of the Swedes cordially accepted the new doctrines, and at a diet held at Westerås in 1527 Gustavus received authority to reorganize the church. This he did thoroughly, making it clear from the beginning that Protestant pastors would never be permitted to wield the power which the Roman priesthood had so often abused. The greater part of the vast estates which had belonged to the Roman clergy he confiscated and applied to the uses of the state. In his secular policy he was as bold and successful as in his dealings with the church. For centuries the independence and arrogance of the great nobles had been the curse of the Swedish people. Gustavus missed no opportunity of limiting their influence. He compelled them to bear their fair share of the public burdens, and secured for himself faithful allies by obtaining for burghers and the peasantry, who had lost almost all their political influence, a recognized place in the diet, which was now summoned more frequently and regularly than it had been for several generations. Gustavus did everything he could to encourage industry. For six years he fought with Lübeck in order to break the supremacy of the Hanseatic League, and he concluded treaties of commerce with England and the Netherlands. So many changes were effected in Sweden in his time that several conspiracies were formed against him, but he had little difficulty in overcoming his enemies, for he had the confidence and affection of the great mass of his subjects. In 1544 it was decided by the diet that the Swedish throne should cease to be elective, and that it should be hereditary in the family of Gustavus.

Eric XIV.

When Gustavus died in 1560, his eldest son Eric became king. Eric was foolish enough to go to war with Frederick II. of Denmark for no better reason than that the latter, like Eric himself, claimed the right to put three crowns in his coat-of-arms. This war, which lasted seven years, caused much suffering to both nations. The Danes were generally beaten at sea, but under the leadership of the stout soldier Daniel Rantzau they gained important victories on land. Intellectually Eric was one of the most cultivated of Swedish kings, but in action he was so headstrong and wayward that most people believed him to be insane. He wasted the treasure amassed by his father, and under the influence of passion and suspicion caused the death of many powerful and loyal subjects. In 1568 his brothers John and Charles rebelled against him. His favorite, Göran Persson, who was accused of having constantly misled him, was seized and executed, and Eric himself was obliged to surrender. He was deprived of the crown and kept in close confinement until 1577, when he was murdered.

John III.

John mounted the throne as John III. (1568–1592). In 1570 the war between Sweden and Denmark was brought to an end by the peace of Stettin. Sweden obtained some advantages by this treaty, but she had to resign to Denmark her claims to the island of Gotland, and to Scania, Halland, and Blekinge. Through the influence of his first wife Catherine, sister of King Sigismund II. of Poland, John had become a Catholic; and as king he labored to restore as far as possible the old religious forms. His efforts were bitterly resented by the Protestants, while at Rome he was condemned for not acting with sufficient decision in the interest of his church. He was succeeded by his son Sigismund, who had been elected king of Poland in 1587. In the interval between John's death and Sigismund's arrival in Sweden supreme power was exercised by Duke Charles, Sigismund's uncle. Charles, the ablest of all the sons of Gustavus Vasa, resolved to take advantage of the opportunity to place the ecclesiastical system of the country on a satisfactory basis. Accordingly a great assembly was summoned at Upsala in 1593, and by this assembly it was decreed that the Augsburg confession of faith should be accepted as the authoritative statement of the theological doctrines of the Swedish church. The decision was of vast importance, and the Swedes have ever since looked back upon it as one that marked an era in their national history.

Sigismund.

Before his coronation in 1594 Sigismund undertook to protect the rights of his Protestant subjects; but, being an ardent Catholic, he soon began to work for the triumph of his own creed. On his return to Poland the discontent he had excited in Sweden found free expression, and he was obliged to place the administration of affairs in the hands of his uncle, Duke Charles. In the time of King John a dispute about frontiers had led to war between Sweden and Russia, and this war was still going on when Charles undertook his new duties. In 1595 he concluded peace, securing for Sweden the provinces of Esthonia and Narva, but yielding to Russia some districts on the borders of Finland. These districts were held by Klas Fleming, an enthusiastic adherent of King Sigismund, and he declined to give them up, nor were they surrendered until the death of this general in 1597. Meanwhile Charles had found that some members of the council of state were bent on thwarting all his schemes, and from them he appealed to the diet. The diet heartily supported him, and appointed him governor-general of Sweden; whereupon he set to work in earnest to put down Catholic intriguers, and to promote the interests of the peasantry in opposition to those of the great nobles. In 1598 Sigismund advanced against him with a Polish army, and was defeated at Stångebro, near Linköping. The war went on for some time, but Sigismund himself returned to Poland. In 1600 the diet demanded that he should reside in Sweden or send his son to be educated as a Protestant. No answer being returned to these demands, Sigismund was dethroned, and his heirs were deprived of the right of succession. Duke Charles was then made king, and reigned as Charles IX. Sigismund continued to regard himself as the lawful sovereign, and as the same pretension was made by his descendants, a very bitter feeling sprang up between Sweden and Poland,—a feeling which led to many wars during the next sixty years.

Charles IX.

Charles IX. (1600–1611) carried on with splendid vigor the work which had been begun by his father

Gustavus Vasa. Under his rule Sweden became a thoroughly Protestant country, and for the first time associated herself to some extent with the general Protestant movement in other lands. Charles watched with especial interest the action of religious parties in Germany, and carefully maintained good relations with the leading German Protestant princes. At home one of his principal aims was to force the aristocracy to be subservient to the crown, and he succeeded as no Swedish king had done before him. For burghers and the peasantry he secured in the diet a more important and more clearly defined place than had formerly belonged to them, and he devised many sagacious measures for the material welfare of his people. He devoted much attention to the development of mining industries, and by the founding of convenient seaports he gave a great impetus to trade. In foreign relations he was not less masterful than in his management of domestic affairs. In 1609 he sent an army into Russia to oppose the false Demetrius, whose pretensions to the Russian throne were supported by Poland. The Swedish generals, after having achieved some success, were obliged to retreat in consequence of a mutiny among their troops; but Charles despatched a fresh force, which did its work so well that the Russians came to terms, and even promised to accept his younger son, Charles Philip, as czar. In the last year of his life Charles was engaged in a war with Christian IV. of Denmark, who invaded Sweden because Charles claimed to be king of the Norwegian Laplanders and sought to exclude the Danes from the extensive trade with Riga. Calmar, notwithstanding the strenuous exertions of Charles, was captured by the Danes, and from this circumstance the struggle came to be known as the Calmar War.

Gustavus Adolphus.

Charles IX. was succeeded by his son Gustavus Adolphus (1611–1632), the most illustrious of the kings of Sweden. He was only seventeen years of age when he became king, but he had already given evidence of high intellectual and moral qualities. One of his first public acts was to appoint as chancellor the youngest of his counsellors, Axel Oxenstjerna, a great statesman whose name is intimately associated with all the most prominent events of his reign. By mingled gentleness and firmness Gustavus won almost immediately the goodwill of his subjects, and before he was many years on the throne he became the object of their most enthusiastic devotion. He showed unfailing respect for the rights of the diet, improved its organization, and summoned it regularly once a year. Industry and trade flourished under his wise rule, and he did much to develop the educational system of Sweden by giving splendid endowments to the university of Upsala and by founding the university of Dorpat and many schools and colleges. He introduced into the army a rigid system of discipline, yet he was adored by his soldiers, who had perfect faith in his military genius and were touched by his care for their welfare and by the cheerfulness with which, when necessary, he shared their hardships.

The war with Denmark which had been begun in his father's time he was obliged to continue, but he did so very unwillingly, and as soon as possible (in 1613) he signed a treaty of peace, by which, in return for the payment of a million thalers [$1,102,000] Sweden received back all the territory that had been conquered by the Danes. Having no further cause of anxiety in this direction, he prosecuted with renewed vigor the war with the Russians, who had not kept their promise to recognize Prince Charles Philip as czar. The Swedish general, Count de la Gardie, had gained many advantages in the struggle, and when Gustavus himself took part in it the Swedes were so successful that in 1617 the czar Michael was glad to conclude the peace of Stolbova, giving up Kexholm, Carelia, and Ingermanland, and confirming Sweden in the possession of Esthonia and Livonia. The next task of Gustavus was to subdue Sigismund of Poland, who had formally renewed his claim to the crown of Sweden after Charles IX.'s death, and had proved himself one of the most troublesome of the young Swedish king's enemies. In 1621 Gustavus took the field against him, and achieved a series of brilliant successes, which were interrupted only when, in 1629, Austria sent to the aid of Poland a force of 10,000 men under Arnheim.

Meanwhile the Thirty Years' War, begun in 1618, had been raging in Germany. Christian IV. of Denmark, who had intervened on behalf of the Protestants, had been forced to lay down his arms; and it seemed in the highest degree probable that the Catholic reaction, headed by the fanatical emperor Ferdinand II., was about to be completely triumphant. Gustavus, like his father and grandfather, was an enthusiastic Protestant, and he had watched with grief and dismay the misfortunes of those who were struggling for the right of free judgment in religion. At last he resolved to give them the support they so urgently needed, and, in order that he might without unnecessary delay act upon his decision, he arranged with Poland in 1629 that there should be an armistice for six years. He then began to make preparations for his great enterprise, and in 1630 he embarked for Germany with an army of 15,000 men. In undertaking this splendid task he was not influenced only by religious motives. He wished to punish the Austrians for having helped the Poles; he hoped to find an opportunity of adding to Swedish territory; and there are reasons for supposing that he dreamed of snatching the imperial crown from the Hapsburg dynasty and placing it on his own head. But all the evidence we possess goes to show that these objects were subordinate. His principal aim was to save Protestantism in Germany from extinction.

He had many unexpected difficulties to contend with, for he was distrusted by most of the German Protestant princes. Very soon, however, his tact and courage enabled him to overcome every obstacle, and at Breitenfeld he gained a decisive victory over the imperial general Tilly. After this great success the confidence of the German Protestants revived, and Gustavus was everywhere received as their deliverer. Tilly tried to prevent him from crossing the Lech, but was again defeated; and the Swedish king took possession of Munich, having already held court at Frankfort. For some time the destinies of the empire appeared to be at his disposal, but all the hopes excited by his heroic career were suddenly cut short by his death in the battle of Lützen in 1632.

Christina.

Gustavus was succeeded by his daughter Christina, whom, before his departure for Germany, he had presented to the diet as heiress to the crown. During her minority Sweden was governed by five nobles whom the diet appointed to be her guardians, the foremost place being given to Axel Oxenstjerna. They continued the foreign policy of Gustavus, maintaining in Germany a powerful army, which, although no longer uniformly successful, gained many victories over the imperial forces. Christina, carefully educated in accordance with instructions left by her father, became one of the most cultivated women of the 17th century; and at an early age she astonished her guardians by the vigor of her understanding. In 1644, on her eighteenth birthday, she assumed supreme power, and for some time she fulfilled all the expectations which had been formed as to her reign. In 1645 she brought to an end a war with Denmark which had been begun two years before. The Danes had been repeatedly defeated, and by the treaty of Brömsebro they resigned to Sweden Jemtland and Harjeaadalen along with the islands of Gotland and Oesel, and gave up Halland for a period of twenty-five years. Contrary to the advice of Oxenstjerna, Christina pressed for the conclusion of peace in Germany, and, when her object was attained, the Swedes had no reason to be dissatisfied with the result. By the peace of Westphalia, concluded in 1648, Sweden obtained the duchies of Bremen, Verden, and Western Pomerania, a part of Eastern Pomerania and Wismar. Moreover, Sweden was recognized as a state of the empire.

Charles X.

The Swedish people were anxious that Christina should marry, but she declined to sacrifice her independence. In 1649, however, she persuaded the diet to accept as her successor the best of her suitors, her cousin Charles Gustavus of Pfalz-Zweibrücken, the son of the only sister of Gustavus Adolphus. In the following year she was crowned with great pomp. About this time her character seemed to undergo a remarkable change. She became wayward and restless, neglected her tried counsellors, and followed the advice of self-seeking favorites. So much discontent was aroused by her extravagance and fickleness that she at last announced her determination to abdicate, and she abandoned her purpose only in deference to Oxenstjerna's entreaties. She now devoted herself to her duties with renewed ardor, and made her court famous by inviting to it Descartes, Grotius, Salmasius, and other scholars and philosophers. But she had soon to encounter fresh difficulties. During the Thirty Years' War the influence of the nobles had been greatly increased, partly in consequence of their position in the army, partly through the wealth they acquired in Germany. They made as usual so bad a use of their power that an agitation which seemed likely to have most serious consequences sprang up against them among the peasants, the burghers, and the clergy. Unable to bring order out of the prevailing confusion, and longing for repose, Christina finally resolved to resign the crown; and in 1654 she formally laid the royal insignia before the diet in order that they might be transferred to Charles Gustavus, who forthwith became king as Charles X. Christina immediately left the country, and did not return to it for many years. She ultimately made some attempts to recover the crown, as well as to be elected queen of Poland, but her efforts were not successful. She joined the Roman Church, and there was much talk at all the courts in Europe about the eccentricities of her character and about her passionate love of art and learning.

Charles X. (1654–1660) devoted his energies chiefly to war, in which he was brilliantly successful. He began his military career by attacking Poland, whose king claimed to be the true heir to the Swedish crown. In a great battle at Warsaw Charles destroyed the Polish army, and Poland would probably soon have been absolutely at his mercy but for the intervention of Russia, which sought to weaken him by invading Esthonia and Livonia. While the war with Poland and Russia was in progress, Charles became involved in a struggle with Denmark, and he conducted it so vigorously and skilfully that the Danes, by the peace of Roeskilde, signed in 1658, gave up Scania, Halland, Blekinge, and various other territories. War with Denmark was several times renewed, and at the time of his death Charles was engaged in making extensive preparations for a fresh onslaught.

Charles XI.

He was succeeded by his son Charles XI., a child of four years of age. During the minority of Charles XI. the government was carried on by his mother Hedwig Eleonore and by the chancellor De la Gardie and four other ministers. In 1660 they concluded with Poland the peace of Oliva, whereby Sweden received the whole of Livonia as far as the Düna. Soon afterwards peace was also concluded with Denmark and Russia, the former receiving back Drontheim and Bornholm, which had been taken by Charles X. Sweden, however, kept Scania, Halland, and Blekinge, which were now finally severed from the Danish monarchy. In 1672 Charles XI. himself assumed the direction of affairs. For some time he seemed to take little interest in public business, and in 1674 he was rash enough to send an army into Germany to aid Louis XIV. in his war with the United Provinces and their allies. The Swedes were defeated at Fehrbellin by the elector of Brandenburg, who at once followed up his victory by taking possession of Pomerania. Christian V. of Denmark, thinking he had now a good opportunity of recovering Scania, joined the enemies of France and Sweden, and at sea the Danes gained several great victories over the Swedes. Charles XI., aroused by these disasters, began to show the real vigor of his character. He placed himself at the head of his army, and in several battles so decisively defeated the Danes that they were driven from Scania, the greater part of which they had occupied. When peace was made in 1679, Sweden had to give up to Brandenburg a part of Pomerania, but she sustained no other losses.

At this time the finances of Sweden were in utter confusion, and the revenue was not nearly large enough to cover the necessary expenditure. So many of the crown lands had from time to time been given away to nobles that the administration could not be carried on without a system of crushing taxation. The common people, unable to bear the burdens imposed upon them, had often insisted that these lands should be taken back. Charles XI. became convinced that there was no other way out of his difficulties, and in 1680, with the sanction of the diet, he ordered that the fourth part of all the crown lands which had been given away during the previous thirty years should be restored. This, however, was only the beginning of the so-called process of reduction, which was soon extended and carried out with ruthless severity. By this measure some of the foremost families in Sweden were ruined, and the crown was made almost independent of the diet, for it recovered no fewer than ten counties, seventy baronies, and many smaller estates. Charles became virtually an absolute sovereign, and on the whole he made an excellent use of his power. For more than a century Sweden had been almost constantly engaged in war. She now enjoyed a period of repose, and profited greatly by the king's vigorous administration. He built fortresses, reorganized the army and navy, and carried on many important public works in the interests of commerce. He also founded the university of Lund, and made larger provision for popular education, frequently impressing upon the clergy the duty of attending to the intellectual needs of their parishioners. His comparatively early death was lamented by the great majority of the people, who were grateful for the steady determination with which he applied himself to the duties of his office.

Charles XII.

Charles XI. was succeeded by his son Charles XII. (1697–1718), the most brilliant although not the greatest figure in Swedish history. He was a youth of fifteen when his father died, and he was so enthusiastically devoted to sport and all kinds of physical exercise that he seemed to be utterly destitute of political ambition. Accordingly Augustus II. of Poland and Saxony, Peter I. of Russia, and Frederick IV. of Denmark, thinking the time had come for the recovery of the possessions taken from their predecessors by Sweden, formed an alliance against him, and they appear to have had no doubt that he would be easily overcome. Charles XII., however, was in reality a man of extraordinary vigor and daring, and he soon convinced his enemies that they would find in him a formidable opponent. In 1700 he began what is known as the Northern War by suddenly advancing against Copenhagen, which he was about to besiege when Frederick, alarmed by the overwhelming numbers of the enemy, accepted Charles's terms, and signed the peace of Travendahl. Charles at once crossed the Baltic to attack Augustus II. and Peter I., the former of whom was besieging Riga, while the latter threatened Narva. At Narva the Swedish king gained a splendid victory, and afterwards he defeated the Saxons, driving them away from Riga. If he had now concluded peace, he might have been for many years by far the greatest potentate in northern Europe. But he was resolved to humiliate Augustus II., and this he did most effectually. Defeated at Klissoff, Augustus was held to have forfeited the throne of Poland, and at Charles's suggestion Stanislaus Leczinski was elected king. Charles followed Augustus into Saxony, and in 1706 forced him to conclude the treaty of Altranstädt. Meanwhile Peter I. had been taking possession of Swedish territory on the Baltic, and on a portion of it had begun to build St. Petersburg. Instead of attacking him directly, Charles resolved to thwart him by seizing Moscow, and this decision proved fatal to his great designs. Worn out by a long and dreary march, during which many soldiers died of hunger and disease, his dispirited army was defeated at Poltava (1709); and Charles, ignorant of the real condition of the enemy's forces, fled across the Russian frontier into Turkey. He remained five years in the Turkish dominions, trying to induce the sultan to become his ally. But, although war did break out between Russia and Turkey, the Turks had little confidence in Charles, for it was supposed that he wished to become king of Poland, and the sultan suspected that if this scheme were effected he might become a dangerous enemy of the Ottoman empire. Convinced at last that nothing was to be gained from Turkey, Charles made his escape, and in fourteen days rode from Adrianople to Stralsund. In his absence the war had been continued by Peter I., who had soon been joined again by Augustus II. and Frederick IV.; and ultimately the alliance was strengthened by the accession of the king of Prussia and the elector of Hanover, each of whom was eager to possess those Swedish territories which were in the neighborhood of his own dominions. In Stralsund, which was besieged by an army of Danes, Saxons, Prussians, and Russians, Charles displayed astonishing valor and military skill, but about a year after his arrival the town was obliged to surrender. He then went to Lund, adopted vigorous measures for the defence of the Swedish coasts, and attacked Norway. By the advice of his friend Baron Görtz he entered into negotiations with Peter I., who was not unwilling to come to terms. Had Charles lived, it is possible that the tide of misfortune might have turned, but he was shot dead while engaged in besieging Frederikshall. His intention was to conquer Norway after having made peace with Russia, and from Norway to cross to Great Britain, where he hoped to punish the elector of Hanover by placing the Pretender on the English throne.

All the conditions of political life in Sweden were now changed. The Swedish people were surrounded by a crowd of enemies whom they could not hope to overcome, and in the confusion caused by the Northern War the nobles had recovered their ancient power. As Charles XII. had no children, it was doubtful whether the crown should pass to his younger sister Ulrica Eleonore or to Charles Frederick of Holstein-Gottorp, the son of his elder sister Hedvig Sophia. The nobles decided in favor of Ulrica Eleonore, who secured their support by undertaking to place all real power in their hands. In 1720 her authority was transferred to her husband, Prince Frederick of Hesse, who reigned as Frederick I. until his death in 1751. He reigned, however, only in name, for the diet, which now practically meant the nobles, usurped every important prerogative of the crown. There were two parties, known as the Hats and the Caps, who assailed one another with much vehemence; but on one point they were agreed, and that was that the Swedish people should in future be ruled, not by a king, or by a king acting in conjunction with the diet, but by the aristocracy.

Ulrica Eleonore.

Frederick I.

Meanwhile Sweden had been shorn of most of the foreign territory for which in past times she had made so many sacrifices. In 1719 she had given up Bremen and Verden to Hanover; in 1720 Stettin and Western Pomerania as far as the Peene were resigned to Prussia; and in 1721 Russia obtained Livonia, Esthonia, Ingermanland, and a part of Viborg län. In 1741, against the wish of King Frederick, the Hats plunged into a war with Russia; and the consequence was that in 1743 Sweden had to conclude the degrading peace of Åbo, by which she lost Eastern Finland. She had even to beg Russia to aid her against Denmark, and she was obliged to recognize Adolphus Frederick of Holstein-Gottorp, a relative of the czarina Elizabeth, as heir to the throne.

From the reign of Charles IX. until that of Charles XII. Sweden had been one of the greatest powers in Europe. She had conducted many wars successfully; she had secured a vast territory beyond her proper limits; in the crisis of the struggle between Catholicism and Protestantism she had lent powerful support to those who were fighting for spiritual freedom. In the management of international relations during this period no great decision was arrived at by any European state without reference to her wishes, and there seemed to be solid reasons for the belief that her power would be enduring. Yet she suddenly sank from her high position to that of a third-rate state, which exercised little or no influence on the affairs of the rest of the world. This striking change was immediately due to the calamities brought upon his country by Charles XII., but sooner or later it would have come even if he had never lived. The circumstances of Europe were in his time very different from those with which Gustavus Adolphus had to deal. Russia had emerged as a united and growing state; Prussia had begun to display some of the qualities which were ultimately to make her supreme in Germany; and Hanover had been made important by the accession of the house of Brunswick to the throne of Great Britain. Sweden could not have permanently maintained her conquests against these new political forces. Charles XII., by his bold but headstrong policy, only hastened a process which was in any case inevitable.

Adolphus Frederick.

Gustavus III.

Under Adolphus Frederick (1751–1771) Sweden took part in the Seven Years' War, siding with the enemies of Frederick the Great. But she was now so feeble, and her statesmen were so incompetent, that her intervention led to no serious results. The Hats, who were responsible for the humiliation brought upon Sweden by this exhibition of her weakness, had to make way for the Caps; but neither party had the power or the will to arouse the nation from the lethargy into which it had fallen. Gustavus III., Adolphus Frederick's son (1771–1792), was a man of a very different temper from his indolent father. He had great energy of character, a thorough comprehension of some of the conditions of political progress, and a frank and persuasive manner. In early youth he seems to have convinced himself that it would be impossible for Sweden to become a prosperous country unless the royal authority were restored, and when at the age of twenty-five he succeeded his father he secretly resolved to make the crown supreme.

He carried out his plans with remarkable ability and caution. Under the pretence that he wished to introduce a new system of military manœuvres, he collected around him about two hundred officers, most of whom were young men, and they were gradually induced to pledge themselves to support him. Agents were despatched to win over the regiments in the provinces, and Gustavus was careful to make a good impression on the burgher class and on the peasantry. When all was ready the commandant of Christianstad, on the 12th of August, 1772, as previously arranged, formally renounced his allegiance to the diet, and one of the king's brothers went to the town with the regiments in the neighborhood and pretended to besiege it. Suspicions were aroused at Stockholm, and at a meeting of the council of state Gustavus was bitterly reproached by some of the members. He then boldly proclaimed his purpose. The members of the council of state were arrested, and the king received the homage of the leading authorities in the military, naval, and civil services. The diet was forthwith summoned, and at its first sitting Gustavus spoke of the lamentable condition of the kingdom, and of the need for more efficient methods of government. He had no wish, he said, to establish an absolute monarchy, but it was necessary that the supremacy of the aristocracy should be destroyed, and that the country should re-establish the system which existed in the time of Gustavus Adolphus, when the crown and the diet had each its separate functions and worked cordially together. A new constitution, which had been drawn up, placing executive power wholly in the king's hands, was afterwards read, and at once accepted.

Delivered from the trammels which had hampered his immediate predecessors, Gustavus worked hard for the welfare of his subjects. Agriculture, industry, and trade revived; the army and navy were improved; and the educated classes began to show greater interest in art, literature, and science. Unfortunately the king took the court of France as the model for his own court, and the country resented the incessant demands for money which were rendered necessary by his personal extravagance. In 1788 he declared war with Russia, hoping to recover Livonia and the part of Finland which Russia had conquered; and the discontent he had aroused found expression in the army, the leaders of which declined to fight, protesting that the war ought not to have been begun without the sanction of the diet. At the same time Denmark was persuaded by the czarina Catherine to attack Sweden. Gustavus seemed to be on the verge of ruin, but he was saved by his own courage and sagacity. Hastening back from Finland, he was able to rescue Gothenburg from the Danes with a force raised in Dalecarlia, and soon afterwards, through the intervention of England and Prussia, Denmark was induced to withdraw from the struggle. The majority of the diet, seeing the dangers to which the nation was exposed, rallied around the king, and, notwithstanding the opposition of the nobles, recognized the right of the crown to declare war. Impressed by the firm and rapid action of Gustavus, the army returned to its allegiance, and the conflict with Russia was begun in earnest. In 1789 the Swedes were very unsuccessful, but in the following year they gained several victories both at sea and on land. Gustavus saw, however, that it would be impossible for him to wrest from Russia any of her territories, and in 1790 peace was concluded on the understanding that both states should occupy the position they held before the war.

Gustavus was greatly excited by the French Revolution, and sought to form an alliance with Russia, Prussia, and Austria for the restoration of Louis XVI. But the diet refused to support his wild schemes. Several nobles, desiring to avenge the supposed wrongs of their order, entered into a conspiracy against him, and in 1792 he was mortally wounded by an assassin who acted as their agent.

Gustavus IV.

Gustavus IV. (1792–1809) was not quite fourteen years old when his father was murdered, and during his minority the government was carried on by his uncle the duke of Södermanland. Gustavus began to exercise royal authority in 1796. His reign was remarkable chiefly for the obstinacy with which he clung to his own ideas, no matter how far they might conflict with the obvious interests of his country. He had a bitter detestation of Bonaparte, and in 1803 went to Carlsruhe in the hope that he might induce the emperor and some of the German princes to act with him in support of the Bourbons. His enmity led to an open rupture with France, and even after the peace of Tilsit, when Russia and Prussia offered to mediate between him and the French emperor, he refused to come to terms. The consequence was that he lost Stralsund and the island of Rügen. He displayed so much friendship for England that Russia and Denmark, acting under the influence of France, declared war against him; and the whole of Finland was soon held by Russian troops. Gustavus attacked Norway, but his army was driven back by the Danes and Norwegians. He still declined to make peace, and he even alienated England when she attempted to influence him by moderate counsels. The Swedish people were so enraged by the consequences of his policy that in 1809 he was dethroned, and the claims of his descendants to the crown were also repudiated. He was succeeded by the duke of Södermanland, who reigned as Charles XIII.

Charles XIII.

Charles XIII. (1809–1818) concluded peace with Russia, Denmark, and France, ceding to Russia by the treaty of Frederikshamm (1809) the whole of Finland. The loss of this territory, which had been so long associated with the Swedish monarchy, was bitterly deplored by the Swedes, but it was universally admitted that under the circumstances the sacrifice was unavoidable. Charles assented to important changes in the constitution, which were intended to bring to an end the struggle between the crown and the aristocracy and to provide some security for the maintenance of popular rights. The king was still to be at the head of the executive, but it was arranged that legislative functions and control over taxation should belong to the diet, which was to consist of four orders—nobles, clergymen, burghers, and peasants.

As Charles XIII. was childless, the diet elected as his successor Prince Christian Augustus of Holstein-Sonderburg-Augustenburg. In 1810, soon after his arrival in Stockholm, this prince suddenly died; and Sweden astonished Europe by asking Marshal Bernadotte to become heir to the throne. Bernadotte, who took the name of Charles John, was a man of great vigor and resource, and soon made himself the real ruler of Sweden. Napoleon treated Sweden as almost a conquered country, and compelled her to declare war with England. Bernadotte, associating himself heartily with his adopted land, resolved to secure its independence, and entered into an alliance with Russia. In 1813 he started with an army of 20,000 Swedes to cooperate with the powers which were striving finally to crush the French emperor. The proceedings of the Swedish crown prince were watched with some suspicion by the allies, as he was evidently unwilling to strike a decisive blow at France; but after the battle of Leipsic he displayed much activity. He blockaded Hamburg, and by the peace of Kiel, concluded in January, 1814, he forced Denmark to give up Norway. He then entered France, but soon returned, and devoted his energies to the conquest of Norway, which was very unwilling to be united with Sweden. Between the months of July and November, 1814, the country was completely subdued, and Charles XIII. was proclaimed king. The union of Sweden and Norway, which has ever since been maintained, was recognized by the congress of Vienna; and it was placed on a sound basis by the frank adoption of the principle that, while the two countries should be subject to the same crown and act together in matters of common interest, each should have complete control over its internal affairs. The new relation of their country to Norway gave much satisfaction to the Swedes, whom it consoled in some measure for the loss of Finland. It also made it easy for them to transfer to Prussia in 1815 what remained of their Pomeranian territories.

Charles XIV.

In 1818 Bernadotte mounted the throne as Charles XIV., and he reigned until he died in 1844. Great material improvements were effected during his reign. He caused new roads and canals to be constructed; he encouraged the cultivation of districts which had formerly been barren; and he founded good industrial and naval schools. He was not, however, much liked by his subjects. He never mastered the Swedish language, and he was so jealous of any interference with his authority that he sternly punished the expression of opinions which he disliked. To the majority of educated Swedes the constitution seemed to be ill-adapted to the wants of the nation, and there was a general demand for a political system which should make the Government more directly responsible to the people. In 1840 a scheme of reform was submitted to the diet by a committee which had been appointed for the purpose, but the negotiations and discussions to which it gave rise led to no definite result.

Oscar I.

Charles XIV. was succeeded by his son Oscar I. (1844–1859). Oscar had always expressed sympathy with liberal opinions, and it was anticipated that the constitutional question would be settled during his reign without much difficulty. These expectations were disappointed. The diet met soon after his accession, and was asked to accept the scheme which had been drawn up in 1840. The measure received the cordial approval of the burghers and peasants, but was rejected by the nobles and the clergy. In 1846 a committee was appointed to prepare a new set of proposals, and late in the following year the discussion of its plans began. While the debates on the subject were proceeding some excitement was produced by the revolutionary movement of 1848, and a new ministry, pledged to the cause of reform, came into office. The scheme devised by this ministry was accepted by the committee to which it was referred, but the provisions of the existing constitution rendered it necessary that the final settlement should depend upon the vote of the next diet. When the diet met in 1850 it was found that the difficulties in the way were for the time insuperable. The proposals of the Government were approved by a majority of the burghers, but they were opposed by the nobles, the clergy, and the peasantry. The solution of the problem had, therefore, to be indefinitely postponed.

Although the constitution was not reformed, much was done in other ways during the reign of Oscar I. to promote the national welfare. The criminal law was brought into accordance with modern ideas, and the law of inheritance was made the same for both sexes and for all classes of the community. Increased freedom was secured for industry and trade; the methods of administration were improved; and the state took great pains to provide the country with an efficient railway system. The result of the wise legislation of this period was that a new spirit of enterprise was displayed by the commercial classes, and that in material prosperity the people made sure and rapid progress.

In 1848, when the difficulty about Schleswig-Holstein led to war between Denmark and Germany, the Swedes sympathized cordially with the Danes, of whom they had for a long time ceased to be in the slightest degree jealous. Swedish troops were landed in Fünen, and through the influence of the Swedish Government an armistice was concluded at Malmö. The excitement in favor of Denmark soon died out, and when the war was resumed in 1849 Sweden resolutely declined to take part in it. The outbreak of the Crimean War greatly alarmed the Swedes, who feared that they might in some way be dragged into the conflict. In 1855, having some reason to complain of Russian acts of aggression on his northern frontiers, the King of Sweden and Norway concluded a treaty with England and France, pledging himself not to cede territory to Russia, and receiving from the Western powers a promise of help in the event of his being attacked. The demands based on this treaty were readily granted by Russia in the peace of Paris in 1856.

Charles XV.

Charles XV. (1859–1872) mounted the throne after his father's death. Nearly two years before his accession he had been made regent in consequence of Oscar I.'s ill-health. Charles was a man of considerable intellectual ability and of decidedly popular sympathies, and during his reign the Swedish people became enthusiastically loyal to his dynasty. In 1860 two estates of the realm—the peasants and the burghers—presented petitions, begging him to submit to the diet a scheme for the reform of the constitution. This request he willingly granted. The main provisions of the plan offered in his name were that the diet should consist of two chambers,—the first chamber to be elected for a term of nine years by the provincial assemblies and by the municipal corporations of towns not represented in those assemblies, the second chamber to be elected for a term of three years by all natives of Sweden possessing a specified property qualification. The executive power was to belong to the king, who was to act under the advice of a council of state responsible to the national representatives. This plan, which was received with general satisfaction, was finally adopted by the diet in 1866, and is still in force.

Early in the reign of Charles XV. there were serious disputes between Sweden and Norway, and the union of the two countries could scarcely have been maintained but for the tact and good sense of the king. He also exercised a steadying influence in 1863, when his people expressed passionate sympathy with the Poles in their insurrection against Russia, and with the Danes in their war with Prussia and Austria.

Oscar II.

Charles XV. died in 1872, and was succeeded by his brother Oscar II., who still reigns (1887). Under him Sweden has maintained good relations with all foreign powers, and political disputes in the diet have never been serious enough to interrupt the material progress of the nation.

Many documents relating to Swedish history have been published in *Scriptores Rerum Suecicarum Medii Ævi*, edited by Fant, Geijer, and Schröder, in *Scriptores Suecici Medii Ævi*, edited by Rietz, and in other collections. Among the older histories of Sweden may be named those by Dalin and Lagerbring in the 18th century and by Rühs in the 19th. More important works on the subject are those by Geijer, Carlson, Fryxell, and Strinnholm. (J. SI.)

PART III.—LITERATURE.

Swedish literature, as distinguished from compositions in the common *norrœna tunga* of old Scandinavia, cannot be said to exist earlier than the 13th century. Nor until the period of the Reformation was its development in any degree rapid or copious. The oldest form in which Swedish[1] exists as a written language is the series of manuscripts known as *Landskapslagarne*, or "The Common Laws." These are supposed to be the relics of a still earlier age, and it is hardly believed that we even possess the first that was put down in writing. The most important and the most ancient of these codes is the "Elder West Göta Law," reduced to its present form by the law-man Eskil about 1230. Another of great interest is Magnus Eriksson's "General Common Law," which was written in 1347. These ancient codes have been collected and edited by Prof. Schlyter. The chief ornament of mediæval Swedish literature is *Um Styrilse Kununga ok Höfdinga* ("On the Conduct of Kings and Princes"), first printed by command of Gustavus II. Adolphus, in 1634. The writer is not known; it has been conjecturally dated 1325. It is a handbook of moral and political teaching, expressed in terse and vigorous language. St. Bridget, or Birgitta (1302?–1373), an historical figure of extraordinary interest, has left her name attached to several important religious works, in particular to a collection of *Uppenbarelser* ("Revelations"), in which her visions and ecstatic meditations are recorded, and a version, the first into Swedish, of the five books of Moses. This latter was undertaken, at her desire, by her father-confessor Mattias (d. 1350), a priest at Linköping. The translation of the Bible was continued a century later by a monk named Johannes Budde (d. 1484).

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[1] For the Swedish language, see SCANDINAVIAN LANGUAGES, vol. xxi. pp. 886–9.

In verse the earliest Swedish productions were probably the folk-songs. The age of these, however, has been commonly exaggerated. It is doubtful whether any still exist which are as old, in their present form, as the 13th century. The bulk are now attributed to the 15th, and many are doubtless much later still. The last, such as "Axel och Valborg," "Liten Karin," "Kampen Grimborg," and "Habor och Signild," deal with the adventures of romantic mediæval romance. Almost the only positive clue we hold to the date of these poems is the fact that one of the most characteristic of them, "Engelbrekt," was written by Tomas, bishop of Strengnäs, who died in 1443. Tomas, who left other poetical pieces, is usually called the first Swedish poet. There are three rhyming chronicles in mediæval Swedish, all anonymous. The earliest, *Erikskrönikan*, is attributed to 1320; *Karlskrönikan* is at least 120 years later; and the third, *Sturekrönikorna*, was probably written about 1500. All three have been edited by G. E. Klemming. The collection of rhymed romances which bears the name of *Queen Euphemia's Songs* must have been written before the death of that lady in 1312. They are believed to date from 1303. They are versions of three mediæval stories taken from French and German sources, and they deal respectively with King Arthur and the Table Round, with Duke Frederick of Normandy, and with Flores and Blancheflor. They possess very slight poetic merit in their Swedish form. A little later the romance of *King Alexander* was translated by, or at the command of, Bo Jonsson Grip; this is more meritorious. A brilliant and pathetic relic of the close of the mediæval period exists in the *Love Letters* addressed in 1498 by Ingrid Persdotter, a nun of Vadstena, to the young knight Axel Nilsson. The first book printed in the Swedish language appeared in 1495.

The 16th century added but little to Swedish literature, and that little is mostly connected with the newly-founded university of Upsala. The Renaissance scarcely made itself felt in Scandinavia, and even the Reformation failed to waken the genius of the country. Psalms and didactic spiritual poems were the main products of Swedish letters in the 16th century. Two writers, the brothers Petri, take an easy prominence in so barren a period. Olaus Petri (1497–1552) and Laurentius Petri (1499–1573) were Carmelite monks who proceeded in 1516 to Wittenberg to study theology under Luther, and who came back to Sweden as the apostles of the new faith. Olaus, who is one of the noblest figures in Swedish annals, was of the executive rather than the meditative class. He found time, however, to write a *Chronicle*, which is the earliest prose history of Sweden, a mystery-play, *Tobie Comedia*, which is the first Swedish drama, and three psalm-books, the best known being published in 1530 under the title of *Någre Gudhelige Visor* ("Certain Divine Songs"). Laurentius Petri, who was archbishop of all Sweden, edited or superintended the translation of the Bible published at Upsala in 1540. He also wrote many psalms. Laurentius Andreæ, who died in 1552, had previously prepared a translation of the New Testament, which appeared in 1526. He was a polemical writer of prominence on the side of the Reformers. Finally, Petrus Niger (Peder Svart), bishop of Vesterås (d. 1562), wrote a chronicle of the life of Gustavus I. up to 1533, in excellent prose. The same writer left unpublished a history of the bishops of Westerås his predecessors. The latter half of the 16th century is a blank in Swedish literature.

With the accession of Charles IX. and the consequent development of Swedish greatness, literature began to assert itself in more vigorous forms. The long life of the royal librarian, Johannes Buræus (1568–1652), formed a link between the age of the Petri and that of Stjernhjelm. Buræus studied all the sciences then known to mankind, and confounded them all in a sort of Rabbinical cultus of his own invention, a universal philosophy in a multitude of unreadable volumes. But he was a patient antiquarian, and advanced the knowledge of ancient Scandinavian mythology and language very considerably. He awakened curiosity and roused a public sympathy with letters; nor was it without significance that two of the greatest Swedes of the century, Gustavus Adolphus and the poet Stjernhjelm, were his pupils. The reign of Charles IX. saw the rise of secular drama in Sweden. The first comedy was the *Tisbe* of Magnus Olai Asteropherus (d. 1647), a coarse but witty piece on the story of Pyramus and Thisbe, acted by the schoolboys of the college of Arboga in 1610. This play is the *Ralph Roister Doister* of Swedish literature. A greater dramatist was Johannes Messenius (1579–1636), who, having been discovered plotting against the Government during the absence of Gustavus in Russia, was condemned to imprisonment for life—that is, for twenty years. Before this disaster he had been professor in Upsala, where his first historical comedy *Disa* was performed in 1611 and the tragedy of *Signill* in 1612. The design of Messenius was to write the history of his country in fifty plays; he completed and produced six. These dramas are not particularly well arranged, but they form a little body of theatrical literature of singular interest and value. Messenius was a genuine poet; the lyrics he introduces have something of the charm of the old ballads. He wrote abundantly in prison; his *magnum opus* was a history of Sweden in Latin, but he has also left, in Swedish, two important rhyme-chronicles. Messenius was imitated by a little crowd of playwrights. Nikolaus Catonius (d. 1655) wrote a fine tragedy on the Trojan War, *Troijenborgh*, in which he excelled Messenius as a dramatist. Andreas Prytz, who died in 1655 as bishop of Linköping, produced several religious chronicle plays from Swedish history. Jacobus Rondeletius (d. 1662) wrote a curious "Christian tragi-comedy" of *Judas Redivivus*. These plays were all acted by schoolboys and university youths, and when they went out of fashion among these classes the drama in Sweden almost entirely ceased to exist. Two historians of the reign of Charles IX., Erik Göransson Tegel (d. 1636) and Ægidius Girs (d. 1639), deserve mention.

Stjernhjelm.

The reign of Gustavus Adolphus was adorned by one great writer, the most considerable in all the early history of Sweden. The title of "the Father of Swedish Poetry" has been universally awarded to Göran Lilja, better known by his adopted name of Georg Stjernhjelm (1598–1672). This extraordinary man was born at Wika in Dalecarlia on the 7th of August, 1598. He took his degree at Greifswald, and spent some years in travelling over every quarter of Europe. On his return he attracted the notice of Gustavus Adolphus, who gave him a responsible post at Dorpat in 1630, and raised him next year to the nobility. After the king's death Christina attached him, as a kind of poet-laureate, to her court in Stockholm. His property lay in Livonia, and when the Russians plundered that province in 1656 the poet was reduced to extreme poverty for two or three years. He died at Brunkeborg in Stockholm on the 22d of April, 1672. Stjernhjelm was a man of almost universal attainment, but it is mainly in verse that he has left his stamp upon the literature of his country. He found the language rough and halting, and he moulded it into perfect smoothness and elasticity. His master Buræus had written a few Swedish hexameters by way of experiment. Stjernhjelm took the form and made it national. His greatest poem, *Hercules*, is a didactic allegory in hexameters, written in very musical verse, and with an almost Oriental splendor of phrase and imagery. In its faults as well as its beauties the style of Stjernhjelm reminds us of that of his great Dutch contemporary Vondel. He was certainly influenced by a writer a few months older than himself, the German poet Martin Opitz. The *Hercules*, which deals with the familiar story of the dispute for the hero between Duty and Pleasure, was first printed, at Upsala, in 1653, but was finished some years earlier. *Bröllops-Besvärs Ihugkommelse*, a sort of seriocomic epithalamium in the same measure, is another very brilliant work of Stjernhjelm. His masques, *Then fägne Cupido* ("Cupid Caught")(1649), *Fredsafl* ("The Birth of Peace") (1649), and *Parnassus Triumphans* (1651), were written for the entertainment of the queen, and have a charming lyrical lightness. He can scarcely, however, be said to have been successful in his attempt, in the first two of these, to introduce unrhymed song-measures. Stjernhjelm was an active philologist, and left a great number of works on language, of which only a few have ever been printed. He wrote letter A of the earliest Swedish dictionary, published in 1643, and a work on mathematics entitled *Archimedes Reformatus*. No brighter intellectual figure arose in Sweden till the beginning of the 19th century.

Rosenhane. The claim of Stjernhjelm to be the first Swedish poet may be contested by a younger man, but a slightly earlier writer, Gustaf Rosenhane (1619–1684), who was a reformer on quite other lines. If Stjernhjelm studied Opitz, Rosenhane took the French poets of the Renaissance for his models, and in 1650 wrote a cycle of one hundred sonnets, the earliest in the language; these were published under the title *Venerid* in 1680. Rosenhane printed in 1658 a "Complaint of the Swedish Language" in thirteen hundred rattling rhyming lines, and in 1682 a collection of eighty songs. He was a metrist of the artistic order, skilful, learned, and unimpassioned. His zeal for the improvement of the literature of his country was beyond question. Most of the young poets followed Stjernhjelm rather than Rosenhane. As personal friends and pupils of the former, the brothers Columbus deserve special attention. Each wrote copiously in verse, but Johan (1640–1684) almost entirely in Latin, while Samuel (1642–1678), especially in his *Odæ Suethicæ*, showed himself an apt and fervid imitator of the Swedish hexameters of Stjernhjelm. Of a rhyming family of Hjärne, it is enough to mention one member, Urban Hjärne (1641–1724), who introduced the new form of classical tragedy from France, in a species of transition from the masques of Stjernhjelm to the later regular rhymed dramas. His best play was a *Rosimunda*. Lars Johansson (1642–1674), who called himself "Lucidor the Unfortunate," has been the subject of a whole tissue of romance, most of which is fabulous. It is true, however, that he was stabbed, like Marlowe, in a midnight brawl at a tavern. His poems were posthumously collected as *Flowers of Helicon, Plucked and Distributed on various occasions by Lucidor the Unfortunate.* Stripped of the myth which had attracted so much attention to his name, Lucidor proves to be an occasional rhymster of a very low order. Haquin Spegel (1645–1714), the famous archbishop of Upsala, wrote a long didactic epic in alexandrines, *God's Labor and Rest*, with an introductory ode to the Deity in rhymed hexameters. He was also a good writer of hymns. Another ecclesiastic, the bishop of Skara, Jesper Svedberg (1653–1735), wrote sacred verses, but is better remembered as the father of Swedenborg. Peter Lagerlöf (d. 1699) cultivated a pastoral vein in his *Elisandra* and *Lucillis;* he was professor of poetry, that is to say, of the art of writing Latin verses, at Upsala. Olof Wexionius (1656–1690?) published his *Sinne-Afvel*, a collection of graceful miscellaneous pieces, in 1684, in an edition of only 100 copies. Its existence was presently forgotten, and the name of Wexionius had dropped out of the history of literature, when Hanselli recovered a copy and reprinted its contents in 1863. We have hitherto considered only the followers of Stjernhjelm; we have now to speak of an important writer who followed in the footsteps of Rosenhane. **Dahlstjerna.** Gunno Eurelius, afterwards ennobled with the name of Dahlstjerna (1661–1709), early showed an interest in the poetry of Italy. In 1690 he translated Guarini's *Pastor Fido*, and in or just after 1697 published, in a folio volume without a date, his *Kunga-Skald*, the first original poem in *ottava rima* produced in Swedish. This is a bombastic and vainglorious epic in honor of Charles XI., whom Eurelius adored; it is not, however, without great merits, richness of language, flowing metre, and the breadth of a genuine poetic enthusiasm. He published a little collection of lamentable sonnets when his great master died. Eurelius struck the lyre several times in honor of Charles XII., but these poems have all perished. He was a true patriot, and grief at the defeat of Poltava is said to have cost him his life. Johan Runius (1679–1713), called the "Prince of Poets," published a collection entitled *Dudaim*, in which there is nothing to praise, and with him the generation of the 17th century closes. Talent had been shown by certain individuals, but no healthy school of Swedish poetry had been founded, and the latest imitators of Stjernhjelm had lost every vestige of taste and independence.

In prose the 17th century produced but little of importance in Sweden. Gustavus Adolphus (1594–1632) was the most polished writer of its earlier half, and his speeches take an important place in the development of the language. **Rudbeck.** The most original mind of the next age was Olof Rudbeck (1630–1702), the famous author of *Atland er Manhem.* He spent nearly all his life in Upsala, building anatomical laboratories, conducting musical concerts, laying out botanical gardens, arranging medical lecture rooms—in a word, expending ceaseless energy on the practical improvement of the university. He was a genius in all the known branches of learning; at twenty-three his physiological discoveries had made him famous throughout Europe. His *Atland* (or *Atlantika*) appeared in four folio volumes, in Latin and Swedish, in 1679–98; it was an attempt to summon all the authority of the past, all the sages of Greece and the bards of Iceland, to prove the inherent and indisputable greatness of the Swedish nation, in which the fabulous Atlantis had been at last discovered. It was the literary expression of the majesty of Charles XI., and of his autocratical dreams for the destiny of Sweden. From another point of view it is a monstrous hoard or cairn of rough-hewn antiquarian learning, now often praised, sometimes quoted from, and never read. Olof Verelius (1618–1682) had led the way for Rudbeck, by his translations of Icelandic sagas, a work which was carried on with greater intelligence by Johan Peringskjöld (1654–1720), the editor of the *Heimskringla*. The French philosopher Descartes, who died at Christina's court at Stockholm in 1650, found his chief, though posthumous, disciple in Anders Rydelius (1671–1738), bishop of Lund, who was the master of Dalin, and thus connects us with the next epoch. Charles XII., under whose special patronage Rydelius wrote, was himself a metaphysician and physiologist of merit.

A much more brilliant period followed the death of Charles XII. The influence of France and England took the place of that of Germany and Italy. The taste of Louis XIV., tempered by the study of Addison and Pope, gave its tone to the academical court of Queen Ulrica Eleonore, and Sweden became completely a slave to the periwigs of literature, to the unities and graces of classical France. Nevertheless this was a period of great intellectual stimulus and activity, and Swedish literature took a solid shape for the first time. This Augustan period in Sweden closed somewhat abruptly about 1765. Two writers in verse connect it with the school of the preceding century. Jacob Frese (1691–1729), whose poems were published in 1726, was an elegiacal writer of much grace, who foreshadowed the idyllic manner of Creutz. Samuel von Triewald

(1688–1743) played a very imperfect Dryden to Dalin's Pope. He was the first Swedish satirist, and introduced Boileau to his countrymen. His *Satire upon our Stupid Poets* may still be read with entertainment.

Dalin. Both in verse and prose Olof von Dalin (1708–1763) takes a higher place than any writer since Stjernhjelm. He was inspired by the study of his great English contemporaries. His *Swedish Argus* (1733–34) was modelled on Addison's *Spectator*, his *Thoughts about Critics* (1736) on Pope's *Essay on Criticism*, his *Tale of a Horse* on Swift's *Tale of a Tub*. Dalin's style, whether in prose or verse, was of a finished elegance. His great epic, *Swedish Freedom* (1742), was written in alexandrines of far greater smoothness and vigor than had previously been attempted. When in 1737 the new Royal Swedish theatre was opened, Dalin led the way to a new school of dramatists with his *Brynhilda*, a regular tragedy in the style of Crébillon *père*. In his comedy of *The Envious Man*, he introduced the manner of Molière, or more properly that of Holberg. His songs, his satires, his occasional pieces, without displaying any real originality, show Dalin's tact and skill as a workman with the pen. He stole from England and France, but with the plagiarism of a man of genius; and his multifarious labors raised Sweden to a level with the other literary countries of Europe. They formed a basis upon which more national and more scrupulous writers could build their various structures. A foreign critic, especially an English one, will never be able to give Dalin so much credit as the Swedes do; but he was certainly an unsurpassable master of *pastiche*.

The only poet of importance who contested the laurels of Dalin was a woman. **Fru Nordenflycht.** Hedvig Charlotta Nordenflycht (1718–1763) was the centre of a society which ventured to rival that which Queen Ulrica Eleonore created and Dalin adorned. Both groups were classical in taste, both worshipped the new lights in England and France. Fru Nordenflycht wrote with facility and grace; her collection of lyrics, *The Sorrowing Turtle-dove* (1743), in spite of its affectation, enjoyed and merited a great success; it was the expression of a deep and genuine sorrow—the death of her husband after a very brief and happy married life. It was in 1744 that she settled in Stockholm and opened her famous literary salon. She was called "The Swedish Sappho," and scandal has been needlessly busy in giving point to the allusion. It was to Fru Nordenflycht's credit that she discovered and encouraged the talent of two very distinguished poets younger than herself, Creutz and Gyllenborg. **Creutz.** Gustaf Filip Creutz (1729–1785) was a Finlander who achieved an extraordinary success with his idyllic poems, and in particular with the beautiful pastoral of *Atis och Camilla*, long the most popular of all Swedish poems. In 1763, the year of the death of Dalin and of Fru Nordenflycht, Creutz ceased to write, having been appointed minister to Spain; he gave up poetry for politics. **Gyllenborg.** Gustaf Frederik Gyllenborg (1731–1808) was a less accomplished poet, less delicate and touching, more rhetorical and artificial. His epic *Tåget öfver Bält* ("The Expedition across the Belt") (1785) is an imitation, in twelve books, of Voltaire's *Henriade*, and deals with the prowess of Charles X. It is impossible to read it. He wrote fables, allegories, and satires. He outlived his chief contemporaries so long that the new generation addressed him as "Father Gyllenborg." Anders Odel (1718–1773) wrote in 1739 the famous "Song of Malcolm Sinclair," the *Sinclairsvisa*. The writers of verse in this period were exceedingly numerous, but it cannot be needful, in a sketch of this kind, to preserve the minor names.

In prose, as was to be expected, the first half of the 18th century was rich in Sweden as elsewhere. The first Swedish novelist was Jakob Henrik Mörk (1714–1763). His romances have some likeness to those of Richardson; they are moral, long-winded, and slow in evolution, but written in an exquisite style, and with much knowledge of human nature. *Adalrik och Göthilda*, which went on appearing from 1742 to 1745, is the best known; it was followed, between 1749 and 1758, by *Thecla*. Jakob Wallenberg (1746–1778) described a voyage he took to the East Indies and China under the very odd title of *Min Son på Galejan* ("My Son at the Galleys"), a work full of humor and originality. We have already indicated that Dalin's activity in prose was scarcely less abundant or less meritorious than that in verse. He wrote an important history of Sweden down to Charles IX. His contemporary Johan Ihre (1707–1780) a professor at Upsala, edited the *Codex Argenteus* of Ulfilas, and produced the first complete Swedish dictionary. In doing this he was assisted by the labors of two other grammarians, Sven Hof (d. 1786) and Abraham Sahlstedt (d. 1776). Karl Gustaf Tessin (1695–1770) wrote on politics and on æsthetics. Anders Johan von Höpken (1712–1789), the friend of Ulrica Eleonore, was a master of rhetorical compliment in addresses and funeral orations. In spite of all the encouragement of the court, drama did not flourish in Sweden. Among the tragedians of the age we may mention Dalin, Gyllenborg, and Erik Wrangel (d. 1765). In comedy Reinhold Gustaf Modée (d. 1752) wrote three good plays in rivalry of Holberg. In science Linnæus, or Karl von Linné (1707–1778), was the name of greatest genius in the whole century; but he wrote almost entirely in Latin. The two great Swedish chemists, Torbern Olof Bergman (1735–1784) and Karl Vilhelm Scheele (1742–1786), flourished at this time. In pathology a great name was left by Nils Rosén von Rosenstein (1706–1773), in navigation by Admiral Fredrik Henrik af Chapman (d. 1808), in philology by Karl Aurivillius (d. 1786). But these and other distinguished savants whose names might be enumerated scarcely belong to the history of Swedish literature. The same may be said about that marvellous and many-sided genius, Emanuel Swedenborg (1688–1772), who, though the son of a Swedish poet, preferred to prophesy to the world in Latin (see SWEDENBORG).

What is called the Gustavian period is supposed to commence with the reign of Gustavus III. in 1771 and to close with the abdication of Gustavus IV. in 1809. This period of less than forty years was particularly rich in literary talent, and the taste of the people in literary matters widened to a remarkable extent. Journalism began to develop; the Swedish Academy was founded; the drama first learned to flourish in Stockholm; and literature began to take a characteristically national shape. This fruitful period naturally divides itself into two divisions, equivalent to the reigns of the two kings. The royal personages of Sweden have commonly been protectors of literature; they have strangely often been able men of letters themselves. Gustavus III. (1746–1792), the founder of the Swedish Academy and of the Swedish theatre, was himself a playwright of no mean ability. One of his prose dramas, *Siri Brahe och Johan Gyllenstjerna*, held the stage for many years. In 1773 the king opened the national theatre in Stockholm, and on that occasion an opera of *Thetis och Pelée* was performed, written by himself. In 1786 Gustavus created the Swedish Academy, on the lines of the French Academy, but with eighteen members instead of forty. The first list of immortals, which included the survivors of a previous age and such young celebrities as Kellgren and Leopold, embraced all that was most brilliant in the best society of Stockholm; the king himself presided, and won the first prize for an oration. The principal writers of the reign of Gustavus III. bear the name of the Academical school. But we must first consider a writer of genius who had nothing academical in his composition.

Karl Mikael Bellman (1740–1795), the most original

Bellman. **Kellgren.** **Leopold.**

and one of the most able of all Swedish writers, was an improvisatore of the first order (see BELLMAN). The riot of his dithyrambic hymns sounded a strange note of nature amid the conventional music of the Gustavians. Of the academical poets Johan Gabriel Oxenstjerna (1750–1818), the nephew of Gyllenborg, was a descriptive idyllist of grace. He translated *Paradise Lost*. A writer of far more power and versatility was Johan Henrik Kellgren (1751–1795), the leader of taste in his time (see KELLGREN). He was the first writer of the end of the century in Sweden, and the second undoubtedly was Karl Gustaf af Leopold (1756–1829), "the blind seer Tiresias-Leopold," who lived on to represent the old school in the midst of romantic times. Leopold was not equal to Kellgren in general poetical ability, but he is great in didactic and satiric writing. He wrote a satire, the *Enebomiad*, against a certain luckless Per Enebom, and a classic tragedy of *Virginia*. He is little read now. Gudmund Göran Adlerbeth (1751–1818) was a translator, and the author of a successful tragic opera *Cora och Alonzo* (1782). Anna Maria Lenngren (1754–1817) was a very popular sentimental writer of graceful verse, chiefly between 1792 and 1798. She was less French and more national than most of her contemporaries; she is a Swedish Mrs. Hemans.

Lidner. **Thorild.**

Two writers of the academic period, besides Bellman and a generation later than he, kept apart, and served to lead up to the romantic revival. Bengt Lidner (1759–1793), a melancholy and professedly elegiacal writer, had analogies with such German sentimentalists as Novalis. He led a strange wandering life, and died, still young, in extreme poverty. His poems appeared in 1788. Tomas Thorild (1759–1808) was a much stronger nature, and led the revolt against prevailing taste with far more vigor. But he is an irregular and inartistic versifier, and it is mainly as a prose writer, and especially as a very original and courageous critic, that he is now mainly remembered. He settled in Germany, and died as a professor in Greifswald. Karl August Ehrensvärd (1745–1800) may be mentioned here as a critic whose aims somewhat resembled those of Thorild. The creation of the Academy led to a great production of æsthetic and philosophical writing. Among critics of taste may be mentioned Nils von Rosenstein (1752–1824); the rhetorical bishop of Linköping, Magnus Lehnberg (1758–1808); and Count Georg Adlersparre (1760–1809). Kellgren and Leopold were both of them important prose writers.

Hammarsköld. **Atterbom.**

The excellent lyrical poet Franz Mikael Franzén (1772–1847) (see FRANZÉN), and a belated academician Johan David Valerius (1776–1852), fill up the space between the Gustavian period and the domination of romantic ideas from Germany. It was Lorenzo Hammarsköld (1785–1827) who in 1803 introduced the views of Tieck and Schelling by founding the society in Upsala called 'Vitterhetens Vänner" (see HAMMARSKÖLD). This passed away, but was succeeded in 1807 by the famous "Aurora förbundet," founded by two youths of genius, Per Daniel Amadeus Atterbom (1790–1855) and Vilhelm Frederik Palmblad (1788–1852). These young men had at first to endure bitter opposition and ridicule from the academic writers then in power, but they supported this with cheerfulness and answered back in their magazines, *Polyfem* and *Fosforos* (1810–1813). They were named "Fosforisterna" (Phosphorists) from the latter. The principal members of the school were the three writers last named (see ATTERBOM) and Karl Frederik Dahlgren (1791–1844), a humorist who owed much to the example of Bellman. Fru Julia Nyberg (1785–1854), under the title of Euphrosyne, was their tenth Muse, and wrote agreeable lyrics. Among the Phosphorists Atterbom was the man of most genius. On the side of the Academy they were vigorously attacked by Per Adam Wallmark (1777–1858). One of them, Atterbom, eventually forced the doors of the Academy itself.

Gothic society. **Geijer.** **Tegnér.** **Wallin.**

In 1811 certain young men in Stockholm founded a society for the elevation of society by means of the study of Scandinavian antiquity. This was the Gothic Society, which began to issue the magazine called *Iduna* as its organ. Of its patriotic editors the most prominent was Erik Gustaf Geijer (1783–1847), but he was presently joined by a young man slightly older than himself, Esaias Tegnér (1782–1846), afterwards bishop of Vexiö, the greatest of Swedish writers (see GEIJER and TEGNÉR). Even more enthusiastic than either in pushing to its last extreme the worship of ancient myths and manners was Per Henrik Ling (1776–1839), now better remembered as the father of gymnastic science than as a poet. The Gothic Society eventually included certain younger men than these—Arvid August Afzelius (1785–1871), the first editor of the Swedish folk-songs; Gustaf Vilhelm Gumælius (1789–1877), who has been somewhat pretentiously styled "The Swedish Walter Scott," author of the historical novel of *Tord Bonde*; Baron Bernhard von Beskow (1796–1868), lyrist and dramatist; and Karl August Nicander (1799–1839), a poet who approached the Phosphorists in manner. The two great lights of the Gothic school are Geijer, mainly in prose, and Tegnér, in his splendid and copious verse. Johan Olof Wallin (1779–1839) may be mentioned in the same category, although he is really distinct from all the schools. He was archbishop of Upsala, and in 1819 he published the national hymn-book of Sweden, now officially used in all churches; of the hymns in this collection, one hundred and twenty-six are written by Wallin himself.

Stagnelius. **Sjöberg.**

From 1810 to 1840 was the blossoming-time in Swedish poetry, and there were several writers of distinguished merit who could not be included in either of the groups enumerated above. Second only to Tegnér in genius, the brief life and mysterious death of Erik Johan Stagnelius (1793–1823) have given a romantic interest to all that is connected with his name. His first publication was the epic of *Vladimir the Great* (1817); to this succeeded the romantic poem *Blanda*. His singular dramas, *The Bacchantes* (1822), *Sigurd Ring*, which was posthumous, and *The Martyrs* (1821), are esteemed by many critics to be his most original productions. His mystical lyrics, entitled *Liljor i Saron* ("Lilies in Sharon"), and his sonnets, which are the best in Swedish, may be recommended as among the most delicate products of the Scandinavian mind. Stagnelius has been compared, and not improperly to Shelley. Erik Sjöberg, who called himself "Vitalis" (1794–1828), was another gifted writer whose career was short and wretched. A volume of his poems appeared in 1820; they are few in number and all brief. His work divides itself into two classes—the one profoundly melancholy, the other witty or boisterous. Two humorous poets of the same period who deserve mention are Johan Anders Wadman (1777–1837), an improvisatore of the same class as Bellman, and Kristian Erik Fahlcrantz (1790–1866), bishop of Vesterås, whose humorous polemical poem of *Noah's Ark* (1825) is a masterpiece.

Almqvist.

Among the poets who have been mentioned above, the majority distinguished themselves also in prose. But the period was not one in which Swedish prose shone with any special lustre. The first prosaist of the time was, without question, the novelist Karl Jonas Ludvig Almqvist (1793–1866), around whose extraordinary personal character and career a mythical romance has already col

Fredrika Bremer.

lected (see ALMQVIST). He was encyclopedic in his range, although his stories preserve most charm; on whatever subject he wrote his style was always exquisite. Frederik Cederborgh (1784–1835) revived the comic novel in his *Uno von Trasenberg* and *Ottar Tralling*. The historical novels of Gumælius have already been alluded to. Swedish history supplied themes for the romances of Count Per Georg Sparre (1790–1871) and of Gustaf Henrik Mellin (1803–1876). But all these writers sink before the sustained popularity of the Finnish poetess Fredrika Bremer (1801–1865), whose stories have reached farther into the distant provinces of the world of letters than the writings of any other Swede except Tegnér (see BREMER). She was preceded by Sofia Zelow, afterwards Baroness von Knorring (1797–1848), who wrote a long series of aristocratic novels.

At the beginning of the romantic period a high position was taken as an independent thinker by Benjamin Höijer (1767–1812), who owed much at the outset to Kant and Fichte. Geijer also distinguished himself in philosophical writing, but the most original of Swedish philosophers has been Kristofer Jakob Boström (1797–1866), a peripatetic talker who wrote little, but whose system has been reduced to literature by K. Claëson (1827–1859), Professor Axel Nyblæus (b. 1821), and other disciples. A polemical writer of great talent was Magnus Jakob Crusenstolpe (1795–1865), of whose work it has been said that "it is not history and it is not fiction, but something brilliant between the one and the other." As an historian of Swedish literature Per Wieselgren (1800–1877) has composed a valuable work, and he has made other valuable contributions to history and bibliography. In history we meet again with the great name of Geijer, with that of Jonas Hallenberg (1748–1834), and with that of Anders Magnus Strinnholm (1786–1862), whose labors in the field of Swedish history were extremely valuable. Geijer and Strinnholm prepared the way for the most popular and perhaps the greatest of all Swedish historians, Anders Fryxell (1795–1881), whose famous *Berättelser ur Svenska Historien* appeared in parts during a space of nearly sixty years, an extraordinary example of persistent and uninterrupted work. As a legal historian the first place is easily maintained by Karl Johan Schlyter (b. 1795). Hans Järta (1774–1847) was a statesman who wrote with vigor on economical subjects. In science it is only possible to mention the celebrated names of Jöns Jakob Berzelius (1779–1848) the chemist, Elias Fries (1794–1878) and Karl Adolf Agardh (1785–1859) the botanists, and Sven Nilsson (1787–1883) the palæontologist.

Runeberg.

In the generation which had just passed away, the first poet of Sweden, without a rival, was Johan Ludvig Runeberg (1804–1877), who divides with Tegnér the highest honor in Swedish literature (see RUNEBERG). The other leading verse-writers were Karl Vilhelm Böttiger (1807–1878), the son-in-law and biographer of Tegnér; Johan Börjesson (1790–1866), the last of the Phosphorists, author of various romantic dramas; Vilhelm August von Braun (1813–1860), a humorous lyrist; "Talis Qualis," whose real name was Karl Vilhelm August Strandberg (1818–1877); and August Teodor Blanche (1811–1868), the popular dramatist. But Runeberg is the only great poetic name of this period. In prose there was not even a Runeberg. Novel-writing was sustained at no very high level by Karl Anton Wetterbergh (b. 1804), who called himself "Onkel Adam," by Emilie Carlén (b. 1807), whose autobiography has lately appeared, by Oskar Patrick Sturzen-Becker, "Orvar Odd" (1811–1869), by August Blanche, and by Marie Sofia Schwartz (b. 1819). Lars Johan Hierta (1801–1872) was the leading journalist, Johan Henrik Thomander, bishop of Lund (1798–1865), the greatest orator, Matthias Alexander Castrén (1813–1853) a Finn and a prominent man of science, and Karl Gustaf af Forsell (1783–1848) the principal statistician of this not very brilliant period. Elias Lönnrot (1802–1884) is distinguished as the Finnish professor who discovered and edited the *Kalevala*. It is impossible to give an exhaustive list of names in so short a sketch as this.

Swedish literature is not in a very lively condition at the present time. The most popular living poet is the Finn, Zakris Topelius (b. 1818). Of a higher artistic merit are the finished lyrics of Count Karl Snoilsky (b. 1841). King Oscar II. (b. 1829) is a genuine poet of the second order, as his father Charles XV. was of the third. Karl David af Wirsén (b. 1842) is an active writer on the conservative side. The best living author of Sweden is undoubtedly Viktor Rydberg (b. 1829), who has written masterly novels and historical works. The latest influences from Denmark and France are beginning to be represented by Strindberg the novelist, and by Fru. A. Ch. Edgren, the most successful Swedish dramatist of the moment. The revival of literature which has been so marked in the other two Scandinavian countries has not yet spread into Sweden.

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(E. W. G.)

SWEDENBORG, or SVEDBERG, EMANUEL (1688–1772), was born at Stockholm January 29, 1688. His father, Dr. Jesper Svedberg, subsequently professor of theology at Upsala and bishop of Skara, was a pious, learned, and a brave man, who did not escape the charge of heterodoxy, and believed himself to be in constant intercourse with angels. Emanuel shared as a child his father's piety, and his parents thought that "angels spoke through him." His education embraced the Latin, Greek, and Hebrew languages, and, above all, mathematics with the natural sciences, but seems to have been curiously defective in theology. Endowed with unusual intellectual powers and an iron constitution, he acquired vast stores of learning in all those branches. Having completed his university course at Upsala, in 1710 he commenced the customary European tour, visiting England, Holland, France, and Germany, studying especially natural philosophy, though alternating it with the composition of Latin verses, little of the poet as there was in his nature. In 1715 he returned to Upsala, and devoted himself to natural science and various engineering works. From 1716 to 1718 he published a scientific periodical, called *Dædalus Hyperboreus*, a record of mechanical and mathematical inventions and discoveries. In 1716 he was introduced to Charles XII., who appointed him assessor in the Swedish college of mines. Two years later he distinguished himself at the king's siege of Frederikshall by the invention of machines for the transport of boats and galleys overland from Stromstadt to Iddefjord, a distance of 14 English miles. The same year he published various mathematical and mechanical works. At the death of Charles XII. Queen Ulrica elevated him and his family to the rank of nobility, by which his name was changed from Svedberg to Swedenborg. The next years were devoted to the duties and studies connected with his office, which involved the visitation of the Swedish, Saxon, Bohemian, and Austrian mines. In 1724 he was offered the chair of mathematics in the university of Upsala, which he declined. Gradually his inquiring and philosophical mind led him to wider studies than those of his profession. As early as 1721 he was seeking to lay the foundation of a scientific explanation of the universe, when he published his *Prodromus Principiorum Rerum Naturalium* and had already writtten his *Principia* in its first form. Thirteen years later, in 1734, appeared in three volumes *Opera Philosophica et Mineralia*, the first volume of which (his *Principia*) contained his view of the first principles of the universe, a curious mechanical and geometrical theory of the origin of things. The same year followed *Prodromus Philosophiæ ratiocinantis de Infinito et Causa Finali Creationis*, which treats of the relation of the finite to the infinite and of the soul to the body, seeking to establish a nexus in each case as a means of overcoming the difficulty of their relation. From this time he applied himself to the problem of discovering the nature of soul and spirit by means of anatomical studies. He travelled in Germany, France, and Italy in quest of the most eminent teachers and the best books dealing with the human frame, and published, as the results of his inquiries, among other works, his *Œconomia Regni Animalis* (London, 1740–41) and *Regnum Animale* (The Hague, 1744–45, London, 1745). But a profound change was coming over him, which was to make of the scientific inquirer the supernaturalist prophet. Neither by geometrical, nor physical, nor metaphysical principles had he succeeded in reaching and grasping the infinite and the spiritual, or in elucidating their relation to man and man's organism, though he had caught glimpses of facts and methods which he thought only required confirmation and development. Late in life, he wrote to Oetinger that "he was introduced by the Lord first into the natural sciences, and thus prepared, and, indeed, from the year 1710 to 1744, when heaven was opened to him." This latter great event is described by him as "the opening of his spiritual sight," "the manifestation of the Lord to him in person," "his introduction into the spiritual world." Before his illumination he had been instructed by dreams, and enjoyed extraordinary visions, and heard mysterious conversations. According to his own account, the Lord filled him with His spirit to teach the doctrines of the New Church by the word from Himself; He commissioned him to do this work, opened the sight of his spirit, and so let him into the spiritual world, permitting him to see the heavens and the hells, and to converse with angels and spirits for years; but he never received anything relating to the doctrines of the church from any angel, but from the Lord alone, while he was reading the word (*True Christian Religion*, No. 779). He elsewhere speaks of his office as principally an opening of the spiritual sense of the word. His friend Robsahm reports, from Swedenborg's own account to him, the circumstances of the first extraordinary revelation of the Lord, when He appeared to him and said, "I am God the Lord, the Creator and Redeemer of the world. I have chosen thee to unfold the spiritual sense of the Holy Scripture. I will Myself dictate to thee what thou shalt write." From that time he gave up all worldly learning, and labored solely to expound spiritual things. But it was some time before he became quite at home in the spiritual world. In the year 1747 he resigned his post of assessor of the college of mines that he might devote himself to his higher vocation, requesting only to be allowed to receive as a pension the half of his salary. He took up afresh his study of Hebrew, and began his voluminous works on the interpretation of the Scriptures. The principal of these is the *Arcana Cœlestia* in eight quarto volumes, which he printed in London between 1749 and 1756, professing to have derived the whole of it by direct illumination from the Almighty Himself, and not from any spirit or angel. His later work *De Cœlo et de Inferno* (London, 1758) consists of extracts and portions of the *Arcana*. His MS. work *Apocalypsis Explicata*, expounding the doctrines of the New Church, was prepared in 1757–59. In 1763 appeared his *Sapientia Angelica de Divino Amore et de Divina Sapientia*, containing the most philosophical brief account of the principles of the New Church. The long list of his subsequent writings will be found in the works mentioned below. His life from 1747 was spent alternately in Sweden, Holland, and London, in the composition of his works and their publication, till his death, which took place in London, March 29, 1772.

He was a man who won the respect, confidence, and love of all who came in contact with him. Though people might disbelieve in his visions, they feared to ridicule them in his presence. His manner of life was simple in the extreme; his diet consisted chiefly of bread and milk and large quantities of coffee. He paid no attention to the distinction of day and night, and sometimes lay for days together in a trance, while his servants were often disturbed at night by hearing what he called his conflicts with evil spirits. But his intercourse with spirits was often perfectly calm, in broad daylight, and with all his faculties awake. Three extraordinary instances are produced by his friends and followers in proof of his seership and admission into the unseen world. But there exists no account at first hand of the exact facts, and Swedenborg's own reference to one of these instances admits of another explanation than the supernatural one. The philosopher Kant was struck by them in 1763, but in 1765, after further inquiries, concluded that two of them had "no other foundation than common report (*gemeine Sage*)." See Kehrbach's edition of Kant's *Träume eines Geistersehers* (Leipsic, 1880).

Swedenborg's theosophic system is most briefly and comprehensively presented in his *Divine Love and Divine Wisdom*. The point of view from which God must be regarded is that of His being the Divine Man. His *esse* is infinite love; His manifestation, form, or body is infinite wisdom. Divine love is the self-subsisting life of the universe. From God emanates a divine sphere, which appears in the spiritual world as a sun, and from this spiritual sun again proceeds the sun of the natural world. The spiritual sun is the source of love and intelligence, or life, and the natural sun the source of nature, or the receptacles of life; the first is alive, the second dead. The two worlds of nature and spirit are perfectly distinct, but they are intimately related by analogous substances, laws, and forces. Each has its atmospheres, waters, and earths, but in the one they are natural and in the other spiritual. In God there are three infinite and uncreated "degrees" of being, and in man and all things corresponding, three degrees, finite and created. They are love, wisdom, use; or end, cause, and effect. The final ends of all things are in the Divine Mind, the causes of all things in the spiritual world, and their effects in the natural world. By a love of each degree man comes into conjunction with them and the worlds of nature, spirit, and God. The end of creation is that man may have this conjunction and become the image of his Creator and creation. In man are two receptacles for God—the will for divine love and the understanding for divine wisdom,—that love and wisdom flowing into both so that they become human. Before the fall this influx was free and unhindered, and the conjunction of man with God and the creation complete, but from that time the connection was interrupted, and God had to interpose by successive dispensations. At last the power and influence of the spirits of darkness, with whom man associates himself by his sin, became so great that the existence of the human race was threatened, and Jehovah was necessitated to descend into nature to restore the connection between Himself and man. He could not come in His unveiled Divinity, for the "hells" would have then perished, whom he did not seek to destroy but only to subjugate. Another purpose of Jehovah's incarnation was the manifestation of His divine love more fully than ever before. Swedenborg wholly rejects the orthodox doctrine of atonement, and the unity of God, as opposed to his idea of the trinity of the church, is an essential feature of his teaching. Another distinctive feature is that Jehovah did not go back to heaven without leaving behind Him a visible representative of Himself in the word of the Scripture. This word is an eternal incarnation, with its threefold sense—natural, spiritual, celestial. And Swedenborg is the divinely commissioned expounder of this threefold sense of the word, and so the founder of the New Church, the paraclete of the last dispensation. That he might perceive and understand the spiritual and the celestial senses of the word he enjoyed immediate revelation from the Lord, was admitted into the angelic world, and had committed to him the key of "correspondences" with which to unlock the divine treasures of wisdom. Swedenborg claimed also to have learnt by his admission into the spiritual world the true states of men in the next life, the scenery and occupations of heaven and hell, the true doctrine of Providence, the origin of evil, the sanctity and perpetuity of marriage, and to have been a witness of the "last judgment," or the second coming of the Lord, which took place in the year 1757. It was then that the New Church, or the New Jerusalem, was inaugurated, and Swedenborg claimed to be the divinely appointed prophet and teacher of its doctrines, and maintained that his revelations excel all that preceded them.

Swedenborgianism.—Swedenborgianism, as professed by Swedenborg's followers, is based on the belief of Swedenborg's claims to have witnessed the last judgment, or the second advent of the Lord, with the inauguration of the New Church through the new system of doctrine promulgated by him and derived from the Scriptures, into the true sense of which he was the first to be introduced. The doctrines of the New Church are those of the internal sense of the word as revealed to Swedenborg, who received them into his understanding and published them through the press, and not as a preacher. They are briefly—(1) that the Lord Jesus Christ is the only God, that in Him there is the Trinity of Father, Son, and Holy Ghost, the Father being His infinite divine nature or soul, the Son His glorified human nature or divine body, and the Holy Spirit the life proceeding from His divine humanity for the salvation of man; (2) that the Father in His eternal humanity descended as the Lord Jesus Christ to the earth, assuming fallen human nature, that in it he might conquer hell and deliver mankind from its influence; (3) that the Sacred Scriptures are the true word of God, accommodated to the understanding of angels and men, and constituting the perpetual medium between heaven and the church, the law of correspondence having been revealed by the Lord to Swedenborg as the key for their interpretation; (4) that man is not saved by faith alone, but by a life according to the word, the summary of which is the decalogue; (5) that heaven is made up of those who keep God's commandments and love Him and His kingdom, and hell of those who love themselves and the world; (6) that the spiritual world—heaven and hell—holds the same relation to the natural world and its inhabitants as the soul to the body, being in and around the natural world and its life, and that after the death of the body the spirit continues to live in the spiritual world it had previously though unconsciously inhabited. Swedenborgians now constitute a widely spread and considerable society, with a regularly constituted ecclesiastical organization and a zealous missionary activity. Soon after Swedenborg's death students of his works in England and Sweden began to translate them from the Latin and to spread his views. First in time and activity amongst these early Swedenborgians was the Rev. John Clowes, rector of St. John's, Manchester, who translated the whole of several treatises. The first public meeting of Swedenborgians, from which dates the foundation of the society, was held in London, December 5, 1783, and was attended by five persons. The separation of the society from the "old church" as a religious body, with its distinct creed, worship, and ecclesiastical organization, took place May 7, 1787, and its first place of worship was in Great Eastcheap, London. The first general conference of the New Church was held April 17, 1789, in this chapel, when a series of resolutions concerning the creed, the sacraments, and ecclesiastical order of the society were adopted. At the same time churches began to be formed in various towns in England and in America. Towards the end of the century Swedenborg's doctrines obtained a considerable degree of acceptance on the Continent, separate societies having arisen here and there. Meantime the Manchester Printing Society, under Mr. Clowes, printed and distributed Swedenborg's works in large numbers. In 1810 a London Printing Society was formed, which has been very active in the same way to the present time. In 1817 a convention of the American New Church was held in Philadelphia, which gave proof of the growth of the body in the United States. The same year the tenth general conference of the English section of the church was attended by twenty-seven delegates and ministers of various societies, and in 1821 there were upwards of fifty-two of these in Great Britain. At the general conference in 1885 it was reported that there were sixty-five societies or churches in Great Britain connected with the conference, having 5700 registered members, the net increase of the year being 119. The names of thirty-two ordained ministers appear in the report; the investments of the society amount to £60,453 [$293,801.58]; and there are a dozen educational and missionary institutions in connection with it. Some of the New Church day schools are amongst the largest and most efficient in the kingdom. From the same report it appears that the New Church has societies or institutions in most British colonies as well as in the principal countries of Europe. The report of the General Convention of the New Jerusalem in the United States, 1885, gives the names of 116 societies in America, with nearly the same number of ordinary ministers. In Italy, Sweden, and Prussia there is a Swedenborg mission sustained by help from England and America. In South Germany there exist congregations of the New Church, and the librarian of the university of Tübingen, Dr. Immanuel Tafel, was exceedingly active until his death (1863) in the publication and translation of Swedenborg's works, and in the vindication of the doctrines of the New Church. In Austria, Norway, and Switzerland also there are congregations. But, in addition to full converts to Swedenborgianism, a considerable number of prominent theologians and other thinkers have been attracted by Swedenborg's works and parts of his system. While the extravagant anthropomorphism, the mechanical materialism, the theological narrowness, the wild allegorizing, the entire absence of historical knowledge, and the astounding prophetic claims of the man and his system,—in a word, the Gnosticism of Swedenborg and his followers,—must be offensive to philosophical minds, they can discover in his writings and the drift of his thought fine ethical views, profound glances of insight into the depths of the universe,—God, nature, man, and his destiny. The names of Oetinger, Herder, Goerres, Coleridge, Emerson, J. D. Morell may be given as proof of this. Such thinkers were attracted by one or more of the dominant and pervading principles or tendencies of his extraordinary mind. For he felt, if he did not adequately expound, the harmony of the universe, the fundamental unity of being and thought, of knowledge and will, of the divine and the human; and his wild system of allegory, with his equally wild communications with the unseen world, failed to conceal a deep moral and intellectual revolt against the most irrational forms of traditional orthodoxy, while his deep spiritual nature spurned the shallow intellectualism of the rationalists of the 18th century.

Literature.—A rich collection of materials for a life of Swedenborg is *Documents concerning the Life and Character of Swedenborg, Collected, Translated, and Annotated*, by Dr. R. L. Tafel, in 3 vols. Swedenborg Society, 1875–77. Of English lives the principal are —*Emanuel Swedenborg, a Biography*, by J. J. G. Wilkinson, London, 1849; *Swedenborg, a Biography and an Exposition*, by E. Paxton Hood, London, 1854; *Swedenborg, his Life and Writings*, by William White, 1856, rewritten in 1867 and in 1868; *Emanuel Swedenborg, the Spiritual Columbus, a Sketch*, by U. S. E., 2d ed., London, 1877. A useful handbook of Swedenborg's theology, consisting of extracts in English from his numerous works, is the *Compendium of the Theological Writings of Emanuel Swedenborg*, by the Rev. Samuel Warren, London, 1885. Brief summaries of his system and writings are given in all the above biographies and in Edmund Swift's *Manual of the Doctrines of the New Church*, London, 1885. Important critiques from independent points of view are "Emanuel Swedenborg," in the *Prospective Review*, May, 1850; "The Mystic," in Emerson's *Representative Men*, 1850; Kant's *Träume eines Geistersehers*, 1766 (the best edition by Kehrbach, Leipsic, 1880); Herder's "Emanuel Swedenborg," in his *Adrastea* (*Werke zur Phil. und Gesch.*, vol. xii. pp. 110–125); Goerres's *Emanuel Swedenborg, seine Visionen und sein Verhältniss zur Kirche*, 1827; Dorner's *Gesch. d. Prot. Theol.*, Munich, 1867, pp. 662–67. For the history of Swedenborgianism, see *Rise and Progress of the New Jerusalem Church in England, America, and other Parts*, by Robert Hindmarsh, edited by E. Madeley, London, 1861. The chief apologetic work is Noble's *Appeal*, 10th ed. 1881, London. See also *National Review*, April, 1858. (J. F. S.)

SWEET POTATO. See POTATO.

SWIFT, a bird so called from the extreme speed of its flight, which apparently exceeds that of any other British species, the *Hirundo apus* of Linnæus and *Cypselus apus* or *murarius* of modern ornithologists, who have at last learned that it has only an outward resemblance but no near affinity to the SWALLOW (*ante*, p. 767) or its allies. Well known as a summer-visitor throughout the greater part of Europe, it is one of the latest to return from Africa, and its stay in the country of its birth is of the shortest, for it generally disappears from England very early in August, though occasionally to be seen for even two months later.

The Swift commonly chooses its nesting-place in holes under the eaves of buildings, but a crevice in the face of a quarry, or even a hollow tree, will serve it with the accommodation it requires. This indeed is not much, since every natural function, except sleep, oviposition, and incubation, is performed on the wing, and the easy evolutions of this bird in the air, where it remains for hours together, are the admiration of all who witness them. Though considerably larger than a Swallow, it can be recognized at a distance less by its size than by its peculiar shape. The head scarcely projects from the anterior outline of the pointed wings, which form an almost continuous curve, at right angles to which extend the body and tail, resembling the handle of the crescentic cutting-knife used in several trades, while the wings represent the blade. The mode of flight of the two birds is also unlike, that of the Swift being much more steady, and, rapid as it is, ordinarily free from jerks. The whole plumage, except a grayish-white patch under the chin, is a sooty black, but glossy above. Though its actual breeding-places are by no means numerous, its extraordinary speed and discursive habits make the Swift widely distributed; and throughout England scarcely a summer's day passes without its being seen in most places. A larger species, *C. melba* or *C. alpinus*, with the lower parts dusky white, which has its home in many of the mountainous parts of central and southern Europe, has several times been observed in Britain, and two examples of a species of a very distinct genus, *Acanthyllis* (or *Chætura*), which has its home in Northern Asia, but regularly emigrates thence to Australia, have been obtained in England (*Proc. Zool. Society*, 1880, p. 1).[1]

Among other peculiarities the Swifts, as long ago described (probably from John Hunter's notes) by Home (*Phil. Trans.*, 1817, pp. 332 *et seq.*, pl. xvi.), are remarkable for the development of their salivary glands, the secretions of which serve in most species to glue together the materials of which the nests are composed, and in the species of the genus *Collocalia* form almost the whole substance of the structure. These are the "edible" nests so eagerly sought by Chinese epicures as an ingredient for soup, and their composition, though announced many years since by Home (*ut supra*), whose statement was confirmed by Bernstein (*Act. Soc. Sc. Indo-Néerlandicæ*, iii. Art. 5, and *Journ. für. Ornithologie*, 1859, pp. 111–119), has of late been needlessly doubted in favor of the popular belief that they were made of some kind of sea-weed, *Algæ*, or other vegetable matter collected by the birds.[2] It may be hoped that the examination and analysis made by Mr. J. R. Green (*Journal of Physiology*, vi. pp. 40–45) have settled that question for all time. These remarkable nests consist essentially of mucus, secreted by the salivary glands above mentioned, which dries and looks like isinglass. Their marketable value depends on their color and purity, for they are often intermixed with feathers and other foreign substances. The Swifts that construct these "edible" nests form a genus, *Collocalia*, of which the number of species is uncertain; but they inhabit chiefly the islands of the Indian Ocean from the north of Madagascar eastward, as well as many of the tropical islands of the Pacific so far as the Marquesas,—one species occurring in the hill-country of India. They breed in caves, to which they resort in great numbers, and occupy them jointly and yet alternately with Bats—the mammals being the lodgers by day and the birds by night.[3]

The genus *Cypselus*, as noted by Willughby, with its American ally *Panyptila*, exhibits a form of pedal structure not otherwise observed among birds. Not only is the hind-toe constantly directed forwards, but the other three toes depart from the rule which ordinarily governs the number of phalanges in the Bird's foot,—a rule which applies to even so ancient a form as *Archæopteryx* (see BIRDS, vol. iii. p. 631),—and in the two Cypseline genera just named the series of digital phalanges is 2, 3, 3, 3, instead of 2, 3, 4, 5, which generally obtains in the Class *Aves*. Other Swifts, however, do not depart from the normal arrangement, and the exception, remarkable as it is, must not be taken as of more value than is needed for the recognition of two sections or subgenera admitted by Mr. Sclater in his monographical essay on the Family (*Proc. Zool. Society*, 1865, pp. 593–617). There seem to be about half a dozen good genera of *Cypselidæ*, and from fifty to sixty species. Their geographical distribution is much the same as that of the *Hirundinidæ* (*cf.* SWALLOW, *ut supra*); but it should be always and most clearly borne in mind that, though so like Swallows in many respects, the Swifts have scarcely any part of their structure which is not formed on a different plan; and, instead of any near affinity existing between the two groups, it can scarcely be doubted by any unprejudiced investigator that the *Cypselidæ* not only differ far more from the *Hirundinidæ* than the latter do from any other Family of *Passeres*, but that they belong to what in the present state of ornithology must be deemed a distinct Order of Birds—that which in the present series of articles has been called *Picariæ*. That the relations of the *Cypselidæ* to the *Trochilidæ* (*cf.* HUMMING-BIRD, vol. xii. pp. 371 *sq.*) are close, as has been asserted by L'Herminie and Nitzsch, Dr. Burmeister and Prof. Huxley, is denied by Dr. Shufeldt (*Proc. Zool. Society*, 1885, pp. 886–914), but the views of the last have since been controverted by Mr. F. Lucas (*Auk*, 1886, pp. 444–451). (A. N.)

SWIFT, JONATHAN (1667–1745), dean of St. Patrick's, the greatest satirist of his own or perhaps of any age, was born in Hoey's Court, Dublin, November 30, 1667. Like Pope's, his family was of Yorkshire origin; in the time of Charles I. the representative of one branch had obtained a peerage, which expired with him. The first of his own immediate ancestors known to us was a clergyman, rector of St. Andrew's, Canterbury, from 1569 to 1592, whose son succeeded him in that living, and whose grandson was the Rev. Thomas Swift, vicar of Goodrich in Herefordshire, renowned for his eccentricity, his mechanical ingenuity, and, above all, his stubborn devotion to Charles I. and the persecutions he underwent in consequence. Plundered thirty-six times, and ultimately ejected from his living, he died in 1658, leaving his thirteen children a small and greatly impoverished landed estate and the questionable advantage of a substantial claim on the gratitude of the restored sovereign. More fortunate than most ruined cavaliers, his eldest son Godwin soon obtained the attorney-generalship of the palatinate of Tipperary. This piece of good fortune naturally attracted other members of the family across the channel,—among them Jonathan, one of the youngest of nine brothers, but already husband of Abigail Ericke of Leicester, a lady of ancient descent and means more limited than his own. A student of law, but never called to the bar, Jonathan appears to have subsisted for some years on windfalls and casual employments. At length (1665) he became steward of the King's Inns (answering to the Inns of Court in England), an office of small emolument. Two years afterwards he died suddenly, leaving an infant daughter and a widow pregnant with the future dean of St. Patrick's. So embarrassed had his circumstances been that, although considerable debts were owing to the estate, Mrs. Swift was for the moment unable to pay the expense of his interment. Thus Swift's first experience of life was that of a dependent on the charity of his uncles, more particularly of Godwin; and the inevitable bitterness of the situation was aggravated by the grudging manner in which the Tipperary official seemed to dole out his parsimonious help. In fact, the apparently prosperous relative was the victim of unfortunate speculations and chose rather to be reproached with avarice than with imprudence. A virulent resentment became ingrained into the youth's whole nature, and, though ultimately acquainted with the real state of the case, he never mentioned his uncle with kindness or respect. Other relatives did more to merit his regard. Yet he took no pride in his Irish connections or nativity, and a singular adventure in his infancy seems to have afforded him a pretext for insinuating that he was really born in England. When he was but two years old his nurse, a native of Whitehaven, was recalled to that town by an illness in her family. So attached had she become to her charge as to clandestinely carry him away with her. Mrs. Swift was induced to consent to his remaining with her for a time, and the child spent three years in Cumberland. By his return his education had made considerable progress, and in the next year he was sent to the grammar school at Kilkenny.

Swift's early years.

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[1] This species, *A. caudacuta*, has been generally, but Mr. Hume says (*Stray Feathers*, ix. p. 230) wrongly, identified with the *Hirundo ciris* of Pallas. So many authors have recently ascribed the foundation of the genus *Chætura* to Stephens in the year 1825 that it may not be amiss to state that its origin dates only from 1826, the same year in which Boie established the commensurate genus *Acanthyllis*.

[2] Hence one species has been called *Collocalia fuciphaga*.

[3] Mr. H. Pryer has given one of the latest accounts of some of these caves in North Borneo (*Proc. Zool. Society*, 1885, pp. 532–538) which may be read to advantage.

There can be no question as to the author of *Gulliver* having been a remarkable child, but unfortunately only one anecdote of his school-days has been preserved. It is the story, graphically narrated by himself, of his having once invested the whole of his pocket-money in the purchase of an old horse condemned to the knacker's yard, his momentary triumph over his school-fellows, and his mortification on discovering the uselessness of his acquisition,—an anecdote highly characteristic of his daring pride and ambition, and from which, instead of the moral he professed to discover, he might have derived an augury of the majestic failure of his life.

In April, 1682, Swift matriculated at Trinity College, Dublin, where he failed to distinguish himself. "By the ill-treatment of his nearest relations," he says, meaning especially his uncle Godwin, "he was so discouraged and sunk in his spirits that he too much neglected his academic studies, for some part of which he had no great relish by nature; so that when the time came for taking his degree as bachelor of arts he was stopped of his degree for dulness and insufficiency, and at last hardly admitted in a manner little to his credit, which is called in that college *speciali gratia*, February 15, 1685." The college roll, nevertheless, shows that the only subject in which Swift absolutely failed was natural philosophy, including mathematics, in which the future author of the *Voyage to Laputa* was hardly likely to excel, nor is it surprising that a student of fitful and unruly temperament should have performed his obligatory theme *negligenter*. His examination in Greek and Latin was satisfactory, and the extent of desultory information evinced by his writings seems to prove that he had always been an industrious reader. His mortification made him reckless, and he repeatedly underwent academic censure during the next three years, though it is not certain whether some of the records supposed to apply to him do not in fact relate to his cousin Thomas.

Swift and Temple.

In 1688 Swift quitted the university, and, after a brief residence with his mother at Leicester, entered the family of Sir William Temple at Moor Park, near Farnham, as he declares for the advantage of Temple's conversation, but at least partly as an amanuensis. A distant relationship between his mother and Lady Temple appears to have recommended him to this post, which he found trying to his pride and independence. Temple was, as Swift admitted, "a man of sense and virtue," but his temper was exclusive, his manners formal, and he had retired from public affairs from self-regard and over-fastidiousness. If he solaced his voluntary ostracism by a comparison with the elegant retirement and lettered ease of Cicero, it did not therefore occur to him to compare his obscure Irish secretary with the Roman orator's amanuensis Tiro, who had, at least, invented shorthand. We, who know that in the patron's place the dependent would have governed the nation, need not be surprised at finding, full twenty years afterwards, the iron of servitude still rankling in the latter's haughty soul. He withdrew from Temple's service on a pretext of ill health from May, 1690, to August, 1691, but returned, and undoubtedly made himself useful to his employer, who on one occasion rendered him the medium of a confidential communication to King William, who had consulted Temple on the bill for triennial parliaments, then sanctioned by both branches of the legislature. Swift did his best to enforce Temple's arguments in favor of the measure, and was in after life wont to refer to the failure of his rhetoric as the most useful lesson his vanity had ever received. Struck, it would seem, rather by the physical than the mental endowments of the robust young Irishman, William offered him a troop of horse, a proposal which appears to have been subsequently commuted into a promise of church preferment. Swift had already (July, 1692) proceeded to the degree of M.A. at Oxford, and the execution of his design to embrace the ecclesiastical profession was hastened by a quarrel with Temple, occasioned by the latter's reluctance to contract any definite engagement to provide for him. Throwing up his employment, he passed (May, 1694) over into Ireland, but found his views impeded by the refusal of all the bishops to ordain him without some certificate of the regularity of his deportment while in Temple's family. Five months passed ere he could bring himself to solicit this favor from his old patron, which he ultimately did in a letter submissive in appearance, but charged to the full with smothered rage and intense humiliation. Forgiveness was easy to one in Temple's place and of Temple's disposition, and he not only despatched the requisite testimonials, but added a recommendation which obtained for Swift the living of Kilroot, in the diocese of Down and Connor (January, 1695). His residence here was not fated to be of long duration. Temple, who knew his value and had not parted with him willingly, soon let him understand that a return was open to him, and Swift, whose resentment was cooled by time, and soothed by the acknowledgment of his value to his patron, readily complied (May, 1696). He continued to reside with Sir William till the latter's death in January, 1699. No further disagreement troubled their intimacy, and Temple bequeathed Swift the charge of editing his writings, a laborious but not an unprofitable commission.

Early writings and settlement in Ireland.

Macaulay has justly indicated the familiarity with public affairs acquired by Swift at Moor Park as one main cause of his subsequent distinction as a politician, and here too he laid the foundation of his literary renown. He is reported to have read regularly for eight hours every day; and we have his own authority for his having, as early as 1691, "written and burned, and written again, more on all manner of subjects than perhaps any man in England." The only relics of these early days, however, belong to a species of composition in which he was little qualified to excel. He has, indeed, a name among the poets of England, but the merit of his verse is usually in the ratio of its approach to the *sermo pedestris*. Mistaking the nature of his powers, he must needs begin with Pindarics, and the result may be imagined. Yet his own simple account of his feelings while endeavoring composition proves that the mood was right though the channel was wrong, and that there was error as well as truth in his kinsman Dryden's severe and unforgiven remark, "Cousin Swift, you will never be a poet." Swift's first prose composition betrayed his resentment. In the *Battle of the Books* (1697) a satirical contribution to the controversy on the comparative merits of the ancients and the moderns raised by Perrault, but with especial reference to the question of the genuineness of the letters of Phalaris, on which his patron Temple had taken the wrong side, Swift for the first and last time committed a plagiarism, and sought to conceal it by an untruth. It is undoubtedly adapted, though certainly improved from, De Callières's *Histoire Poëtique de la Guerre nouvellement déclarée entre les Anciens et les Modernes*. Here also his sarcasm for the first and last time recoiled upon himself. The satire against Dryden and Bentley wants, indeed, nothing but truth to be excellent; but the pictures of the former in his monstrous helmet and the latter in his patchwork mail yield in ludicrousness to the idea of the author of the *Pindaric Odes* presuming to ridicule the author of *Absalom and Achitophel*, and the inglorious student of Trinity College, Dublin, challenging the first philologist of the age on a question of classical scholarship. It is, however, to his credit that his learning was greater than that of the other writers on his side and his pretensions less. Swift's next literary labor was his edition of Temple's posthumous works, already mentioned. They appeared with a dedication to King

William, which was to have made the editor a prebendary. A petition to this effect miscarried, as he always believed, through the negligence or ill-will of the nobleman who undertook to present it. Be this as it may, he had become too important to be overlooked, and soon obtained the post of secretary and chaplain to Earl Berkeley, one of the lord justices of Ireland. The better half of this appointment, however, escaped him on his arrival in that country, his secretaryship being transferred to a Mr. Bushe, who, when Lord Berkeley had at length an opportunity of recompensing Swift's disappointment by the gift of the deanery of Derry, successfully exerted his influence in favor of another clergyman, who is asserted to have gained his interest by the judicious outlay of a thousand pounds. With bitter indignation Swift threw up his chaplaincy, but was ultimately reconciled to his patron by the presentation to the rectory of Agher, in Meath, with the united vicarages of Laracor and Rathbeggan. For the first time in his life he might now call himself his own master, and had an opportunity of exhibiting, free from suspicion of external constraint, that stern regard to duty which was not the least prominent feature of his character. In an age of general laxity—in a priest of an alien church, whose most energetic servants commonly succumbed to the mortifying conviction of their uselessness and the detestation they excited among the people for whom they labored, the parishioners of Laracor found a clergyman whom they might have heard three times a week. The energy, however, which probably gained the respect, certainly failed to influence the convictions, of his Catholic flock. We have his own authority for reckoning his average congregation at "half a score"; and on one occasion his clerk Roger was his only auditor. In fact, his exertions in the pulpit were more meritorious than his achievements; he entirely lacked the fire, the self-oblivion, the expansive geniality of the orator. He himself characterized his discourses as "pamphlets," and, if meant to imply their arid and argumentative character, the criticism is just. The author of the *Tale of a Tub*, which he had had by him since 1696 or 1698, must have felt conscious of powers capable of far more effective exercise; and his resolution to exchange divinity for politics must appear fully justified on a comparison of these inconclusive essays with another performance of the same period. The *Discourse on the Dissensions in Athens and Rome* (September, 1700), written in the Whig interest, "without humor and without satire," and intended as a dissuasive from the pending impeachment of Somers and three other noblemen, received the honor, extraordinary for the maiden publication of a young politician, of being generally attributed to Somers himself or to Burnet, the latter of whom found a public disavowal necessary. Three years and a half later appeared a more remarkable work. Clearness, cogency, masculine simplicity of diction, are conspicuous in the pamphlet, but true creative power told the *Tale of a Tub*. "Good God! what a genius I had when I wrote that book?" was his own exclamation in his later years. It is, indeed, if not the most amusing of Swift's satirical works, the most strikingly original, and the one in which the compass of his powers is most fully displayed. In his kindred productions he relies mainly upon a single element of the humorous,—logical sequence and unruffled gravity bridling in an otherwise frantic absurdity, and investing it with an air of sense. In the *Tale of a Tub* he lashes out in all directions. The humor, if less cogent and cumulative, is richer and more varied; the invention too, is more daringly original and more completely out of the reach of ordinary faculties. The supernatural coats and the quintessential loaf may be paralleled but cannot be surpassed; and the book is throughout a mine of suggestiveness, as, for example, in the anticipation of Carlyle's clothes philosophy within the compass of a few lines. At the same time it wants unity and coherence, it attains no conclusion, and the author abuses his digressive method of composition and his convenient fiction of hiatuses in the original manuscript. The charges it occasioned of profanity and irreverence were natural, but groundless. There is nothing in the book inconsistent with Swift's professed and real character as a sturdy Church of England parson, who accepted the doctrines of his church as an essential constituent of the social order around him, battled for them with the fidelity of a soldier defending his colors, and held it no part of his duty to understand, interpret, or assimilate them.

Whig connections; pamphlets on the church.

Before the publication of the *Tale of a Tub*, Swift had taken a step destined to exercise a most important influence on his life, by inviting two ladies to Laracor. Esther Johnson, a dependent of Sir William Temple's (born in March, 1681), whose acquaintance he had made in the latter's family, and whom he has immortalized as "Stella,"[1] came over with her chaperon, Mrs. Dingley, and was soon permanently domiciled in his neighborhood. The melancholy tale of Swift's attachment will be more conveniently narrated in another place, and is only alluded to here for the sake of chronology. Meanwhile the sphere of his intimacies was rapidly widening. He had been in England for three years together, 1701 to 1704, and counted Pope, Steele, and Addison among his friends. The success of his pamphlet gained him ready access to all Whig circles; but already his confidence in that party was shaken, and he was beginning to meditate that change of sides which has drawn down upon him so much but such unjustifiable obloquy. The true state of the case may easily be collected from his next publications—*The Sentiments of a Church of England Man*, and *On the Reasonableness of a Test* (1708). The vital differences among the friends of the Hanover succession were not political, but ecclesiastical. From this point of view, Swift's sympathies were entirely with the Tories. As a minister of the church he felt his duty and his interest equally concerned in the support of her cause; nor could he fail to discover the inevitable tendency of Whig doctrines, whatever caresses individual Whigs might bestow on individual clergymen, to abase the Establishment as a corporation. He sincerely believed that the ultimate purpose of freethinkers was to escape from moral restraints, and he had an unreasoning antipathy to Scotch Presbyterians and English Dissenters. One of his pamphlets, written about this time, contains his recipe for the promotion of religion, and is of itself a sufficient testimony to the extreme materialism of his views. Censorships and penalties are among the means he recommends. His pen was exerted to better purpose in the most consummate example of his irony, the *Argument against Abolishing Christianity*. About this time, too (November, 1707), he produced his best poem, *Baucis and Philemon*, which, as he frankly tell us, owes very much to the corrections of Addison.

Swift joins the Tories; activity as a ministerial writer.

From February, 1708 to April, 1709, Swift was in London, urging upon the Godolphin administration the claims of the Irish clergy to the first-fruits and tenths ("Queen Anne's bounty"), already granted to their brethren in England. His having been selected for such a commission shows that he was not yet regarded as a deserter from the Whigs, although the ill-success of his representations probably helped to make him one. By November, 1710, he was again domiciled in London, and writing his *Journal to Stella*, that unique exemplar of a giant's playfulness, "which was written for one person's private pleasure and has had indestructible attractiveness for every one since." In the first pages of this marvellously minute record of a busy life we find him depicting the decline of Whig credit and complaining of the cold reception accorded him by Godolphin, whose penetration had doubtless detected the precariousness of his allegiance. Within a few weeks he had become the lampooner of the fallen treasurer, the bosom friend of Oxford and Bolingbroke, and the writer of the *Examiner*, a journal established as the exponent of Tory views (November, 1710). He was now a power in the state, the intimate friend and recognized equal of the first writers of the day, the associate of ministers on a footing of perfect cordiality and familiarity. "We were determined to have you," said Bolingbroke to him afterwards; "you were the only one we were afraid of." He gained his point respecting the Irish endowments; and, by his own account, his credit procured the fortune of more than forty deserving or undeserving clients. The envious but graphic description of his demeanor conveyed to us by Bishop Kennett attests the real dignity of his position no less than the airs he thought fit to assume in consequence. The cheerful, almost jovial, tone of his letters to Stella evinces his full contentment, nor was he one to be moved to gratitude for small mercies. He had it, in fact, fully in his own power to determine his relations with the ministry, and he would be satisfied with nothing short of familiar and ostentatious equality. His advent marks a new era in English political life, the age of public opinion, created indeed by the circumstances of the time, but powerfully fostered and accelerated by him. By a strange but not unfrequent irony of fate the most imperious and despotic spirit of his day labored to enthrone a power which, had he himself been in authority, he would have utterly detested and despised. For a brief time he seemed to resume the whole power of the English press in his own pen and to guide public opinion as he would. His services to his party as writer of the *Examiner*, which he quitted in July, 1711, were even surpassed by those which he rendered as the author of telling pamphlets, among which *The Conduct of the Allies* and *Remarks on the Barrier Treaty* (November and December, 1711) hold the first rank. In truth, however, he was lifted by the wave he seemed to command. Surfeited with glory, the nation wanted a convenient excuse for relinquishing a burdensome war, which the great military genius of the age was suspected of prolonging to fill his pockets. The Whigs had been long in office. The High Church party had derived great strength from the Sacheverell trial. Swift did not bring about the revolution with which, notwithstanding, he associated his name. There seems no reason to suppose that he was consulted respecting the great Tory strokes of the creation of the twelve new peers and the dismissal of Marlborough (December, 1711), but they would hardly have been ventured upon if *The Conduct of the Allies* and the *Examiners* had not prepared the way. A scarcely less important service was rendered to the ministry by his *Letter to the October Club*, artfully composed to soothe the impatience of Harley's extreme followers. He had every claim to the highest preferment that ministers could give him, but his own pride and prejudice in high places stood in his way.

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[1] The name "Stella" is simply a translation of Esther. Swift may have learned that Esther means "star" from the *Elementa Linguæ Persicæ* of John Greaves or from some Persian scholar; but he is more likely to have seen the etymology in the form given from Jewish sources in Buxtorf's *Lexicon*, where the interpretation takes the more suggestive form "Stella Veneris."

Swift made dean of St. Patrick's; fall of the Tory ministry.

Generous men like Oxford and Bolingbroke cannot have been unwilling to reward so serviceable a friend, especially when their own interest lay in keeping him in England. Notwithstanding, therefore, some dubious expressions in Swift's letters, natural to the deferred hope, we need not doubt their having actually used their best efforts to obtain for him the vacant see of Hereford. Swift, however, had formidable antagonists in the archbishop of York, whom he had scandalized, and the duchess of Somerset, whom he had satirized. Anne was particularly amenable to the influence of priestly and female favorites, and it must be considered a proof of the strong interest made for Swift that she was eventually persuaded to appoint him to the deanery of St. Patrick's, Dublin, vacant by the removal of Bishop Sterne to Dromore. It is to his honor that he never speaks of the queen with resentment or bitterness. In June, 1713, he set out to take possession of his dignity, and encountered a very cold reception from the Dublin public. The dissensions between the chiefs of his party speedily recalled him to England. He found affairs in a desperate condition. The queen's demise was evidently at hand, and the same instinctive good sense which had ranged the nation on the side of the Tories, when Tories alone could terminate a fatiguing war, rendered it Whig when Tories manifestly could not be trusted to maintain the Protestant succession. In any event the occupants of office could merely have had the choice of risking their heads in an attempt to exclude the elector of Hanover, or of waiting patiently till he should come and eject them from their posts; yet they might have remained formidable could they have remained united. To the indignation with which he regarded Oxford's refusal to advance him in the peerage the active St. John added an old disgust at the treasurer's pedantic and dilatory formalism, as well as his evident propensity, while leaving his colleague the fatigues, to engross for himself the chief credit of the administration. Their schemes of policy diverged as widely as their characters; Bolingbroke's brain teemed with the wildest plans, which Oxford might have more effectually discountenanced had he been prepared with anything in their place. Swift's endeavors after an accommodation were as fruitless as unremitting. His mortification was little likely to temper the habitual virulence of his pen, which rarely produced anything more acrimonious than the attacks he at this period directed against Burnet and his former friend Steele. One of his pamphlets against the latter (*The Public Spirit of the Whigs*) was near involving him in a prosecution, some invectives against the Scots having proved so exasperating to the peers of that nation that they repaired in a body to the queen to demand the punishment of the author, of whose identity there could be no doubt, although, like all Swift's writings, except the *Proposal for the Extension of Religion*, the pamphlet had been published anonymously. The immediate withdrawal of the offensive passage, and a sham prosecution instituted against the printer, extricated Swift from his danger.

Meanwhile the crisis had arrived, and the discord of Oxford and Bolingbroke had become patent to all the nation. Foreseeing, as is probable, the impending fall of the former, Swift retired to Upper Letcombe, in Berkshire, and there spent some weeks in the strictest seclusion. This leisure was occupied in the composition of his remarkable pamphlet, *Free Thoughts on the State of Public Affairs*, which indicates his complete conversion to the bold policy of Bolingbroke. The utter exclusion of Whigs as well as Dissenters from office, the remodelling of the army, the imposition of the most rigid restraints on the heir to the throne,—such were the measures which, by recommending, Swift tacitly admitted to be necessary to the triumph of his party. If he were serious, it can only be said that the desperation of his circumstances had momentarily troubled the lucidity of his understanding; if the pamphlet were merely intended as a feeler after public opinion, it is surprising that he did not perceive how irretrievably he was ruining his friends in the eyes of all moderate men. Bolingbroke's daring spirit, however, recoiled from no extreme, and, fortunately for Swift, he added so much of his own to the latter's MS. that the author was obliged to recall a production which might not improbably have cost him his liberty and his deanery. This incident but just anticipated the revolution which, after Bolingbroke had enjoyed a three days triumph over Oxford, drove him into exile and prostrated his party, but enabled Swift to perform the noblest action of his life. Almost the first acts of Bolingbroke's ephemeral premiership were to order him a thousand pounds [$4860] from the exchequer and despatch him the most flattering invitations. The same post brought a letter from Oxford, soliciting Swift's company in his retirement; and, to the latter's immortal honor, he hesitated not an instant in preferring the solace of his friend to the offers of St. John. When, a few days afterwards, Oxford was in prison and in danger of his life, Swift begged to share his captivity; and it was only on the offer being declined that he finally directed his steps towards Ireland, where he was very ill received. The draft on the exchequer was intercepted by the queen's death.

Literary friendships and miscellaneous writings.

These four busy years of Swift's London life had not been entirely engrossed by politics. First as the associate of Steele, with whom he quarrelled, and of Addison, whose esteem for him survived all differences, afterwards as the intimate comrade of Pope and Arbuthnot, the friend of Congreve and Atterbury, Parnell and Gay, he entered deeply into the literary life of the period. He was treasurer and a leading member of the Brothers, a society of wits and statesmen which recalls the days of Horace and Mæcenas. He promoted the subscription for Pope's *Homer*, contributed some numbers to the *Tatler*, *Spectator* and *Intelligencer*, and joined with Pope and Arbuthnot in establishing the Scriblerus Club writing *Martinus Scriblerus*, his share in which can have been but small, as well as *John Bull*, where the chapter recommending the education of all blue-eyed children in depravity for the public good must surely be his. His fugitive productions during this period are very numerous, and mostly distinguished not only by pungent wit but by overflowing animal spirits. The most celebrated are the cruel but irresistibly ludicrous satires on the astrologer Partridge, a man in fact respectable for his sincere belief in his art, and no mean writer. Many of his best poems belong to this period. A more labored work, his *Memorial* to Harley, proposing the regulation of the English language by an academy, is chiefly remarkable as a proof of the deference paid to French taste by the most original English writer of his day. His *History of the Last Four Years of Queen Anne* is not on a level with his other political writings. To sum up the incidents of this eventful period of his life, it was during it that he lost his mother, always loved and dutifully honored, by death; his sister had been estranged from him some years before by an imprudent marriage, which, though making her a liberal allowance, he never forgave.

Stella and Vanessa.

The change from London to Dublin can seldom be an agreeable one. To Swift it meant for the time the fall from unique authority to absolute insignificance. All share in the administration of even Irish affairs was denied him; every politician shunned him; and his society hardly included a single author or wit. At a later period he talked of "dying of rage, like a poisoned rat in a hole"; for some time, however, he was buoyed up by feeble hopes of a restoration to England. So late as 1726 he was in England making overtures to Walpole, but he had no claim on ministerial goodwill, and as an opponent he had by that time done his worst. By an especial cruelty of fate, what should have been the comfort became the bane of his existence. We have already mentioned his invitation of Esther Johnson and Mrs. Dingley to Ireland. Both before and after his elevation to the deanery of St. Patrick's these ladies continued to reside near him, and superintended his household during his absence in London. He had frustrated a match proposed for Stella, and, with his evident delight in the society of the dark-haired, bright-eyed, witty beauty, a model, if we may take his word, of all that woman should be, it seemed unaccountable that he did not secure it to himself by the expedient of matrimony. A constitutional infirmity has been suggested as the reason, and the conjecture derives support from several peculiarities in his writings. But, whatever the cause, his conduct proved none the less the fatal embitterment of his life and Stella's and yet another's. He had always been unlucky in his relations with the fair sex. In 1694 he had idealized "as Varina" a Miss Waring, who then discouraged his attentions, but two years later made him advances in her turn. Swift's mind had also changed, and he could find no better way out of the difficulty than an insulting letter affecting to accept her proposals on terms which he knew must put it out of the question. Varina was avenged by Vanessa, who pursued Swift to far other purpose. Esther Vanhomrigh, the orphan daughter of a commissioner of Irish trade, had become known to Swift at the height of his political influence. He lodged close to her mother, and was a frequent guest at her table. Vanessa insensibly became his pupil, and he insensibly became the object of her impassioned affection. Her letters reveal a spirit full of ardor and enthusiasm, and warped by that perverse bent which leads so many women to prefer a tyrant to a companion. Swift, on the other hand, was devoid of passion. Of friendship, even of tender regard, he was fully capable, but not of love. The spiritual realm, whether in divine or earthly things, was a region closed to him, where he never set foot. As a friend he must have greatly preferred Stella to Vanessa; and from this point of view his loyalty to the original object of his choice, we may be sure, never faltered. But Vanessa assailed him on a very weak side. The strongest of all his instincts was the thirst for imperious domination. Vanessa hugged the fetters to which Stella merely submitted. Flattered to excess by her surrender, yet conscious of his binding obligations and his real preference, he could neither discard the one beauty nor desert the other. It is humiliating to human strength and consoling to human weakness to find the Titan behaving like the least resolute of mortals, seeking refuge in temporizing, in evasions, in fortuitous circumstance. He no doubt trusted that his removal to Dublin would bring relief, but here again his evil star interposed. Vanessa's mother died (1714), and she followed him. Unable to marry Stella without destroying Vanessa, or to openly welcome Vanessa without destroying Stella, he was thus involved in the most miserable embarrassment; still, for a time he continued to temporize. At length, unable to bear any more Stella's mute reproach and his own consciousness of wrong, he gave a reluctant consent to a private marriage, which, as at least the weight of testimony seems to prove, though there is no documentary evidence, was accordingly performed. This was in 1716. At the same time he insisted on their union being kept a strict secret, justifying a demand really dictated by tenderness for Vanessa, and perhaps by the unavowable reason to which allusion has been made, on the most futile and frivolous pretexts. Never more than a nominal wife, the unfortunate Stella commonly passed for his mistress till the day of her death, bearing her doom with uncomplaining resignation, and consoled in some degree by unquestionable proofs of the permanence of his love, if his feeling for her deserves the name. Meanwhile his efforts were directed to soothe Miss Vanhomrigh, to whom he addressed *Cadenus* [*Decanus*] *and Vanessa*, the history of their attachment and the best example of his serious poetry, and for whom he sought to provide honorably in marriage, without either succeeding in his immediate aim or in thereby opening her eyes to the hopelessness of her passion. In 1717, probably at his instance, she retired from Dublin to Marley Abbey, her seat at Celbridge. For three years she and Swift remained apart, but in 1720, on what occasion is uncertain, he began to pay her regular visits. Sir Walter Scott found the Abbey garden still full of laurels, several of which she was accustomed to plant whenever she expected Swift, and the table at which they had been used to sit was still shown. But the catastrophe of her tragedy was at hand. Worn out with his evasions, she at last (1723) took the desperate step of writing to Stella, or according to another account to Swift himself, demanding to know the nature of the connection with him, and this terminated the melancholy history as with a clap of thunder. Stella replied by the avowal of her marriage, sent her rival's letter to Swift, and retired to a friend's house. Swift rode down to Marley Abbey with a terrible countenance, petrified Vanessa by his frown, and departed without a word, flinging down a packet which only contained her own letter to Stella. Vanessa died within a few weeks. She left the poem and correspondence for publication. The former appeared immediately, the latter was suppressed until it was published by Sir Walter Scott.

Five years afterwards Stella followed Vanessa to the grave. The grief which the gradual decay of her health evidently occasioned Swift is sufficient proof of the sincerity of his attachment, as he understood it. It is a just remark of Thackeray's that he everywhere half-consciously recognizes her as his better angel, and dwells on her wit and her tenderness with a fondness he never exhibits for any other topic. Yet he could never overcome his repugnance to acknowledge their union till she lay on her death-bed, when he was heard by Mrs. Whiteway (his cousin, a lady of fortune and talent, who, though not residing with him, superintended his household during his latter years) to say, "Well, my dear, if you wish it, it shall be owned." She answered, "It is too late." On January 28, 1728, she died, and her wretched lover sat down the same night to record her virtues in language of unsurpassed simplicity, but to us who know the story more significant for what it conceals than for what it tells. A lock of her hair is preserved, with the inscription in Swift's handwriting, most affecting in its apparent cynicism, "Only a woman's hair!" "Only a woman's hair," comments Thackeray; "only love, only fidelity, purity, innocence, beauty, only the tenderest heart in the world stricken and wounded, and passed away out of reach of pangs of hope deferred, love insulted, and pitiless desertion; only that lock of hair left, and memory, and remorse, for the guilty, lonely wretch, shuddering over the grave of his victim." The more unanswerable this tremendous indictment appears upon the evidence the greater the probability that the evidence is incomplete. *Tout comprendre c'est tout pardonner.* The hypothesis to which we have referred must forever remain an hypothesis, but better than any other it not only excuses but explains.

The Drapier's letters.

Between the death of Vanessa and the death of Stella, as though withheld by an evil fate until he could no longer enjoy them, came the greatest political and the greatest literary triumph of Swift's life. He had fled to Ireland a broken man, to all appearance politically extinct; a few years were to raise him once more to the summit of popularity, though power was forever denied him. With his fierce hatred of what he recognized as injustice, it was impossible that he should not feel exasperated at the gross misgovernment of Ireland for the supposed benefit of England, the systematic exclusion of Irishmen from places of honor and profit, the spoliation of the country by absentee landlords, the deliberate discouragement of Irish trade and manufactures. An Irish patriot in the strict sense of the term he was not; he looked upon the indigenous population as conquered savages; but his pride and sense of equity alike revolted against the stay-at-home Englishmen's contemptuous treatment of their own garrison, and he delighted in finding a point in which the triumphant faction was still vulnerable. His *Proposal for the Universal Use of Irish Manufactures*, published anonymously in 1720, urging the Irish to disuse English goods, became the subject of a prosecution, which at length had to be dropped. A greater opportunity was at hand. One of the chief wants of Ireland in that day, and for many a day afterwards, was that of small currency adapted to the daily transactions of life. Questions of coinage occupy a large part of the correspondence of the primate, Archbishop Boulter, whose anxiety to deal rightly with the matter is evidently very real and conscientious. There is no reason to think that the English ministry wished otherwise; but secret influences were at work, and a patent for supplying Ireland with a coinage of copper halfpence was accorded to William Wood on such terms that the profit accruing from the difference between the instrinsic and the nominal value of the coins, about 40 per cent., was mainly divided between him and the duchess of Kendal, the king's mistress, by whose influence he had obtained the privilege. Swift now had his opportunity, and the famous letters signed M. B. Drapier (1724) soon set Ireland in a flame. Every effort was used to discover, or rather to obtain legal evidence against, the author, whom, Walpole was assured, it would then have taken ten thousand men to apprehend. None could be procured; the public passion swept everything before it; the patent was cancelled; Wood was compensated by a pension; Swift was raised to a height of popularity which he retained for the rest of his life; and the only real sufferers were the Irish people, who lost a convenience so badly needed that they might well have afforded to connive at Wood's illicit profits. Perhaps, however, it was worth while to teach the English ministry that not everything could be done in Ireland. Swift's pamphlets, written in a style more level with the popular intelligence than even his own ordinary manner, are models alike to the controversialist who aids a good cause and to him who is burdened with a bad one. The former may profit by the study of his marvellous lucidity and vehemence, the latter by his sublime audacity in exaggeration and the sophistry with which he involves the innocent halfpence in the obloquy of the nefarious patentee.

Gulliver's Travels.

The noise of the Drapier's letters had hardly died away when Swift acquired a more durable glory by the publication of *Gulliver's Travels* in 1726. The work had been at least partly written by 1722, and the keenness of the satire on courts and statesmen suggests that it was planned while Swift's disappointments as a public man were still rankling and recent. It is Swift's peculiar good fortune that his book can dispense with the interpretation of which it is nevertheless susceptible, and may be equally enjoyed whether its inner meaning is apprehended or not. It is so true, so entirely based upon the facts of human nature, that the question what particular class of persons supplied the author with his examples of folly or misdoing, however interesting to the commentator, may be neglected by the reader. It is also fortunate for him that in three parts out of the four he should have entirely missed "the chief end I propose to myself, to vex the world rather than divert it." The world, which perhaps ought to have been vexed, chose rather to be diverted; and the great satirist literally strains his powers *ut pueris placeat.* Few books have added so much to the innocent mirth of mankind as the first two parts of Gulliver; the misanthropy is quite overpowered by the fun. The third part, equally masterly in composition, is less felicitous in invention; and in the fourth Swift has indeed carried out his design of vexing the world at his own cost. Human nature indignantly rejects her portrait in the Yahoo as a gross libel, and the protest is fully warranted. An intelligence from a superior sphere, bound on a voyage to the earth, might actually have obtained a fair idea of average humanity by a preliminary call at Lilliput or Brobdingnag, but not from a visit to the Yahoos. While *Gulliver* is infinitely the most famous and popular of Swift's works, it exhibits no greater powers of mind than many others. The secret of success, here as elsewhere, is the writer's marvellous imperturbability in paradox, his teeming imagination, and his rigid logic. Grant his premises, and all the rest follows; his world may be turned topsy-turvy, but the relative situation of its contents is unchanged. The pains he took to be correct are evinced by the care with which, as Prof. De Morgan has shown, he calculated the proportions of Lilliput and Brobdingnag to ordinary humanity on the basis of 1 to 12 and 12 to 1 respectively, and his copying the description of the storm word for word from Sturmy's *Compleat Mariner*. By such accuracy and consistency he has given the wildest fiction imaginable an air of veracity rivalling Defoe.

Swift's latter years.

Swift's grave humor and power of enforcing momentous truth by ludicrous exaggeration were next displayed in his *Modest Proposal for Preventing the Children of Poor People in Ireland from Being a Burden to their Parents*, by fattening and eating them (1729), a parallel to the *Argument against Abolishing Christianity*, and as great a masterpiece of tragic as the latter is of comic irony. The *Directions to Servants* in like manner derive their overpowering comic force from the imperturbable solemnity with which all the misdemeanors that domestics can commit are enjoined upon them as duties. The power of minute observation displayed is most remarkable, as also in *Polite Conversation* (written in 1731, published in 1738), a surprising assemblage of the vulgarities and trivialities current in ordinary talk. As in the *Directions*, the satire, though cutting, is good-natured, and the piece shows more animal spirits than usual in Swift's latter years. It was a last flash of gayety. The attacks of giddiness and deafness to which he had always been liable increased upon him, and his literary compositions became confined to occasional verses, not seldom indecent and commonly trivial, with the exception of his remarkable lines on his own death and the delightful *Hamilton's Bawn*, and to sallies against the Irish bishops, in whose honest endeavors to raise the general standard of their clergy he could only see arbitrary interference with individuals. He fiercely opposed Archbishop Boulter's plans for the reform of the Irish currency, but admitted that his real objection was sentimental: the coins should be struck as well as circulated in Ireland. His exertions in repressing robbery and mendicancy were strenuous and successful. His popularity remained as great as ever, and, when he was menaced by the bully Bettesworth, Dublin rose as one man to defend him. He governed his cathedral with great strictness and conscientiousness, and for years after Stella's death continued to hold a miniature court at the deanery. But his failings of mind were exacerbated by his bodily infirmities; he grew more and more whimsical and capricious, morbidly suspicious and morbidly parsimonious; old friends were estranged or removed by death, and new friends did not come forward in their place. For many years, nevertheless, he maintained a correspondence with Pope and Bolingbroke, and with Arbuthnot and Gay until their deaths, with such warmth as to prove that an ill opinion of mankind had not made him a misanthrope, and that human affection and sympathy were still very necessary to him. The letters become scarcer and scarcer with the decay of his faculties; at last, in 1740, comes one to his best Dublin friend, Mrs. Whiteway, of heart-rending pathos:

> "I have been very miserable all night, and to-day extremely deaf and full of pain. I am so stupid and confounded that I cannot express the mortification I am under both of body and mind. All I can say is that I am not in torture; but I daily and hourly expect it. Pray let me know how your health is and your family: I hardly understand one word I write. I am sure my days will be very few; few and miserable they must be. I am, for those few days, yours entirely,—Jonathan Swift.
>
> "If I do not blunder, it is Saturday, July 26, 1740.
>
> "If I live till Monday I shall hope to see you, perhaps for the last time."

Insanity and death.

In March, 1742, it was necessary to appoint guardians of Swift's person and estate. In September of the same year his physical malady reached a crisis, from which he emerged a helpless wreck, with faculties paralyzed rather than destroyed. "He never talked nonsense or said a foolish thing." The particulars of his case have been investigated by Dr. Bucknill and Sir William Wilde, who have proved that he suffered from nothing that could be called mental derangement until the "labyrinthine vertigo" from which he had suffered all his life, and which he erroneously attributed to a surfeit of fruit, produced paralysis, "a symptom of which was the not uncommon one of aphasia, or the automatic utterance of words ungoverned by intention. As a consequence of that paralysis, but not before, the brain, already weakened by senile decay, at length gave way, and Swift sank into the dementia which preceded his death" (Craik, *Life of Swift*). The scene closed on October 19, 1745. With what he himself described as a satiric touch, his fortune was bequeathed to found a hospital for idiots and lunatics. He was interred in his cathedral, in the same coffin as Stella, with the epitaph, written by himself, "Hic depositum est corpus Jonathan Swift, S.T.P., hujus ecclesiæ cathedralis decani; ubi sæva indignatio ulterius cor lacerare nequit. Abi viator, et imitare, si poteris, strenuum pro virili libertatis vindicem."

Personal and literary character.

The stress which Swift thus laid upon his character as an assertor of liberty has hardly been ratified by posterity, which has comparatively neglected the patriot for the genius and the wit. Not unreasonably; for if half his patriotism sprang from an instinctive hatred of oppression, the other half was disappointed egotism. He utterly lacked the ideal aspiration which the patriot should possess: his hatred of villany was far more intense than his love of virtue. The same cramping realism clings to him everywhere beyond the domain of politics,—in his religion, in his fancies, in his affections. At the same time, it is the secret of his wonderful concentration of power: he realizes everything with such intensity that he cannot fail to be impressive. Except in his unsuccessful essay in history, he never, after the mistake of his first Pindaric attempts, strays beyond his sphere, never attempts what he is not qualified to do, and never fails to do it. His writings have not one literary fault except their occasional looseness of grammar and their frequent indecency. Within certain limits, his imagination and invention are as active as those of the most creative poets. As a master of humor, irony, and invective he has no superior; his reasoning powers are no less remarkable within their range, but he never gets beyond the range of an advocate. Few men of so much mental force have had so little genius for speculation, and he is constantly dominated by fierce instincts which he mistakes for reasons. As a man the leading note of his character is the same,—strength without elevation. His master passion is imperious pride,—the lust of despotic dominion. He would have his superiority acknowledged, and cared little for the rest. Place and profit were comparatively indifferent to him; he declares that he never received a farthing for any of his works except *Gulliver's Travels*, and that only by Pope's management; and he had so little regard for literary fame that he put his name to only one of his writings. Contemptuous of the opinion of his fellows, he hid his virtues, paraded his faults, affected some failings from which he was really exempt, and, since his munificent charity could not be concealed from the recipients, labored to spoil it by gratuitous surliness. Judged by some passages of his life he would appear a heartless egotist, and yet he was capable of the sincerest friendship and could never dispense with human sympathy. Thus an object of pity as well as awe, he is the most tragic figure in our literature,—the only man of his age who could be conceived as affording a groundwork for one of the creations of Shakespeare. "To think of him," says Thackeray, "is like thinking of the ruin of a great empire." Nothing finer or truer could be said.

Swift's correspondence is the best authority for his life. Of his contemporaries, we are mainly indebted to his panegyrist Delany and his detractor Lord Orrery. Hawkesworth compiled the particulars of his life, and published what was the standard edition of his works till the appearance of Sir Walter Scott's in 1814. This edition is not likely to be seperseded, but might with great advantage be reissued with amendments and additions. The biography prefixed is based on Hawkesworth, but is far more copiously and elegantly written. At the same time the author's views are frequently conventional, his judgments superficial, and his good nature has made him too indulgent to his hero. The late John Forster subjected all available records of Swift's life to the most diligent scrutiny, and in 1875 published the first volume, coming down to 1711, of a biography intended to have been completed in three volumes. Invaluable in many respects, it exhibited the process as well as the result of biography, and hence threatened to be too long. Mr. H. Craik, succeeding to the post vacated by Forster's death, judiciously reduced the scale, and produced in one volume (1882) a work which will long rank as the standard one on the subject. Remarkable monographs on Swift have been produced by Leslie Stephen in the "Men of Letters" series, Dr. Johnson in the *Lives of the Poets*, Thackeray in the *English Humorists*. Mr. Stephen is anxiously impartial; Johnson's acuteness is perverted by his antipathy; Thackeray, as is natural in a novelist, has dwelt disproportionately on the romantic side of Swift's history, and his pity for Stella and Vanessa forms too large an element in his general judgment. But he has, better than any one else, apprehended the fearfully tragic element in Swift's character and fortunes. Swift's early life has been carefully investigated by Dr. Barrett of Trinity College, and the final epoch of his life by Monck Mason and Sir William Wilde. His greatness is exaggerated and his failings are extenuated in two brilliant articles in the *Quarterly Review*, vols. cli. and clvi. Minor points in his life and writings have received much elucidation from numerous inquirers, especially the late Mr. Charles Dilke and Colonel F. Grant. Mr. Stanley Lane Poole has edited selections from his works and correspondence, with excellent notes and prefaces, and has prepared a valuable bibliography. (R. G.)

SWIMMING AND DIVING. In the case of man the power of swimming is acquired, not natural. As compared with the lower animals, to most of which it comes perfectly easily, he is at a disadvantage in its acquisition, owing not to his greater relative weight so much as to the position of his centre of gravity, along with the fact that in the case of quadrupeds the motions which serve to support and propel them in the water are very similar to those of locomotion on land. No race of mankind, however, can be mentioned to which the art is unknown, and in many barbarous countries it is more widely diffused and carried to greater perfection than amongst the civilized nations of the world.

For learning to swim, a quiet sandy beach is the best place, as sea water is more buoyant than fresh. All artificial aids, such as corks, air belts, cork jackets, inflated bladders, and the like, may be avoided: they raise some parts of the body too high above and so sink others too far below the natural plane of flotation, whereas the first fundamental rule is that the mouth only should be above water, and the legs close to the surface. Belts, etc., are also apt to become misplaced and so cause trouble and annoyance as well as danger. It is best for beginners to take some instruction from a practical teacher, though many have become adepts by merely watching good performers. Confidence in the floating power of the body is the first thing to be acquired. The easiest way of floating is to lie on the back (which should be slightly hollowed), the arms being stretched out beyond the head but not lifted out of the water; this attitude not only facilitates respiration but counterbalances the weight of the lower limbs. The knees may be bent outward, the toes also pointing sideways, the hips rigid, so assisting to keep the legs up as close as possible to the top of the water. By easy breathing one will soon be convinced that properly balanced and with lungs kept charged, the body will assert its buoyancy.

To further enable him to realize that water is capable of supporting the human body, the learner may adopt the following plan. Walk down the steps of a bath, or along a shelving beach on a calm day, into about 3 feet of water: turn and face the shallow place, and, having taken a breath, stoop down and try to pick an egg or some similar object (a handful of sand will suffice) from the bottom. Repeat this several times leisurely, going farther out at each venture, till the water reaches up to but not higher than the middle of the chest. It will soon be found that the object is not so easy of recovery, and the beginner learns that but little exertion is required to keep the body afloat. When this experience has been gained the novice should commence with the *Breast Stroke*, which is nowadays sometimes unjustly set aside as the "old stroke." It is neat, natural, and graceful enough, though necessarily the slowest, from the great resistance of the chest to the water and the fact that part of the arm stroke is negatived by its own movement. Like walking in pedestrianism, however, it forms the groundwork of every other branch of the art, and cannot safely be overlooked. The stroke is commenced by placing the hands with the backs upward, and the wrists bent so that the fingers will point to the front, the insides of the wrist-joints between arm and thumbs touching the breast not lower than 4 inches under water. Begin the stroke by pushing the arms gently forward to their full extent, keeping the palms flat and the fingers closed. Now turn the palms of both hands outward, and make a strong stroke to the right and left by each arm through an angle of 90°; in this part of the stroke the two arms describe a semicircle, of which the head may be termed the centre. It must be most distinctly borne in mind that all depression of the hands will tend to raise the body perpendicularly, whereas the only true position in swimming is the horizontal, which propels it forward. To complete the arm movement, bend the elbows backward and inward, until they come close to (but not necessarily touching) the sides of the body. Carry the hands in a straight line edgeways to the position from which they started in front of the chest. Simultaneously with the stretching of the hands from the front of the body the feet are struck out to the utmost width in a way cleft for them by the toes. As the arms are being brought round in the semicircular motion the lower limbs are stiffened and brought firmly together by grasping the water, so to speak, with the whole of the leg, more especially between the knees, ankles, and soles and toes of the feet. Whilst thus imparting forward motion to the swimmer, they finish in a straight line behind the body. Then, when the arms are bent, and the hands are being brought to the front of the body, the knees are turned outward, heels kept together, toes also turned out, and the feet are carried up to the body and in this position are once more ready for repeating the movements as described. Beginners must be careful not to make the arm movements quicker than those of the legs, and it must be distinctly remembered that the latter are the great propellers. Unison of the movements as mentioned, and regularity in each part of the stroke, are indispensable to perfection. All hurry and excitement must be carefully avoided, and every complete stroke and kick gone about with mechanical precision and neatness. The only part requiring strong muscular exertion being the closing of the legs after they have been spread wide apart,—the one strong propelling element,—every effort is to be made to ensure correctness and power in its performance. The arm movements should be easy and graceful, all jerkiness or suddenness of motion being carefully avoided.

Breathing should be unrestrained and natural, without gasping, sputtering, or short or sudden heavings.

A safe rule is to have a full breath at every stroke, its division being regulated as follows: Blow slowly outward when the first part of the arm movement is being performed, *i.e.*, stretched out in front; inspire as the hands are going outward and round. Then, as the lungs are fully charged, no effort is necessary to suspend respiration while the hands are carried in to the front of the body again. This regularity of breathing is essential to pleasure, comfort, and gracefulness of action. The nostrils and air-passages should always be thoroughly cleared, the mouth cleansed, and the throat gargled before entering the water.

Swimming on the Back is a pleasant and useful branch of the art; the chief requisite for its acquirement is confidence. The tyro should begin practice in water reaching up to about the upper part of the chest, turn his back shoreward, take a long breath, and lie gently backward in the water, keeping the hands on the waist with the elbows extended outward, the chest being expanded, and the breath held. As one lies well back the feet will be lifted off the ground; they should then be spread outward as far apart as possible, in the same position as when they are opened up in breast swimming. The body and legs are thus lying extended at full length like the letter Y, the legs forming the branches or fork. Now comes the propelling part of the movement. As in the front stroke, the muscles are set, and the legs are by one strong motion brought firmly and closely together. While this is being done the toes, by a slight movement of the ankle, are turned upward, and so, as the movement is finished, the great toes, inner ankles, and inside of the whole leg meet. This motion, strongly but not jerkily executed, sends the body forward, and when the impetus obtained is nearly—not quite—expended, the legs are bent, so that the feet are drawn close up to the trunk, with the knees outward and heels together. The stroke is renewed by spreading apart, closing again, and so on. The breath is exhaled when spreading and closing the legs, and inhaled as the feet are drawn up to the body. If greater speed is wanted, the hands can be used as sculls by carrying them outward from the body, but at the same time level with it, palms facing downward. When the arms are sufficiently extended to be in a line across from hand to hand, the wrists are turned to allow of the palms of the hands facing toward the feet, thumbs upward. Elbows, wrists, and hands are now firmly braced, and a strong pull towards the legs is made. This is the progressive motion, and should be performed just as the legs are being closed.

Another style is to bend the elbows downward, so as to allow of the hands being carried upward along the sides of the body, thumbs inward, and palms facing the bottom of the water. When the hands have been carried up to the armpits they are spread apart to the full extent of the arms, and the propelling part is performed as in the other method by pulling strongly toward the legs.

A still more powerful stroke, and one used at competitions, is accomplished by carrying the hands up to the armpits, as described in last method; then, turning the wrist so as to allow of the palms of the hands facing upward, point the fingers in the direction of progress, stretch both arms as far as possible in a line with the body and beyond the head, and turn the wrists half round, until the hands are back to back, thumbs upward. The propelling action is now performed by sweeping both hands outward and round until they touch the legs and the arms are once more straight along the sides of the body. There is a double kick in this style, and the action is as follows: When the hands are being carried up to the shoulder one kick is delivered; then as the arms are being carried beyond the head the nether limbs are drawn up in position for another kick, which is delivered as the arms are sweeping down on the stroke. This is no mere ornamental stroke, but combines in its practice grace with power, and enables the swimmer to move through the water at great speed.

Another racing back stroke is performed by lifting hands and arms out of the water at the finish of the pull downward, carrying them in the air, stretching them at full length forward beyond the head, and then dipping them into the water, executing the positive part of the stroke as in the last-described method. In this stroke there is only a single kick to each pull of the arms, the legs being drawn up as the arms are swung up in the air and closed as the arms are pulled through the water. While this movement is much practiced by some experts, it is neither so graceful nor so speedy as the other, and there is much splashing, while steering is, in the case of a close race, likely to become rather erratic. Both are at the present time the fastest known methods of swimming on the back, and, with moderately good turning and pushing in a swimming bath, 100 yards should be covered in about 74 seconds, probably less.

Of *treading* as a branch of swimming something should be known by every one. It is the only department of the art that is at all natural; and, if treading were resorted to in cases of accidental immersion, three-fourths of the resulting deaths would be prevented. The essential condition, of course, is that the hands be kept under water. When one falls into water the legs sink and the body assumes a perpendicular position, the water splashes over the face, and, once the eyes become filled or the mouth covered, the inclination of any one unable to swim is to throw the hands up and make an effort as if to creep along on the surface. These efforts only increase the danger of the position. On becoming submerged one should keep perfectly inactive for a brief time; the head will soon rise above the surface, and at this moment one ought to beat downward with both hands alternately, never allowing them to splash or disturb the surface, the head being leaned back so as to keep only the face and nostrils clear. The back of the head and ears may be covered, but this does not matter. The motions of the hands, exactly similar to those of a dog's forepaws when swimming and walking, are to be continued, the feet at the same time striking down—not hurriedly, nor with sudden jerky movement, but easily and gracefully, the ankles moving as if working treadles, so that the soles of the feet act as sustaining and, it may be, propelling surfaces. The movements of hands and feet may be altered by beating downward with both hands at once, or both feet at once, but in cases of accident the former action is to be recommended. Swimmers, when treading at competitions or for display, either fold their arms across their chest or hold hands and arms above the surface. In artistic swimming trials, as much as possible of the body should be shown above the surface, and bobbing up and down ought to be avoided. Treading is of much importance even to a good swimmer, as it allows him to divest himself of upper clothing, and enables him to lay hold of anything, such as a rope or line that does not quite reach the surface; it is also the most comfortable position in which one can partake of refreshment in case of a long swim, and is useful for purposes of conversation.

The *Side Stroke* may be said to hold in swimming a position somewhat similar to that of running in pedestrianism; as it becomes better known, the advantages of this style of aquatic progression are becoming more and more appreciated. The practice of it, however, ought not to be begun until complete proficiency has been attained in the primary stroke. Its main recommendations are apparent almost at a glance. A good average side movement will carry the swimmer a stroke in two seconds, each stroke covering a distance of fully six feet. The method is said by some to have been introduced by George Pewters about the year 1850. The body is turned on either side, but preferably with the right side downward, as thereby the legs act more freely and naturally and the heart has no weight on it to impede its action. The head is more immersed and thereby reduced in weight, being supported by the water and not by any muscular exertion of the neck or shoulder, and the lower extremities are less immersed than in the breast stroke. If one is lying on the right side, the right arm is thrown boldly out in front, with the palm of the hand downward and on a level with the lower side of the head. When pushed out to the utmost it is kept rigid, brought downward through the water in one strong movement, without any bending of either wrist or elbow, and this, the positive action, is finished when the hand has reached the legs, and comes between these limbs at full stretch. It is then carried up along the body to the chin, and the stroke renewed. The left hand is formed into a scoop, turned outward by the wrist at right angles to the fore-arm. The left arm, with the elbow bent, is then directed outward, and makes a straight pulling (not circular nor swinging) stroke to the left hip. When one arm is performing the negative the other is at the positive part of the stroke. The action of the legs should be long and vigorous, and they should never cross each other, but should work in unison with the arms and shoulders. The left knee is brought up in front of the body, with the foot in front of and at right angles to the body. Put the foot in a line with the front of the leg, and bring it round to meet the other in a line with the body. Meanwhile stretch the right or lower leg as far away as possible from the body toward the back and then bring it down to meet the other by a powerful plain stroke. The legs are then returned upward to the body, the heels touching, the knees apart, the toes of the left foot forward and of the right foot downward. To learn this graceful and useful side stroke some persons need long and steady practice; others acquire it comparatively quickly. The swimmer steers with his left or right hand and arm as the direction demands. The head and neck must be held in one position, not raised nor turned at any part of the stroke. Bearings should be taken from what can be seen in the line of vision away from and in front of the body, and only very seldom, indeed, should the head be turned to look in advance. Breath is inhaled as the under hand is pulling downward, and exhalation should take place while the mouth is immersed, which is when the uppermost hand is performing the stroke along the body.

The coincident movement of arms and legs may be thus described: As the legs are bent up to the body the upper or left hand has been stretched in front and the right or lower arm has just finished the pull. As the top arm pulls downward the legs are opened wide and almost in the same motion swung round and closed. It will be apparent that the legs are returned upward with knees bent as the downward pull is being performed with the lower arm. No effort is to be made to sink the head, neither is it to be held up in any way. The turn of the body by the power of the strokes will be quite enough to allow of the lips being sufficiently clear of the water for the purpose of inspiration. There should be no sudden pull at any part whatever of this complete stroke.

The *Overhand Stroke*, when properly practiced and acquired, is the most useful and easy of all styles of swimming. Beginners, however, should beware of acquiring it before they are thorough adepts with the side stroke, otherwise they lose all power of speed and good appearance. Harry Gurr is sometimes said to have been the inventor of this stroke in 1863, but Harry Gardener, in August of the year previous, when he won the 500 yards championship in Manchester, used the overhand or overarm stroke. The only movements of the side stroke which differ from those of the overhand are those of the left or upper arm and hand. By carrying this arm in the air a lengthened reach is obtained above the surface. As in the side stroke, the head lies as far as possible into the water. the body, legs, and feet in a straight line level with and close to the surface. The left arm is carried forward and stretched as far as possible out of the water in a line with the face and in advance of the head. The arm and hand re-enter the water, and are pulled through it with the strongest propelling stroke. The limb out of water should be carried through the air quietly, gracefully, and evenly till dipped for the stroke, not swung uselessly round from the shoulder in a half circle. The left arm and hand being in the air, the head lies deeper in the water than in the side stroke, and it is reduced in weight. The legs work simultaneously with the left arm; that is, they are drawn up as this arm reaches in front, and are at their nearest wide stretch by the time it is in position for the pull; they are then pulled strongly together as the upper arm is performing its strong movement. At no time when the upper arm is being carried forward above the water should the hand be higher than a very few (say about three) inches above the surface. The elbow alone is elevated, and is the highest part of the arm. In fact, the hand is so close to the surface that, on being lifted upward after the delivery of the stroke, the wrist has to be bent; otherwise the fingers would actually touch the water. Once, however, the hand comes opposite the eyes it is straightened in a line with the fore-arm and in this position carried to the dipping point. Breathing is regulated in precisely the same way as when swimming by means of the side stroke.

Touching and Turning.—The methods of "touch and turn" were brought into vogue by the now numerous swimming races in baths. Whether the baths be long or short, from 10 to 15 feet in the push-off is gained at each end of every length by all competitors. Assuming that the swimmer is using the side or overhand stroke and going on the right side, the method to be adopted is as follows: When within 3 feet of the end wall of the bath the left or upper hand quits its propelling movement, and reaches in front of the head till it touches the wall just above water-mark. The palm of the hand is then placed horizontally on the wall, the fingers to the right, which is the direction to which one is turning; the little finger is uppermost and thumb undermost. The knees are bent, and the body, now close to the wall, is turned to the right on its own axis by the left hand, after which the feet press against the wall under the hand. As in diving and plunging, the body, arms, and hands are in a straight line, and the head between the biceps, all under water. The thighs are doubled up under the loins, the calves of the legs touching the back of the thighs, and the soles of the feet pressing hard against the wall. A strong push-off is made by the feet and legs, and the swimmer resumes his ordinary stroke and course for a new length.

Ocean Swimming.—Persons having from any cause to swim in the heavy rolling breakers of mid-ocean should use the side stroke when available. No attempt should be made to breast or mount the waves. By taking their direction a side-stroke swimmer is carried an unexpectedly long distance. The large dangerous rollers come almost in regular succession after an interval of small waves. The swimmer soon notices them, fills his lungs, swims into them, ducking the head, and quickly emerges when the wave has passed. Then a fresh supply of breath is inhaled.

Plunging.—In this the performer enters the water in somewhat the same manner as when diving (see below), but at a flat angle, and from the moment of doing so makes no active muscular movement whatever of any part of the body under water. Plunging came into vogue as the most graceful and practical method of starting in swimming races. From 3 to 5 feet above the water-level makes the best springing point, whether from bank, board, or rock. The knees should be kept together and slightly bent, with the weight on the balls of the feet and the lungs fully charged. The spring forward at the signal to start is given with all muscular power available. A swing of the arms from behind is taken, and, as the feet quit their support, the arms are swung forward so as to rise up to and straight beyond the head. The body is shot into mid-air as far as possible, and, before touching the water, the head falls between the arms till the chin just touches the chest and the ear grazes the inside of the biceps. The body now glides gracefully and almost noiselessly into the water, with the chest slightly hollowed, the shoulders contracted, and the arms rigidly braced out straight. The hands are now laid flat and the thumbs locked, while the hips and ankles are kept in one rigid straight line, with the soles of the feet turned upward and level with the surface, the toes pointing straight behind. The forward motion from the spring continues as long as the body will float and the air in the lungs can be held, when the feet, followed by the arms, begin to sink, and the plunger ends his performance by merely raising his head. Adepts in this branch have saved themselves from a sinking vessel by a long plunge from the ship's side, and so by one effort have got clear out of the vortex that is caused by her settling down and sinking.

Diving. — The rule in diving, as distinguished from plunging, is most explicit. In diving alone are the limbs allowed to make muscular movements under water. When properly performed it is a most graceful feat to the eye, and a good swimmer is, as a rule, known by the way in which he enters the water. The height of the end of the board from the surface of the water may be from 3 to 20 feet. If the water is taken properly a clean dive or header is made, but some swimmers are careless and will flop into the water with the body contracted like a ball, instead of straightened out like an arrow. The descent of good divers into the water varies from 3 to 4 feet, of clumsy performers from 7 to 8 feet. The dive may be a standing or running one. The feet and legs are kept together, with the chest inflated, the arms slightly swung to and fro twice or so, and the body and legs bent towards the water. The lungs are charged, and the dive is made immediately before the arms and hands are raised forward into the air above the bent head. The feet are used with all the power possible in springing off. When in mid-air the diver straightens himself out from finger tips to toes. The shoot downwards is made by declining the arms so as to inclose the head, the chest is momentarily contracted, and the water is gracefully and noiselessly entered fingers first. The instant the body is covered, throw up the head and arms so as to reach the surface. The eyes instinctively close as they enter the water; if it were otherwise, the force with which the surface is struck might cause injury, especially in the case of high diving. As soon as the water is entered the eyes should be opened, as swimming under water with them closed may be attended with danger. The best method for novices is to begin from a board 3 feet high; and, as confidence and a good style are acquired, the height may be raised 1 or 1½ feet at a time. Running headers are accomplished by running 10 or 12 paces before springing off, and the diver endeavors to clear as long a distance as possible before entering the water. Muscles and weight have nothing whatever to do with perfection in diving. Slim youths and heavy middle-aged men and women have alike excelled in this branch of aquatics. The important requisites are courage and strength of nerve, combined with experimental knowledge of the behavior of the body while in air and water. Do not enter the water feet first. This is only done by those who have not the courage to dive in the proper manner, and it sometimes causes harm to the respiratory organs, while one may lose balance and so come on to the water quite flat and be seriously injured in the stomach, ribs, or spine.

Object Diving.—Some divers move over the bottom in straight lines, and others search on no plan at all. The best way is to strike to the right or left on the circumference of the circle surrounding the objects and work spirally inwards to the centre of the circle. If the face be kept close to the bottom and the eyes brought well into use success will reward one's efforts, and no object ought to be missed. For object diving the drawers should have a pocket easily accessible to one hand, in order to receive the objects raised. These are collected by swimming on the breast as quickly as possible. All movements under water ought to be gone about with the utmost alacrity, but at the same time without undue haste or flurry, otherwise the heart's action will be increased, the breath will suffer, and the stay under water will be shortened.

Plate Swimming.—This is a most interesting and enjoyable branch of the art. From a very early period we find references to mechanical appliances as aids to progression and support in the water, these helps generally taking the form of large flat surfaces made of wood, tin, leather, waterproof fabrics, or other similar materials. Sometimes they were flat, in other instances slightly concave. Some were made banded like the covers of a book, or hinged, others opened and closed with umbrella-like action, while quite a large number were made web-like, to resemble a duck's foot; nearly all were more or less collapsible. From what can be gleaned of the style of these articles it is evident that the inventors cannot have been familiar with the principles of swimming, or aquatic propulsive action, and so, while a number of the contrivances were undoubtedly the outcome of much thought and ingenuity, they could not be regarded as in any way improving on the ordinary or primitive swimming movements; and, while greater surface than is offered by hands and feet was always given, with the evident intention of reducing "slip," much resistance took place at the neutral or negative part of the stroke. The one good effect in most of these inventions was thus more than nullified by this "drag," which, besides being objectionable in itself, had the additional disadvantage of bringing into requisition muscles of legs and arms the development of which was antagonistic to perfection of swimming. In 1876 Mr. R. H. Wallace-Dunlop, C.B., announced that he had invented swimming plates which afforded increased speed without causing undue straining of the muscles; and these claims have been justified by subsequent experience. The arrangements for a lateral movement of the heels in the footboards or plates, with freedom of the ankles, showed at once that Mr. Dunlop had fully studied the details of the art of swimming, with the effect of greatly reducing "slip" in the positive and altogether doing away with "drag" in the negative parts of the leg stroke. Slow swimmers, by the use of the new appliances, move quickly and easily through the water, whilst moderately fast swimmers have their speed increased to an almost wonderful extent. To swim 100 yards in 70 seconds without artificial aid is regarded as a good performance; there are not half a dozen living swimmers who can reduce this time by so much as five seconds. Yet about ten years ago a London swimmer, not by any means the fastest, with the assistance of the plates covered the distance of 100 yards in 60 seconds. It will thus be apparent that the invention marks an important advance in the art of swimming. These plates are made of wood—mahogany or American bass,—and are in shape somewhat like an artist's palette, with this difference, that the bay or indentation of the edge runs in to where the thumb-hole would be. The straps are made of leather, and all buckles and metal should be of bronzed or lacquered brass; the woodwork ought to be kept well polished or varnished. The hand plates are at the thickest part ⅜ of an inch thick, but those for the feet must be much stronger, as the whole weight of the body is upon them while one is standing at or walking to the water's edge. In learning to use them, let the swimmer begin by lying flat on the water, straightening the arms out about 24 inches apart. Spread the feet and legs well outward; then so place the feet that the plates shall be vertical, and thus offer the soles as resisting surfaces to the water; close the legs in such a way that the flat parts will meet when the legs come together. The return of the feet to the body is the same as in natural or unaided swimming, *i.e.*, by bringing them heels first so that the plates are carried up edgeways. Next, turn the ankles so as to allow of the soles facing outward, this being in plate swimming the point from which the positive or propelling part of the stroke actually starts. Now press outward and round until the plates meet as before, and repeat. Practice slowly and steadily until sure that in the recovery there is no drag, and that when spreading apart and closing the resisting surfaces are squared so as to reduce slip to its minimum. The hands are moved as in ordinary swimming, with this difference, that they are all the time lying flat; on their return to the body after the propelling movement no motion of wrist is to be made, great care being taken to keep the hand plates perfectly parallel with the surface of the water, as the slightest deviation from this rule, at any one part of the arm stroke, will sink or raise the head and chest, and so alter the natural and correct plane of the whole body. As the plates are lighter than the water the feet will tend to come close to the surface, if not indeed sometimes above it, causing splashing unless care be taken to avoid this. Floating in any position is easy and comfortable with plates on, and diving, sculling, and back swimming are all facilitated. The length of stroke in plate-swimming is nearly double that of ordinary water movements. The recommendations of the invention, especially in sea and long-distance swims, may be summed up in four words—safety, power, endurance, speed.

Long Immersions.—It is on record that on October 6, 1835, Samuel Brock, a Yarmouth fisherman, after being capsized, remained in the water for 7½ hours before he was picked up. As a long-distance swimmer in ocean and tidal waters no one has ever approached Matthew Webb (1848–83), of the British mercantile marine service. His first great feat was plunging (April 23, 1873) off the Cunard S.S. "Russia" into a heavy sea in the unsuccessful endeavor to save a young sailor who had fallen overboard, when he passed 37 minutes in the sea before the lifeboat relieved him. He received the silver medal from the Royal Humane Society of London, the Stanhope gold medal, and a £100 [$486] purse subscribed by the passengers of the "Russia." In June, 1874, he swam from Dover to the northeast Varne buoy (9½ sea miles). On July 3, 1875, he went from Blackwall Pier to Gravesend Town Pier on an ebb tide (18½ miles) in

4 h. 52 m. 44 s., and on July 19, 1875, from Dover to Ramsgate (15 sea miles) in 8¾ h. An unsuccessful attempt to swim from Dover to Calais (17½ sea miles) in the narrowest part of Dover Straits took place on August 12, 1875. He afterwards successfully accomplished the feat on August 24–25, 1875, after 21 h. 44 m. 55 s. immersion, the distance swum having been as nearly as possible 39½ statute miles. A foolhardy attempt to swim the whirlpool rapids of Niagara cost Webb his life on July 24, 1883. On September 15, 1875, F. Cavil swam on the ebb of a strong spring tide from Putney to Blackwall (13 miles 3 furlongs) in 3 hr. 50 m. Miss Agnes Beckwith, of London, on the 17th July, 1878, swam 20 miles in the Thames, without any assistance whatever, in 6 hours 25 minutes. Horace Davenport, of London, for years amateur champion of Great Britain, on 2d September, 1884, swam from Southsea, Portsmouth, to Ryde, Isle of Wight, and back again in 5 h. 25 m.

Remarkable and Best Swimming Records.—The great majority of these have been achieved in England, but accurate statistics cannot be said to be plentiful. The following are some of the authentically recorded results:

Best Records in Open and Still Water.—100 yards, 1 m. 5¾ s.; 220 yards, 2 m. 54¼ s.; 300 yards, 4 m. 57 s.; 500 yards, 7 m. 58 s.; half-mile, 14 m. 17½ s.; 1000 yards, 13 m. 51½ s.; 1 mile, 28 m. 19¾ s.; 8 miles, 1 h. 53 m. 30 s.

Bath Swimming.—Of the innumerable inclosed swimming baths in Great Britain not many are exactly similar in measurement as regards length and breadth. The shorter the bath the faster becomes the time test of speed by the aid of each turn. The Lambeth bath, where the greatest number of championship and other celebrated bath races in the kingdom have been decided, is 40 yards long. The following are the best Lambeth records: 40 yards, 23¼ s.; 80 yards, 52½ s., 100 yards, 1 m. 7¼ s.; 120 yards, 1 m. 28½ s.; 160 yards, 2 m. 2 s.; 200 yards, 2 m. 41¼ s.: 220 yards, 2 m. 59¼ s.; 400 yards, 5 m. 44½ s.; ¼ mile, 6 m. 21½ s.; 500 yards, 7 m. 19¼ s.; 600 yards, 8 m. 46½ s.; 800 yards, 11 m. 46½ s.; ½ mile (21 turns), 13 m. ½ s.; 1000 yards, 14 m. 56¼ s.; 1200 yards, 18 m. 5½ s.; ¾ mile, 20 m. ¾ s.; 1400 yards, 21 m. 17¼ s.; 1 mile (43 turns), 27 m. 3½ s. The records of other baths include: 500 yards, 6 m. 55 s. (Oldham Baths); 100 yards, 1 m. 4½ s. (Blackburn Baths); 1 mile, 26 m. 21 s. (Westminster Aquarium) (80 turns).

Longest Time under Water, in Glass Tank.—4 m. 29½ s.

Longest Dives.—109 yards 2 feet 6 inches, and 113 yards 1 foot.

Longest Plunges.—From a springboard 5 feet above the level surface of the water, 73 feet 1 inch; from a fixed board, 3 feet 6 inches above the water level, 76 feet 3 inches.

For baths and bathing, see BATHS, vol. iii. p. 375. For drowning and rescuing life, see DROWNING, vol. vii. p. 409. There are two societies with headquarters in London which consist of delegates from nearly all the swimming clubs in the metropolis. These have framed rules and regulations for the conduct of clubs, races, and other performances included under "swimming." The Professional Swimming Association was successfully floated by Mr. Robert Watson on July 6, 1881. The Amateur Swimming Association was reinaugurated in 1886 by the amalgamation of the Swimming Association of Great Britain and the Amateur Swimming Union. There are annual competitions for the amateur championships at 500 yards, ½ mile, 1 mile in still water, and 5½ miles in the Thames. There are also the Associated Swimming Clubs of Glasgow and the Associated Clubs of Dundee, each similar in its objects and composition to the Amateur Swimming Association.

The literature of the subject of swimming is considerable, and the following works may be mentioned: Thevenot, *The Art of Swimming*, transl. from the French, London, 1789; *Swimming*, two letters by Benjamin Franklin, Bungay, 1791; Walker's *Manly Sports*, art. "Swimming," London, 1836; G. H. Cliss, *Gymnastics and Swimming*, London, 1840; W. H. Leveral, *Swimming and Swimmers*, London, 1861; S. W. Higgenson, "Swimming," in *The American and Continental Monthly*, May, 1870; "Piscator," *How to Swim*, London, 1872; Charles Steedman, *Manual of Swimming*, London, 1873; Leahy, *Swimming in the Eton Style*, Nottingham, 1875; J. Bell Pettigrew, *Animal Locomotion*, London, 1874; W. Wilson, *Swimming, Diving, and How to Save Life*, Glasgow, 1876; Torkington, *Swimming Drill*, London, 1876; R. H. W. Dunlop, *Plate Swimming*, London, 1877; Menstery, *New Manual of Swimming*, New York, 1878; W. Wilson, *The Swimming Instructor*, 1883; J. H. Walsh, art. "Swimming," *British Rural Sports*, London, 1886. (H. F. W.—W. WI.)

SWINDON. The towns of Old and New Swindon, in Wiltshire, England, are situated on several railway lines, about 77 miles west of London and 30 east-northeast of Bath. The old town is built on an eminence commanding fine views of the surrounding country. It received a charter for a fair from Charles I., and has weekly markets for corn and cattle. The church was erected in 1851, from the designs of Sir Gilbert Scott. There is a town-hall and a corn exchange. Swindon New Town, to the north from Old Swindon, has grown up since the construction of the Great Western Railway, which has its principal works there. There is a market-house for meat, fish, and vegetables. Connected with the Great Western Railway mechanics' institution there is a library of about 14,000 volumes. The combined areas of Old and New Swindon, which form separate urban sanitary districts, amount to 2524 acres, with a population in 1881 of 22,374. Old Swindon (area 1214 acres) had a population in 1871 of 4092 and in 1881 of 4696, and New Swindon (area 1310 acres) a population in 1881 of 17,678.

SWINE. The oldest known even-toed or Artiodactyle Ungulates (see MAMMALIA, vol. xv. p. 435) were neither Oxen, Antelopes, Deer, Camels, nor Pigs, but presented a generalized type, which by modification in various directions has given rise to all these very diverse forms. They were mostly of small size, and had invariably the full number of teeth of the typical mammalian heterodont dentition, viz., 44, of which the incisors were $\frac{3}{3}$ on each side, the canines $\frac{1}{1}$, the premolars $\frac{4}{4}$, and the true molars $\frac{3}{3}$. The molars were short and square, crowned with blunt, rounded cusps, and the canines were not remarkably developed. All the feet terminated in four toes, the two middle ones (the third and fourth of the complete typical mammalian extremity) of nearly equal size, the outer ones (second and fifth) smaller, and also equal. The five-toed ancestor of these forms has not yet been discovered. They had no special weapons, as horns or antlers, on their foreheads. Such was the condition of all the hitherto discovered animals of this division at the commencement of the Tertiary period. Very early a change took place in the characters of the molar teeth in certain members of the group: the rounded tubercles became sharp ridges curved in a crescentic form, and better adapted for a purely herbivorous diet, especially for cutting and bruising the comparatively dry and hard blades of grass which grow in open plains. The animals thus separated from the rest—the Selenodont (crescent-toothed) Artiodactyles —have undergone various further modifications of teeth, feet, and other parts, and constitute the diverse forms of ruminating animals mentioned above. Those whose molar teeth retained more of the primitive tuberculated (bunodont) form, were the ancestors of the present family of Swine, some of which, looking upon their organization as a whole, have undergone less change since the Eocene period than almost any other mammals.

Remains of very generalized swine-like animals have been abundantly found in Eocene and early Miocene formations both in America and Europe. In the former continent they never (as far as present evidence indicates) underwent any great diversity of modification, but gradually dwindled away and almost died out, being only represented in the actual fauna by the two closely-allied species of peccary, among the smallest and most insignificant members of the group, which have existed almost unchanged since the Miocene age at least, if the evidence of teeth alone can be trusted. In the Old World, on the other hand, the swine have played a more important part in recent times, having become widely distributed, and throwing off some curiously specialized forms. At the present time, though not very numerous in species, they range through the greater part of the Old World except within or near the Arctic Circle, although, in common with all the other members of the great Ungulate order, they were completely absent from the whole of the Australian region until introduced by man in very recent times.

The existing swine-like animals may be divided naturally into three families: I. *Hippopotamidæ*; II. *Suidæ*, or true Pigs; III. *Dicotylidæ*, or Peccaries.

I. FAMILY HIPPOPOTAMIDÆ.

Muzzle very broad and rounded. Feet short and broad, with four subequal toes, with short rounded hoofs, all reaching the ground in walking. Incisors not rooted but continuously growing; those of the upper jaw curved and directed downwards; those of the lower straight and procumbent. Canines very large, curved, continuously growing; upper ones directed downwards. Premolars $\frac{4}{4}$; *molars* $\frac{3}{3}$. *Stomach complex. No cæcum.*

This appears to be an exclusively Old-World form, —no animals belonging to it, either recent or fossil, having been found in America. The family has been divided into three genera, according to the number of the incisor teeth. (1) *Hexaprotodon*, incisors $\frac{3}{3}$, a type which comes nearest to the generalized or ancestral form of the group, is now extinct, being only known from the early Pliocene formations of the Sub-Himalayan range. (2) *Hippopotamus* proper, incisors $\frac{2}{2}$, contains the one well-known species *H. amphibius*, now confined to the rivers and lakes of Africa, but formerly (in the Pliocene period) abundantly distributed, under various minor modifications, in Europe, as far north as England. Remains of an allied form have been found in the island of Madagascar, where it is now extinct. (3) *Chœropsis*, incisors reduced to $\frac{1}{1}$, contains one very small and still little known species, from rivers of Liberia, West Africa, *C. liberiensis*. See HIPPOPOTAMUS.

II. FAMILY SUIDÆ.

An elongated mobile snout, with an expanded, truncated, nearly naked, flat, oval terminal surface in which the nostrils are placed. Feet narrow; four completely developed toes on each. Hoofs of the two middle toes with their contiguous surfaces flattened. The outer (second and fifth) digits not reaching to the ground in the ordinary walking position. Teeth variable in number, owing to the suppression in some forms of an upper incisor and one or more premolars. Incisors rooted. Upper canines curving more or less outwards or upwards. Stomach simple, except for a more or less developed pouch near the cardiac orifice. A cæcum. Colon spirally coiled. Confined to the Old World.

Sus.—Dentition: $i\,\frac{3}{3}$, $c\,\frac{1}{1}$, $p\,\frac{4}{4}$, $m\,\frac{3}{3}$; total 44. Upper incisors diminishing rapidly in size from the first to the third. Lower incisors long, narrow, closely approximated, and almost horizontal in position, their apices inclining towards the middle line; the second slightly larger than the first, the third much smaller. Canines strongly developed and with persistent roots and partial enamel covering, those of the upper jaw not having the usual downward direction, but curving strongly outwards, upwards, and finally inwards, while those of the lower jaw are directed upwards and outwards with a gentle backward curve, their hinder edges working and wearing against the front edges of the upper canines.[1] They appear externally to the mouth as tusks, the form of the upper lip being modified to allow of their protrusion, but are much less developed in the females than in the males. The teeth of the molar series gradually increase in size and complexity from first to last, and are arranged in contiguous series, except that the first lower premolar is separated by an interval from the second. First and second upper premolars with compressed crowns and two roots. The third and fourth have an inner lobe developed on the crown, and an additional pair of roots. The first and second true molars have quadrate crowns, with four principal obtuse conical cusps, around which numerous accessory cusps are clustered. The crown of the third molar is nearly as long (antero-posteriorly) as those of the first and second together, having, in addition to the four principal lobes, a large posterior talon or heel, composed of numerous clustered conical cusps, and supported by several additional roots. The lower molar teeth resemble generally those of the upper jaw, but are narrower. Milk dentition: $i\,\frac{3}{3}$, $c\,\frac{1}{1}$, $m\,\frac{3}{3}$; total 28,—the first permanent premolar having no predecessor in this series. The third incisor, in both upper and lower jaw, is large, developed before the others, and has much the size, form, and direction of the canine. Vertebræ: C 7, D 13–14, L 6, S 4, C 20–24. The hairy covering of the body varies much under different conditions of climate, but when best developed, as in the European wild boar, consists of long, stiff bristles, mostly abundant on the back and sides, and of a close softer curling under-coat.

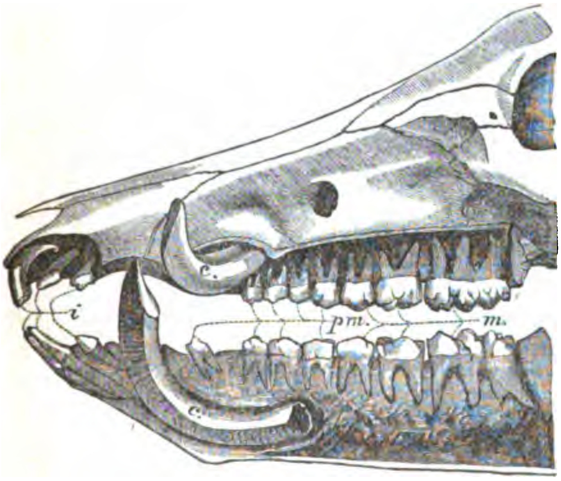

FIG. 1.—Dentition of Boar (*Sus scrofa*).

This genus occurs at present under three principal modifications or subgenera.

A. *Sus* proper comprises a number of animals found in a wild state throughout the greater part of Europe (except where exterminated by human agency), the north of Africa, southern continental Asia, and the great islands of the Malayan archipelago, Formosa, and Japan. The following among others have been admitted by zoologists as distinct species: *Sus scrofa*, the wild boar of Europe, Asia Minor, and North Africa, once common throughout the British Isles; *S. sennaarensis*, Northeast Africa; *S. cristatus*, Hindustan; *S. vittatus*, Java, Borneo, Amboyna, Batchian; *S. barbatus*, Borneo; *S. papuensis*, New Guinea; *S. timorensis*, Timor and Rotti; *S. andamanensis*, Andaman Islands; *S. celebensis*, Celebes; *S. taivanus*, Formosa; *S. leucomystax*, Japan; *S. verrucosus*, Java, Borneo, Ceram. This list will give some idea of the geographical distribution of wild pigs, but it must be borne in mind that through the whole of this region, and in fact now throughout the greater part of the habitable world, pigs are kept by man in a domesticated state, and it is still an open question whether some of the wild pigs of the islands named above may not be local races derived originally from imported domestic specimens. In New Zealand a wild or rather "feral" race is already established, the origin of which is of course quite recent, as it is well ascertained that no animal of the kind ever lived upon the island until after its settlement by Europeans. Whether the various breeds of domestic pigs have been derived from one or several sources is still unknown. As in so many similar cases there is no historic evidence upon the subject, and the researches of naturalists, as Nathusius, Rutimeyer, Rolleston, and others, who have endeavored to settle the question on anatomical evidence, have not led to satisfactory conclusions. It is, however, tolerably certain that all the species or forms of wild pigs enumerated above and all the domestic races are closely allied, and it is probable (though of this there has been no opportunity of proof) will breed freely together. It is a curious circumstance that the young of all the wild kinds of pigs (as far as is known at present) present a uniform coloration, being dark brown with longitudinal stripes of a paler color, a character which completely disappears after the first few months. On the other hand, this peculiar marking is rarely seen in domestic pigs in any part of the world, although it has been occasionally observed. It is stated by Darwin that the pigs which have run wild in Jamaica and the semiferal pigs of Colombia have resumed this aboriginal character, and produce longitudinally striped young; these must of course be the descendants of domestic animals introduced from Europe since the Spanish conquest, as before that time there were no true pigs in the New World. Another character by which the European domestic pig differs from any of the wild species is the concave outline of the frontal region of the skull, a form still retained by the feral pigs in New Zealand.[1]

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[1] If from any accidental circumstances these teeth are not constantly worn down by friction, they grow into a complete circle, the point penetrating the bone of the jaw close to the root of the tooth. The natives of the Fiji Islands avail themselves of this circumstance to produce one of their most valued ornaments—a circular boar's tusk: the upper canines being extracted, the lower ones are allowed to grow to the desired form.

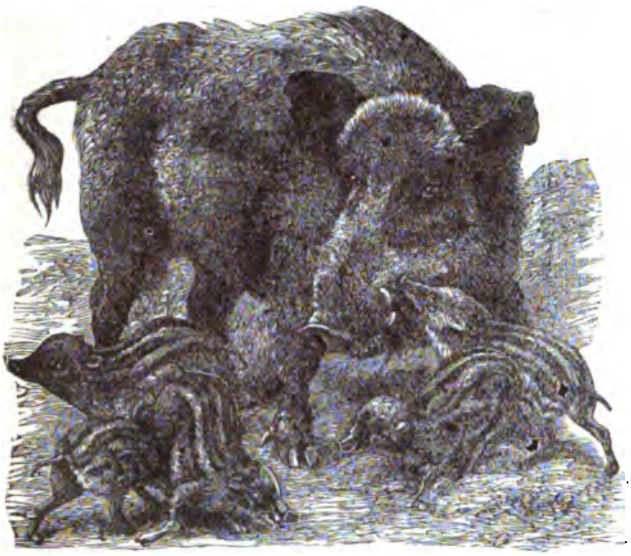

FIG. 2.—Wild Boar and Young.

B. The diminutive pig of Nepal, the Terai, and Bhutan, *Sus salvanius*, has been separated from the rest by Hodgson under the generic name of *Porcula*, but all the alleged distinctive characters prove on more careful investigation to have little real value. Owing to its retired habits, and power of concealment under bushes and long grass in the depths of the great Saul Forest, which is its principal home, very little has been known of this curious little animal, scarcely larger than a hare. The recent acquisition of living specimens in the London Zoological Gardens, has, however, afforded opportunities for careful anatomical observation.[2]

C. Two well-marked species of African swine have been with more reason separated under the name of *Potamochœrus*. The dentition differs from that of true *Sus*, inasmuch as the anterior premolars have a tendency to disappear; sometimes in adult specimens the first upper premolar is retained, but it is usually absent, as well as the first and often the second lower premolars. The molar teeth are also less complex; the last especially has a much less developed heel. There are also characteristic cranial differences. The two species are very distinct in outward appearance and coloration. One is *P. africanus*, the South African River-Hog, or Bosch-Vark, of a gray color, and the other *P. porcus* or *penicillatus*, the West African Red River-Hog, remarkable for its vivid coloring and long pencilled ears. It should be noted that the young of both these species, as well as of the pigmy *S. salvanius*, present the striped character of true *Sus*, a strong indication of close affinities, whereas in all the following forms this is absent.

Babirussa.—Dentition: $i\frac{2}{3}$, $c\frac{1}{1}$, $p\frac{2}{2}$, $m\frac{3}{3}$; total 34. The total number of teeth is therefore considerably reduced, the outer upper incisor and the two anterior premolars of both jaws being absent. The molars, especially the last, are smaller and simpler than in *Sus*, but the great peculiarity of this genus is the extraordinary development of the canines of the male. These teeth are ever-growing, long, slender, and curved, and entirely without enamel covering. Those of the upper jaw are directed upwards from their base, so that they never enter the mouth, but pierce the skin of the face, resembling horns rather than teeth, and curve backwards, downwards, and finally often forwards again, almost or quite touching the skin of the forehead. There is but one species, *B. alfurus*, found only in the islands of Celebes and Buru. Its external surface is almost entirely devoid of hair. With regard to the curiously modified dentition, Wallace (*Malay Archipelago*, i. p. 435) makes the following observations: "It is difficult to understand what can be the use of these horn-like teeth. Some of the old writers supposed that they served as hooks by which the creature could rest its head on a branch. But the way in which they usually diverge just over and in front of the eye has suggested the more probable idea, that they serve to guard these organs from thorns and spines while hunting for fallen fruits among the tangled thickets of rattans and other spiny plants. Even this, however, is not satisfactory, for the female, who must seek her food in the same way, does not possess them. I should be inclined to believe rather that these tusks were once useful, and were then worn down as fast as they grew, but that changed conditions of life have rendered them unnecessary, and they now develop into a monstrous form, just as the incisors of the beaver and rabbit will go on growing if the opposite teeth do not wear them away. In old animals they reach an enormous size, and are generally broken off as if by fighting."

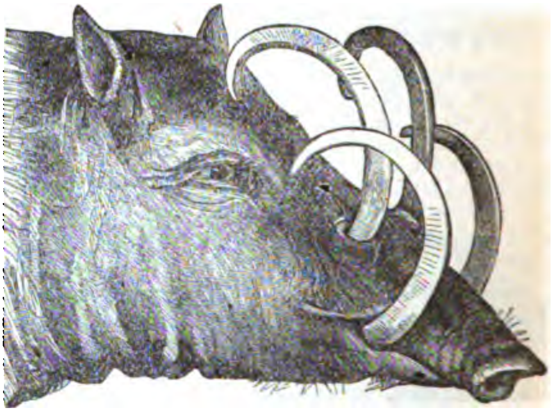

FIG. 3.—Head of Babirussa.

Phacochœrus.—The Wart-Hogs, so called from the large cutaneous lobes projecting from each side of the face, have the teeth still more remarkably modified than in *Babirussa*. The milk dentition, and even the early condition of the permanent dentition, is formed on the same general type as that of *Sus*, except that certain of the typical teeth are absent, the formula being $i\frac{1}{3}$, $c\frac{1}{1}$, $p\frac{3}{2}$, $m\frac{3}{3}$, total 34; but as age advances all the teeth have a tendency to disappear, except the canines and the posterior molars, but these, which in some cases are the only teeth left in the jaws, attain an extraordinary development. The upper canines especially are of great size, and curve outwards, forwards, and upwards. Their enamel covering is confined to the apex, and soon wears away. The lower canines are much more slender, but follow the same curve; except on the posterior surface, their crowns are covered with enamel. Unlike those of the babirussa, the canines of the wart-hog are large in both sexes. The third molar tooth of both jaws is of great size, and presents a structure at first sight unlike that of any other mammal, being composed of numerous (22–25) parallel cylinders or columns, each with pulp cavity, dentine, and enamel covering, and packed together with cement. Careful examination will, however, show that a similar modification to that which has transformed the comparatively simple molar tooth of the mastodon into the extremely complex grinder of the Indian elephant has served to change the tooth of the common pig into that of *Phacochœrus*. The tubercles which cluster over the surface of the crown of the common pig are elongated and drawn out into the columns of the wart-hog, as the low transverse ridges of the mastodon's tooth become the leaf-like plates of the elephant's.

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[1] The breeding of pigs has of late years been practiced with more care and skill than formerly, especially in the United States, where the "hog product" ranks with wheat and cotton as one of the leading agricultural exports. Several volumes have been published of the pedigrees of two breeds—the Berkshire and the Poland-China. The official estimate of the number of swine in the United States in 1886 is 46,000,000, and about the same number is assigned unofficially to Europe, where Servia takes the lead in proportion to population and Norway stands lowest.

[2] See Garson, *Proc. Zool. Soc., Lond.*, 1883, p. 413.

Two species of this genus are distinguished: *P. africanus*, Ælian's Wart-Hog, widely distributed over the continent; and *P. æthiopicus*, Pallas's Wart-Hog, confined to southeastern Africa. In the latter species the dentition reaches its most complete reduction, as in adult specimens the upper incisors are absent and the lower ones worn down to the roots.

III. FAMILY DICOTYLIDÆ.

Snout as in Suidæ. *Dentition:* i $\frac{2}{3}$, c $\frac{1}{1}$, p $\frac{3}{3}$, m $\frac{3}{3}$; *total* 38. *Incisors rooted; upper canines directed downwards, with sharp cutting hinder edges. Toes, four on the fore feet and three on the hind feet* (*the fifth wanting*). *Stomach complex. A cæcum. Confined to the New World.*

There is one genus, *Dicotyles*, with two species, *D. tagaçu*, the Collared Peccary, and *D. labiatus*, the White-Lipped Peccary. See PECCARY. (W. H. F.)

SWINEMÜNDE, a Baltic port and bathing-place on the island of Usedom in Pomerania, Prussia, is situated at the mouth of the Swine, 35 miles to the northwest of Stettin. Its broad unpaved streets and one-story houses built in the Dutch style give it an almost rustic appearance, although its industries, beyond some fishing are entirely connected with its shipping. The entrance to the harbor, one of the best on the Prussian Baltic coast, is protected by two long breakwaters, and is strongly fortified. Swinemünde lighthouse, 216 feet high, the loftiest in Germany, rises beside the new docks on the island of Wollin, on the other side of the narrow Swine. Ships drawing not more than 16 feet can proceed to Stettin, but those of heavier burden discharge or lighten at Swinemünde, which thus stands in the relation of a fore-port to the larger city, with which it is connected by railway. Exclusive of merely passing ships, 615 vessels with a burden of 189,491 tons entered and 607 vessels with a burden of 179,336 tons cleared the port in 1880. In 1882 it possessed a fleet of 39 vessels with a burden of 5218 tons. The population in 1880 was 8478.

The Swine, the central and shortest passage between the Stettiner Haff and the Baltic Sea, was formerly flanked by the fishing villages of West and East Swine. Towards the beginning of last century it was made navigable for large ships, and Swinemünde, which was founded on the site of West Swine in 1748, was fortified and raised to the dignity of a town by Frederick the Great in 1765. In 1775 it had 1000 inhabitants, in 1816, 3191.

SWINTON, a town in the West Riding of Yorkshire, is situated at the junction of the Dearne and Dove navigation with the river Don navigation, and of the South Yorkshire and Midland railway lines, 9 miles northeast of Sheffield and 8 southwest of Doncaster. In the church of St. Margaret (rebuilt in 1817) two beautiful Norman arches of the old church are preserved. There are collieries, quarries, and brickfields in the neighborhood. A large number of persons are employed in the South Yorkshire Railway establishment for the repairing of engines and wagons. There are also flint and glass-bottle works, iron-works (for stoves, grates, fenders, and kitchen ranges), and earthenware manufactures. The town was formerly renowned for its Rockingham ware, but the manufacture has been discontinued for some years. A free warren was granted to Swinton by Henry II. King John, on his march from York to Boston, slept at Swinton old hall. The population of the urban sanitary district (area 1700 acres) in 1871 was 5150, and in 1881 it was 7612.

SWINTON, a large village of Lancashire, is situated on several railway lines, 5 miles northwest of Manchester and 6 southeast of Bolton. The Swinton industrial schools, opened in February, 1846, are a fine range of buildings of brick with stone facings, surrounded with grounds extending to 20 acres. The church of St. Peter, a fine building of stone with a lofty western tower, was erected from the designs of Sir Gilbert Scott in 1869. The manufacture of cotton and coal mining are the chief industries. Anciently a large part of Swinton was possessed by the Knights Hospitallers of St. John of Jerusalem. Swinton and Pendlebury form an urban sanitary district (area 2166 acres) under the government of a local board of twelve members; its population, estimated at 14,052 for 1871, amounted in 1881 to 18,107.

SWITHUN, ST., bishop of Winchester from 852 to 862. The name of St. Swithun, patron saint of Winchester cathedral from the 10th to the 16th century, is scarcely to be found in any contemporary document. His death is entered in the *Anglo-Saxon Chronicle* under the year 861; and his signature is appended to several charters in K[illegible]ble's *Codex Diplomaticus*. Of these charters thre[illegible]elong to 833, 838, and some year between 860 and 862. In the first the saint signs as "Swithunus presbyter regis Egberti," in the second as "Swithunus diaconus," and in the third as "Swithunus episcopus." Hence if the second charter be genuine the first must be spurious, and is so marked in Kemble.

More than a hundred years later, when Dunstan and Ethelwold of Winchester were inaugurating their church reform and supplanting the secular canons of the degenerate English foundations by monks, St. Swithun was adopted as patron of the restored church at Winchester, formerly dedicated to St. Peter and St. Paul. His body was taken up from its almost forgotten grave outside the old monastery and transplanted to Ethelwold's new basilica on 15th July, 971. Numerous miracles preceded and followed this translation. "We have seen," says one contemporary writer, "the precincts of the monastery so thronged with crowds of ailing folk that a traveller could scarcely make his way to the shrine; and yet, after some days, so numerous were the cures that even within the church itself there were scarcely five sick people to be seen." Another writer, likewise a contemporary, claims to the saint's credit two hundred cures in the short space of ten days.

The revival of St. Swithun's fame gave rise to a mass of legendary literature, from which it can only be deduced that towards the end of the 10th century very little was known concerning his career. The so-called *Vitæ Swithuni* of Lantfred and Wulstan, written about this time, hardly contain the very smallest kernel of biographical fact; and all that has in later years passed for authentic detail of St. Swithun's life is extracted from a biography, ascribed with much probability to Gotzelin, a monk who came over to England with Hermann, bishop of Salisbury from 1058 to 1078. From this writer, who has perhaps preserved some fragments of genuine tradition, we learn that St. Swithun was born in the reign of Egbert, and was ordained priest by Helmstan, bishop of Winchester (838–c. 852). His fame reached the king's ears, who appointed him tutor of his son Adulphus (Ethelwulf) and numbered him amongst his chief friends. Under Ethelwulf he was appointed bishop of Winchester, to which see he was consecrated by Archbishop Ceolnoth. In his new office he was remarkable for his piety and his zeal in building new churches or restoring old ones. At his request Ethelwulf gave the tenth of his royal lands to the church. His humility was such that he made his diocesan journeys on foot; and when he gave a banquet he invited the poor and not the rich. He built near the eastern gate of his cathedral city a bridge whose stone arches were so strongly constructed that in Gotzelin's time they seemed a work "non leviter ruiturus." He died 2d July, 862, and gave orders that he was not to be buried within the church but outside in "a vile and unworthy place."

William of Malmesbury adds that, as Bishop Alhstan of Sherborne was Ethelwulf's minister for temporal, so St. Swithun was for spiritual matters. The same chronicler uses a remarkable phrase in recording the bishop's prayer that his burial might be "ubi et pedibus prætereuntium et stillicidiis ex alto rorantibus esset obnoxius." This expression has been taken as indicating that the well-known weather myth contained in the doggerel lines—

> St. Swithin's day if thou dost rain
> For forty days it will remain;
> St. Swithin's day if thou be fair
> For forty days 'twill rain na mair—

had already, in the 12th century, crystallized round the name of St. Swithun; but it is doubtful if the passage lends itself by any straining to this interpretation. Mr. Raine has suggested that the legend is derived from the tremendous downpour of rain that occurred, according to the Durham chroniclers, on St. Swithun's day, 1315 (*Hist. Dunelm.*, pp. xiii. 96–7). Another theory, more plausible, but historically worthless, traces it to a heavy shower by which, on the day of his translation, the saint marked his displeasure towards those who were removing his remains. This story, however, cannot be traced farther back than some two or three centuries at the outside, and is at variance with the 10th-century writers, who are all agreed that the translation took place in accordance with the saint's desire as expressed by vision. More probable is Mr. Earle's suggestion that in the legend as now current we have the survival of some pagan or possibly prehistoric day of augury, which has sheltered itself and preserved its vitality under the protection of an ecclesiastical saint. This view is supported by the fact adduced in *Notes and Queries* (1st ser., xii. p. 137) that in France St. Médard (June 8) and St. Gervase and St. Protais (June 19) are accredited with an influence on the weather almost identical with that attributed to St. Swithun in England. Mr. Parker professes to detect a shower of rain as the symbol of St. Swithun in the clog almanacs (of Queen Elizabeth's time), but Mr. Earle doubts the resemblance. Of other stories connected with St. Swithun the two most famous are those of the Winchester egg-woman and Queen Emma's ordeal. The former is to be found in Gotzelin's life (*c.* 1100), the latter in Rudborne's *Historia Major* (15th century),—a work which is also responsible for the not improbable legend that this prelate accompanied Alfred on his visit to Rome in 856.

The so-called lives of St. Swithun written by Wulstan, Lantfred, and perhaps others towards the end of the 10th century may be found in Bollandus's *Acta Sanctorum* (July), i. 321–327; Mabillon's *Acta SS. O. B.*, vi. 70, etc., vii. 628, etc.; and Earle's *Life and Times of St. Swithun*, 59, etc. See also William of Malmesbury, *Gest. Reg.*, i. 150, and *De Gest. Pont.*, 160, 167, 179; Florence of Worcester, i. 168; Rudborne ap. Wharton's *Anglia Sacra*, i. 287; Hardy's *Cat. of MSS.*, i. 513–17; Brand's *Popular Antiquities*; Chambers's *Book of Days*. Ethelwulf's *Tithe Charters*, nearly all of which refer to St. Swithun in the body of the text, may be studied in Haddon and Stubbs's *Councils*, iii. 636–45; a comparison of the charter on page 642 with Gotzelin's life (ap. Earle, 69) and William of Malmesbury (*Gest. Reg.*, 150; *De Gest. Pont.*, 160) seems to show that these charters, even if forgeries, date back at least to the 11th century, as well as the story of his being Ethelwulf's "altor et ductor."

SWITZERLAND.

PART I.—GEOGRAPHY AND STATISTICS.

General configuration.

As the Swiss Confederation consists of a number of small districts, differing from each other in many points, but gathered round a common centre, originally for common defence against a common foe, it is not surprising that its political boundaries do not coincide with those of nature. So we find that Ticino is south of the main chain of the Alps, a large part of the Grisons is east of the Rhine and of the ranges separating it from Tyrol, while Schaffhausen is north of the Rhine, and Porrentruy is in the French plain far down the western slope of the Jura. Putting aside these exceptional cases (all of them outside the original limits of the Confederation), the physical geography of Switzerland may be thus roughly summed up:

(1) To the south there is the main chain of the Alps, which is joined at Mont Dolent (12,566 feet) by the lower ranges running east from the east end of the Lake of Geneva, and which continues to be the boundary up to the Stelvio Pass.

(2) To the north of this main chain of the Alps there is another great range, only slightly inferior in height and extent, which starts from the hills known as the Mont Jorat above Lausanne, rises in the great peaks of the Bernese Oberland and in the Tödi, trends to the north near Chur, and, after rising once more to form the Säntis, dies away on the south shore of the Lake of Constance.

(3) The main chain of the Alps and this great north outlier are parallel to each other from Mont Dolent to near Chur; joined for a short space near the Pizzo Rotondo (west of the St. Gotthard), they again part near the Oberalp Pass (east of the St. Gotthard). Between these two great ranges flow two of the mightiest European rivers, the Rhine towards the east and the Rhone towards the west, their head waters being separated only by the tangled mountain mass between the Pizzo Rotondo and the Oberalp Pass.

(4) To the north of the great north outlier of the main chain of the Alps there are what may be called the plains of Switzerland, really the huge undulating valley of the Aar (and its affluents), to which must be added the Thur valley between the Aar basin and the Lake of Constance.

Thus, omitting the special cases named above, we may roughly describe Switzerland as consisting of two great trenches traversed by two great rivers, and inclosed by two huge mountain masses, together with the enormous valley of the Aar and the smaller one of the Thur, both these shut in by the great north outlier of the main chain of the Alps, the Rhine, and the Jura,—two deeply cut trenches, and two wide and undulating valleys.

The main chain of the Alps rises in Swiss territory to the height of 15,217 feet in Monte Rosa, and its north outlier to 14,026 feet in the Finsteraarhorn. The mean level of the Aar valley has been estimated at 1378 feet, its lowest point being the low-water mark of the Rhine at Basel (914 feet); the lowest level within the Confederation, however, is on the Lago Maggiore (646 feet).

Area.

According to the most recent calculations, the total area of the Confederation is 15,964.2 square miles, of which 71.7 per cent., or 11,443.3 square miles, are classed as "productive," 3032 square miles being covered by forests, and 132.3 square miles by vines. Of the other 28.3 per cent., or 4520.9 square miles (classed as "unproductive"), 709.9 are occupied by glaciers, 520.3 by lakes, 90 by beds of rivers and streams, and 62.4 by towns, villages, and buildings. Of the whole area the three great cantons of the Grisons, Bern, and Valais take up 7439.9 square miles, or nearly one-half, while, if to them be added Vaud, Ticino, and St. Gall, the extent is raised to 10,552 square miles, or about two-thirds of the entire Confederation.

Rivers.

The total area of Switzerland (15,964.2 square miles) is distributed over four great river basins (draining to three different seas) in the following proportions: Rhine, 11,166; Rhone, 2717; Po, 1358; and Inn, 721.

The *Rhine* basin is by far the largest in Switzerland, and drains of course to the North Sea. The Rhine itself is formed of two branches,—Vorder Rhine (valley of Dissentis) and Hinter Rhine (from the Splugen and St. Bernardino),—which unite at Reichenau, near Chur. The joint stream receives several mountain torrents, expands into the Lake of Constance, and then turns west, receiving the Thur, and opposite Waldshut the great stream of the Aar, finally leaving Swiss territory at Basel, where it turns north. Its main affluent is the Aar, the basin of which covers no less than 6794 square miles. This stream rises in the glaciers of the Bernese Oberland, expands into the Lakes of Brienz and of Thun, receives from the left the Kander, the Saane, and the Zihl, and from the right the Emme, as well as (near Brugg, that great meeting-place of the waters) the Reuss flowing through the Lake of Lucerne and the united stream of the Linth and the Limmat flowing through the Lakes of Wallenstadt and Zurich. It is interesting historically to note the fact that the thirteen cantons which till 1798 formed the Confederation are all comprised in the Rhine basin, the ten oldest (*i.e.*, all before 1500) being within that of the Aar, and that it was only after 1798 that certain Romansch-, French-, and Italian-speaking "allies" and subject lands—with their respective river basins—were tacked on. The *Rhone* rises in the glacier of the same name and flows west, receiving the mountain torrents of the Visp, the Lonza, and the Dranse, besides others, expands into the Lake of Geneva, and a little way from Geneva quits Swiss territory on its way to the Mediterranean. The main stream flowing from Switzerland to the *Po* basin is the Ticino (from the St. Gotthard), which widens into the Lago Maggiore; another stream expands into the Lake of Lugano; and others run into the Lake of Como,—all finally joining the Po in the Lombard plains, thus draining to the Adriatic. The Ramm, flowing through the Münsterthal, joins the Adige and so drains into the Adriatic. The *Inn* basin is composed of the upper part of the river (above Martinsbruck) and drains into the Danube and so into the Black Sea.

Most of the great Swiss rivers, being in their origin mere mountain torrents, tend to overflow their banks, and hence much is required and has been done to prevent this by embanking them, and regaining arable land from them. So the Rhine (between Ragatz and the Lake of Constance), the Rhone, the Aar, the Reuss; and in particular we may mention the great work on the Linth (1807 to 1822) carried out by J. Konrad Escher, who earned by his success the surname of "Von der Linth," and on the Zihl near the Lakes of Neuchâtel and Bienne, while the diversion of the Kander from its junction with the Aar at Uetendorf to a channel by which it flows into the Lake of Thun was effected as early as 1714.[1]

Lakes.

There are very many lakes in Switzerland. The two largest (Geneva and Constance) balance each other at the southwest and northeast corners of the Confederation. The following list gives details regarding the fifteen over 4 square miles in extent. It will be noticed that of these twelve are in the Rhine basin (eleven of them being in that of the Aar), two in the Po basin, one in the Rhone basin, and none at all in the Inn basin. It has been estimated that in the Rhine basin there are no fewer than nineteen large and thirty-seven small lakes. Of the smaller Swiss lakes we may mention the Dauben See, and the Oeschinen See, as well as the Märjelen See close to the Gross Aletsch glacier. There are of course an infinite number of Alpine tarns.

Name of Lake.	River Basin.	Area in Square Miles.	Mean Height of Surface above Sea Level in Ft.	Approximate Depth in Feet.
Geneva*......	Rhone.	223	1230.3	984.3
Constance*.	Rhine.	208.1	1305.8	905.5
Neuchâtel...	Aar, Rhine.	92.3	1427.2	472.4
Maggiore*...	Ticino, Po.	82.7	646.3	1230.3
Lucerne......	Reuss, Aar, Rhine.	43.7	1433.7	? 853
Zurich........	Limmat, Aar, Rhine	33.8	1341.9	469.1
Lugano*.....	Po.	19.4	889.1	902.2
Thun	Aar, Rhine.	18.5	1837.3	711.9
Bienne........	Aar, Rhine.	16.2	1423.9	255.9
Zug............	Reuss, Aar, Rhine.	14.8	1368.1	1321.4
Brienz	Aar, Rhine.	11.5	1851	856.4
Morat.........	Aar, Rhine.	10.5	1427.2	157.4
Wallenstadt	{ Linth, Limmat, Aar, Rhine. }	8.9	1394.4	c 500
Sempach.....	Aar, Rhine.	5.4	1663.4	? ...
Hallwyl	Aar, Rhine.	4	1483	? 1522.8

The lakes marked * are only partly in Swiss territory.

Waterfalls.

There are a great number of waterfalls in Switzerland, the loftiest being that of the Staubbach (1001 feet), in the valley of Lauterbrunnen, or "Clear Springs" (Bernese Oberland). In the Oberland, too, we find the Handeck (200–220 feet), near the source of the Aar, while the Reichenbach descends in seven falls and the Giessbach in thirteen. The falls of the Rhine at Schaffhausen contain an enormous mass of water, though they are only 82 feet in height. In southern Switzerland the Pissevache fall (200 feet), in the Rhone valley, is the best known.

Glaciers.

Dr. A. Heim[2] reckons up 471 glaciers in Switzerland and 462 in Austria, his figures for France and Italy being untrustworthy and incomplete; but Switzerland has 138 glaciers of the first rank (*i.e.*, over 4⅔ miles long) as against 71 in Austria, though Austria has 391 of the second rank (*i.e.*, between 4⅔ and 3 miles long) as against 333 in Switzerland. The distribution of the Swiss glaciers deserves notice, for in eleven cantons (that is, half of those in the Confederation) there are no glaciers at all, while in five others (Unterwalden, Vaud, St. Gall, Schwyz, and Appenzell) they only cover about 13 square miles out of 709.9 square miles of ice and snow in the Confederation according to the official survey. Valais heads the list with 375.1 square miles, then come the Grisons (138.6), Bern (111.3), Uri (44.3), Glarus (13.9), and Ticino (13.1). The longest glacier in the Alps is the Gross Aletsch in the Bernese Oberland, 15 miles long; it has a basin of 49.8 square miles and a maximum breadth of 1968 yards. In point of length the Unteraar glacier comes next (10.4 miles), followed by the Gorner and Viescher glaciers (each 9.4 miles). The lowest point to which a Swiss glacier is known to have descended is 3225 feet, attained by the Lower Grindelwald glacier in 1818. Dr. Heim has ascertained that the maximum annual snowfall in the Alps takes place in the lower snow regions, a conclusion which the present writer can confirm from personal experience gained on the ascent of several of the highest Oberland peaks in January, 1874 and 1879. Dr. Heim states that in the central Alps of Switzerland the limit of perpetual snow varies from 9259 to 9023 feet. See GLACIER.

Climate.

In Switzerland, where the height above sea-level varies from 646 feet (Lago Maggiore) to 15,217 feet (Monte Rosa), we naturally find very many climates, from the regions of olives, vines, oaks and beeches, pines and firs, to those of high mountain pastures, rhododendrons, and of eternal snow (see ALPS). As regards the duration of the seasons, there is a corresponding variety. It has been reckoned that, while in Italian Switzerland winter lasts only three months, at Glarus it lasts four, in the Engadine six, on the St. Gotthard eight, on the Great St. Bernard nine, and on the St. Théodule always. A painstaking writer has calculated that, if Switzerland were flattened out into a plain, and reduced to the level of the sea, it would be comprised between the isotherms 51.8° and 55.4° F. As a matter of fact the mean temperature varies no less than 34½°, for at Bellinzona it is 54½° F., at Geneva 49¼°, at Basel 49⅓°, at Chur 48⅔°, at Interlaken 48°, while on the Great St. Bernard it sinks to 30°, and on the St. Théodule to 20°. The Alps form the boundary between the region where the rainfall is greatest in summer and that where it is greatest in autumn, the winter and spring rainfall varying but slightly. These are the percentages of the annual rainfall in Switzerland at different seasons:

Rhine Basin:	winter, 18;	spring, 25;	summer, 83;	autumn, 24.
Rhone Basin:	" 21;	" 26;	" 26;	" 27.
Ticino Basin:	" 12;	" 26;	" 27;	" 35.

It has been shown by careful observations that the rain (or snow) fall is greatest as we approach the Alps, whether from the north or south, the flanks of the great ranges and the valleys opening out towards the plains receiving much more rain than the high Alpine valleys inclosed on all sides by lofty ridges. Thus the annual rainfall is 35 inches at Basel, but 64½ at Beatenberg (above Interlaken) and 69 at Schwyz, rising to 88 on the Grimsel and 102 on the St. Bernardino, and falling again at Lugano to 63. Dr. Heim calculates that the percentage of snow in the total annual rainfall in Switzerland varies from 63 on the Great St. Bernard to 6 at Geneva, the mean fall of 34 being at Platta in the Grisons. Thunderstorms generally vary in frequency with the amount of rainfall, being most common near the great ranges, and often very local. The floods caused by excessive rainfall are sometimes very destructive, as in 1839, 1852, and 1868, while the same cause leads to landslips, of which the most remarkable have been those on the

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[1] The hydrographic bureau of Switzerland publishes annually a series of graphic tables representing the seasonal changes in the volume of all the important rivers.

[2] In his epoch-making work, *Handbuch der Gletscherkunde*, Stuttgart, 1885.

Rossberg above Goldau (1806), at Evionnaz (1835), and at Elm (1881).

As regards the larger cyclones or storms of Europe, a south wind in the Alps indicates that the barometrical minimum is in the English Channel, a west wind that it is in the North Sea, a north wind that it is in the Eastern Alps, and an east wind that the depression is in the Mediterranean, about Corsica. When the barometrical minimum shifts from the Atlantic over Scandinavia to Russia, a southwest wind in the Alps is followed by west and then north winds. The "föhn" is the most remarkable of the local winds in Switzerland,—a strong southwest or south wind, very hot and very dry. It was formerly supposed to come from the Sahara, but is now held to be a southwest or south wind which, saturated with moisture, crosses the Alps, precipitating a copious rainfall in its course; commencing its descent in the northern valleys with a high temperature for these great heights, it necessarily increases in temperature and dryness as it passes into the high pressure of lower levels. Dr. Hann concludes from observation that, assuming the air to cool at the rate of 1° C. in every 100 metres of ascent, and the ridge crossed by the föhn to be 2000 metres in height, the heat lost on the ascent is only 0.5° C., so that when the föhn reaches the north side it will have a heat, not of 10°, but of 20°. The föhn occurs most frequently in spring. Other local winds in the Alps are those which blow up a valley in the morning and down it in the evening, due to the heating of the air in the valleys by the sun during the day and its cooling by terrestrial radiation at night. The cloud streamers from great Alpine peaks are due to the condensing of the moisture in a layer of air, and, as the moisture is carried away by the wind, so the streamer is dissolved.

For all these reasons Switzerland has many varieties of climate; and, while, owing to the distribution of the rainfall, the Ticino and Aar valleys are very fertile, the two great trenches between the main chain and its north outlier, though warm, are less productive, as the water comes from the rivers and not from the skies.

Mineral products.

Asphalt is the only raw mineral product the export of which exceeds the import; and it is obtained only in the canton of Neuchâtel, where the output of the Val de Travers deposit in 1883 reached 28,000 tons. Though iron ores are known (according to Weber and Brosi's map) to exist in 13 localities, gold in 3, silver in 22, copper in 29, lead in 27, nickel and cobalt in 2, tin in 1, sulphur in 3, Switzerland is practically dependent for all its metals on foreign supply. While 35,161 tons of iron were obtained in 1870 (mostly from mines in the Jura), only 19,045 were obtained in 1881. True coal is wholly absent; lignites, however, occur both in the Tertiary and the Quaternary formations, the most important workings being those of Käpfnach, Utznach, Mörschwyl, Dürnten, Lutry, Conversion, and Oron. In 1870 the output was 33,364 tons, in 1881 only 6184. Anthracite occurs in Valais. Peat is common in many parts. Salt (42,000 tons) is procured from wells in Aargau, Basel, and Vaud. The first salt-deposit was discovered in 1836 at Rothenhaus (Basel canton), that of Rheinfelden in 1844, of Ryburg in 1845, and of Kaiseraugst in 1865. The wells at Bex have been worked since 1554.[2]

Game.

Game is not abundant in any part of Switzerland; and rigorous game laws and other devices have been adopted in order to increase the number of wild animals. In 1875 a law was passed in accordance with which a commission marked out certain reservations or "districts francs pour la chasse au gibier de montagne"; and in 1881 their limits were revised for another term of five years, including an area of 5268 square kilometres [2033.45 square miles] in 1885. There were then within this area 8487 chamois and about 106 roebuck. The chamois were most abundant in the Grisons, Bern, Glarus, and Freiburg. In the Alpine regions the marmot and Alpine hare are still common, and their numbers have increased under the protective system. Grouse, partridge, wild duck, and snipe are the chief game birds. A close time protects birds not considered game, and the federal council in 1885 appointed a commission to draw up a catalogue of all birds found in Switzerland, and to establish stations for collecting facts of ornithological interest.

Fisheries.

Attention has recently been directed to the diminution of the supply of freshwater fish, due in part to overfishing and in part to pollution of the streams. It is estimated that the fish-bearing waters in the whole country cover an aggregate area of 1581 square kilometres (1348 belonging to lakes and 233 to rivers and streams), the cantons with the greatest areas being Vaud (443 square kilometres), Bern (161), Thurgau (139), and Neuchâtel (98). Close seasons, and in certain places close years, have been established, and numerous fish-hatcheries are also in operation (57 in 1885), the species treated being mainly salmon, lake trout, river trout, grayling (ombre), red trout or Röthel, the Swiss *Coregonus*, American *Coregonus* (*C. albus*), *Salmo fontinalis*, and the "mäder." No fewer than 5,709,432 fish were introduced into the lakes and rivers in 1885. By a law of 1884 the

Canton.[1]	Date of Admission.	Date of Present Constitution.	Area in English Square Miles.	Population.		Density per Square Mile.	Deputies in National Rath.	Cantonal Capital.	Population of Capitals.
				1850.	1880.				
Grisons (Graubünden)....G 46, R 40, I 14..K; L	1803	1880	2754.0	89,840	94,991	35	5	Chur..........	8,889
Bern (Berne)................G 85, F 15..........A; L	1353	1846	2659.5	457,921	532,164	205	27	Bern............	44,087
Valais (Waliis).................F 67, G 32..........D; L	1815	1875	2026.3	81,527	100,216	500	5	Sion............	4,871
Vaud (Waadt)...................F 89, G 9..........B; M	1803	1861 ('72)	1244.3	199,453	238,730	194	12	Lausanne......	30,179
Ticino (Tessin)...............I 99.0................ C; N	1803	1830 ('83)	1088.0	117,397	130,777	122	7	Bellinzona....	2,436
St. Gall (Sankt Gallen)...G 99.1..................A; L	1803	1861 ('75)	779.5	169,508	210,491	281	10	St. Gall........	21,438
Zurich................................G 98.8.................A; O	1351	1869	665.9	250,134	317,576	500	16	Zurich.........	75,956
Freiburg (Fribourg)...... F 69, G 31..........D; L	1481	1857	644.4	99,805	115,400	181	6	Freiburg......	11,546
Lucerne (Luzern)..........G 99.5...................A; L	1332	1875 ('82)	579.4	132,789	134,806	234	7	Lucerne.......	17,850
Aargau (Argovie)...........G 99.6...................A; L	1803	1852 ('77)	542.0	199,720	198,645	364	10	Aarau..........	5,944
Uri ....G 76, I 22......A, E; P	1291	1850–51	415.4	14,500	23,694	57	1	Altorf..........	2,901
Thurgau (Thurgovie) ....G 99.5...................A; L	1803	1869	381.4	88,819	99,552	295	5	Frauenfeld...	5,811
Schwyz ....G 96.9...................A; O	1291	1876–77	350.7	44,159	51,235	151	3	Schwyz........	6,543
Neuchâtel (Neuenburg)..F 75, G 24..........B; M	1815	1858 ('80)	311.8	70,679	103,732	343	5	Neuchâtel....	15,612
Soleure (Solothurn)........G 98.9...................A; O	1481	1875	305.9	69,613	80,424	272	4	Soleure........	7,668
Unterwalden Obwald...G 99.3...................A; P	1291	1867	295.4	25,135	27,348	94	1	Sarnen.........	4,039
Unterwalden Nidwald..G 99.0...................A; P		1877					1	Stanz...........	2,210
Glarus...............................G 99.3...................H; P	1352	1842 ('80)	266.8	30,197	34,213	124	2	Glarus.........	5,530
Basel (Basle, Bâle)........ Urban......G 96.3...................A; L	1501	1875	13.8	77,385	124,372	769	3	Basel...........	61,399
Basel (Basle, Bâle)........ Rural..... G 99.5...................A; Q		1863	162.7				3	Liestal.........	4,679
Appenzell Outer.........G 99.6...................A; P	1513	1876	93.4	54,869	64,799	66	3	Appenzell.....	4,302
Appenzell Inner.........G 99.9...................E; P		1872	68.5				1	Herisau........	11,082
Schaffhausen...................G 99.4...................A; L	1501	1876	113.6	35,278	38,348	335	2	Schaffhausen	11,795
Geneva (Genf, Ginevra)..F 85, G 11..........B; M	1815	1847 ('79)	107.8	63,932	101,595	1013	5	Geneva........	68,320
Zug..................................G 98.3...................A; O	1352	1873 ('81)	92.3	17,456	22,994	259	1	Zug.............	4,924

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[1] *Languages.*—G, German; F, French; I, Italian; R, Romansch. *Executive Authority.*—A, Regierungsrath; B, Conseil d'état; C, Consiglio di stato; D, Staatsrath; E, Standeskommission; H, Rath u. Standeskommission; K, Kleiner Rath u. Standeskommission. *Legislative Authority.*—L, Grosser Rath; M, Grand conseil; N, Gran consiglio; O, Kantonsrath; P, Landsgemeinde; Q, Landrath. For details regarding the Stände Rath, of 44 members, and the National Rath, of 145 (made up as shown in column 8 above), see p. 834; and for information regarding the *referendum* in the cantons, see p. 834.

[2] See Stockalper, *Rapport sur le groupe 16 Produits Bruts Exp. Nat. S. à Zurich*, 1883, and Hermann Streng, "Rohprodukte u. deren Fundorte in der Schweiz," in *Zeitsch. f. schweiz. Statistik*, 1884.

federal council is allowed to defray one-third of the expense of the construction of fish-ladders. In 1882 a Swiss fisheries society was founded. Conventions in regard to the fisheries have been signed with Italy, France, and Germany.

Live-stock.

Great importance attaches to the domestic animals of Switzerland. In 1876 there were 284,478 owners of live-stock, in 1886 289,610. The following are the numbers for those two years: horses, 100,935 and 98,333; cattle, 1,035,930, 1,211,713; sheep, 367,549, 341,632; goats, 396,055, 415,916; pigs, 334,515, 394,451; mules, 3145, 2741; asses, 2113, 2042; and bee-hives, 177,825, 207,180. See *Z. f. schw. Statistik*, 1886.

Table of cantons.

The table on p. 816 gives a variety of details regarding the twenty-two Swiss cantons, arranged in the order of their extent. In the first column the languages principally spoken in the different cantons are indicated by letters, as described in the appended foot-note, and the percentages of population speaking them in 1880 are given. In every case the official language is that of the majority, with the exception of Freiburg, where it is German. The same column also shows the various executive and legislative authorities.

Census returns.

The first federal census of which the results were published was neither quite synchronous (April, 1836, to February, 1838) nor quite systematic. That of 1850 took account only of the population with right of residence (*population domiciliée*), and not of the population actually present at the date of the census. In 1860 the census was declared decennial. The following are the numbers returned: March 18-23, 1850, 2,392,740; December 10, 1860, 2,507,170; December 1, 1870, 2,669,147; December 1, 1880, 2,846,102.

Density of population.

As regards density of population, Switzerland, with 198.5 persons to the square mile, stands considerably above Scotland (125) and a long way below England and Wales (446). The Alpine region is the sparsest generally, though certain districts, like Appenzell Ausser-Rhoden, are very densely peopled; the Jura region has a much higher ratio; and the densest region of all is the Swiss plateau. If we draw an irregular line from the east end of the Lake of Geneva by Thun, Lucerne, and the south of the Lake of Zurich to Rheineck, we shall have nearly all the more densely populated portions of the country to the north, the only notable exception being what might be called the Swiss peninsula of Lugano. A large proportion of the country to the south has only from 1 to 19 inhabitants to the square kilometre [.386 square mile]. The districts where the density rises above 250 to the square kilometre are that to the southeast and southwest of Geneva, the vicinity of Lausanne, the districts of Chaux de Fonds, Neuchâtel, Biel, Bern, Soleure, Basel, a large tract along both sides of the Lake of Zurich, and the district between St. Gall and Rheineck. The districts in which an increase of population had taken place between 1870 and 1880 are curiously distributed. An increase of 30 per cent. or over occurs only in the environs of Basel and in two large areas of which the chief centres are Altdorf and Airolo. Decrease was prevalent throughout a large part of the better populated regions of the north, while a certain increase had taken place throughout much of the southwestern area.

Vital statistics.

In 1880 there were 960.8 males to every 1000 females, a rather smaller preponderance of females than in England and Wales. For every 1000 above the age of 50 there are 176 unmarried females to 154 unmarried males. The disproportion of the sexes in the country at large is mainly due to emigration; but in certain cantons it is partly due to excess of women in the immigrants from neighboring countries. In Uri, Schwyz, and Valais only is there an excess of males. In every 1000 of the population there were, in 1860, 296 under 15 years of age, 620 between 15 and 60 years, and 84 upwards of 60; the corresponding figures in 1870 being 315, 595, and 90; and for 1880, 319, 593, and 88. The proportion of married persons to the total number of the adults (47.4 per cent.) is less than in most other countries, though this proportion has been gradually raised both before and since 1880 by certain legislative changes, including the new marriage law in 1874. At the same time the average fertility of the marriages has decreased. Early marriages on the part of the males are slightly more frequent than in England. Divorce and separation are frequent. Thus in 1876-80 they formed nearly 5 per cent. of the marriages, while in Belgium and the Netherlands they do not reach 1 per cent. As regards the marriage relations of the different creeds, the five years 1877-81 showed that (excluding the canton of Geneva, where the creed is not registered) there were only 0.7 separations per 1000 existing marriages where both husband and wife were Catholics, 2.8 where both were Protestants, 3.2 where the husband was a Catholic and the wife a Protestant, and 4.5 where the husband was a Protestant and the wife a Catholic.

The percentage of illegitimate births during the years 1871-77 was 5.7, 5.2, 5.1, 4.8, 4.4, 5.0, and 4.9 respectively, a rate almost identical with that of England and Wales. Infant mortality has been decreasing. While 20.32 per cent. of the quick-born children of 1876 died in their first year, only 17.3 died in 1885.

The following table shows the annual number of births, etc.:

	Marriages.	Per 1000	Births.	Per 1000	Deaths.	Per 1000
1871-75	21,732	8.0	85,832	31.6	64,479	23.8
1876-80	20,740	7.4	91,197	32.5	64,671	23.1
1881-84	19,708	6.8	85,612	29.6	61,082	21.1
1885	20,105	6.8	83,579	28.6	61,548	21.0

Foreigners.

At the census of 1880 there were in Switzerland 211,035 foreigners (112,311 males and 98,724 females), or one foreigner to every 13 or 14 of the population. The origin of this alien element was very various: from Alsace-Lorraine, 2607 males, 2732 females; Germany, 43,923, 45,991; Austria-Hungary, 8389, 4929; Italy, 27,821, 13,709; Spain and Portugal, 175, 93; France, 26,264, 27,389; Holland and Belgium, 445, 493; Great Britain, 1027, 1785; Russia, 599, 685; Servia, Roumania, and Greece, 119, 35; Denmark, Norway, and Sweden, 194, 188; America, 563, 548.

Emigration.

Between 1868 and 1877 the average number of emigrants from Switzerland was 3516 per annum; between 1878 and 1882 it was 7196. In 1883, 1884, and 1885 the figures were respectively 13,502 (12,758 of them native-born Swiss), 9608, and 7583. By far the greater proportion of the emigrants found their way to America, and mainly to the United States, though some of the South American republics (as Chili) attract a considerable number. In the five years 1876-80 3172 persons on an average left for North America annually, 99 for Central America, 594 for South America, and 107 for Australia, while Asia and Africa together did not count more than 167.

Cities.

The population is to a very great extent rural. Only three cities (Zurich, Geneva, and Basel) have a population exceeding 50,000, and at the census of 1880 only 59 other towns had each more than 4000 inhabitants. Of these Bern (see table above), Lausanne, Chaux de Fonds (22,456), St. Gall, Lucerne, Neuchâtel, Winterthur (13,595), Schaffhausen, Biel (11,623), Freiburg, Herisau (11,082), and Locle (10,464) exceeded 10,000.

Religion.

A religious census was taken in 1850, 1860, 1870, and 1880; in the first case only three categories were recognized—Catholic, Protestant, and Jew; in 1860 and 1870 four—Catholic, Protestant, Christians of other denominations, and non-Christian. After much discussion the federal council, which had proposed to drop the religious census in 1880, was prevailed upon by the arguments of ten cantons to adopt a similar classification in 1880. The figures in 1870 were—1,566,347 Protestants, 1,084,369 Catholics, 11,435 members of other sects, and 6996 Jews; in 1880 the Protestants numbered 1,667,109, the Catholics 1,160,782, the Jews 7373, and miscellaneous 10,838. The Jews are most strongly represented in the cantons of Bern (1316 in 1880), Basel (1053), Aargau (1234), Zurich (806), Neuchâtel (689), and Geneva (662).

Agricultural statistics.

It has been estimated that, of the whole area of Switzerland, 1,642,471 acres are under arable cultivation and 1,917,632 acres in forest, while 2,866,113 acres are altogether unproductive. Agricultural statistics have never been systematically registered by the federal authorities, and only a few of the cantons have devoted serious attention to the matter. Herr C. Mühlemann (*Z. f. schweiz. Stat.*, 1886) gives the following estimate of the area cropped and the annual value (in thousands of francs) of the produce:

	Acres.	Value		Acres.	Value
Wheat	153,308	36,054	Other fodder plts.	15,532	2,666
Spelt	193,993	43,346	Pease and beans.	9,574	1,060
Rye	86,689	18,805	Rape	1,966	486
Barley	33,610	5,057	Hemp and flax	12,463	6,101
Oats	122,645	20,468	Chicory	62	18
Potatoes	264,938	79,859	Tobacco	1,730	704
Beet and turnips	43,850	13,254	Vegetables	41,545	4,842
Carrots	16,056	3 148	Meadows, good	529,122	153,512
Mixed fodder	333,612	86,677	" medium	609,865	82,928
Clover	217,897	66,048	" poor	578,940	28,115
Lucerne	27,744	7,449	Pasture & "alps"	1,962,693	139,001
Esparcet	89,324	19,340	Vineyards	79,020	62,350

The value of the fruit produce is given as 127,418,391 francs [$24,591,749.46] (apples, 71,316,992 [$13,764,179.45]; pears, 38,656,150 [$7,460,636.95]).

"Allmends."

The name "allmend" is given to land still held in common, whether arable, meadow, pasture, or forest. The main part of the "allmends" now existing consists of pasture and forest land.

"Alps."

The pasture lands. "alps," or high mountain pastures comprise "voralpen," used in the spring, "mittelalpen," or cow-pastures, and "hochalpen" (sometimes 9000 feet above the sea), for sheep and goats. They are most numerous in Neuchâtel, Bern, and Grisons. The capital value of the whole is estimated at 200,000,000 francs or more.

Forests.

Of the 3032 miles of forest land 127.3 belong to the state, 2007.1 to "communes" or private associations, and 897 to private persons. The federal Government has done much to reafforest tracts, both by itself and by stimulating cantonal effort, and generally to promote the science of forestry.

Industries.

The silk industry of Switzerland was already established at Zurich and Basel in the latter half of the 13th century; but after a period of prosperity it died out. It was again introduced by the Protestants expelled from Locarno in 1555. Crape, velvet, and taffetas were the favorite products of the first stage; ribbon-weaving came later with another band of Locarno refugees and the French Huguenots. In 1872 116 firms were engaged in the silk trade, in 1881 134. Between those dates the employés had increased from 39,940 to 49,816 (65,000 in 1883), and the wages from 15,382,186 to 19,815,453 francs [$2,968,761.90 to $3,824,382.43]. In 1881 2,153,100 kilos [4,747,585½ ℔] of raw silk and 1,067,700 [2,354,278½ ℔] of silk-waste were imported; and the export of silk goods, ribbons, and ferret silk was 1,152,300 [2,540,821½ ℔], 1,965,400 [4,333,707 ℔], and 819,000 kilos [1,805,895 ℔] respectively. Cotton began to be manufactured in Switzerland in the 15th century, and power-loom weaving was introduced in 1830. The industry has owed a good deal to the abundant water-power of the country. In 1881 there were about 23,000 cotton looms; and cotton-spinning employed about 60,000 spindles. The workers numbered 88,046 in 1883. Bleaching and cloth-dressing have attained a great development in the neighborhood of St. Gall, both in the cantons of St. Gall and Appenzell. Printworks are especially numerous in Glarus. Aargau is the chief seat of the woollen manufacture, having 4 millions [$777,000] of the total production valued at 11½ million francs [$2,219,500]. Linen, the first of the Swiss textile fabrics to find its way to a foreign market, is no longer manufactured on a large scale. Embroidered goods are the great specialty of the export trade of eastern Switzerland,—the cantons of St. Gall, Appenzell, Thurgau, and part of Zurich. In flat-stitch machine embroidery 15,256 workers were employed in 1872, and 27,801 in 1880 (43 and 47 per 1000 inhabitants). In the different departments of hand embroidery 33,359 persons were employed in 1881. The St. Gall market is also supplied by a large number of workers in Vorarlberg. The value of the embroidered goods exported from the consular district of St. Gall for America alone increased from 19 to nearly 30 million francs [$3,667,000 to $5,790,000] between 1879 and 1882. Straw-plaiting is an important industry in Aargau (centre at Wohlen), Ticino, and Freiburg. In 1867-68, when the trade was at its best, the total export was worth 10½ million francs [$2,026,500]. Watch and clock making is a specially Swiss industry, giving employment to 44,000 workers in 1883. In Geneva alone 296 establishments were at work in 1882 in some department or other of the manufacture. The valley of Joux (Vaud and Saint Croix), Chaux de Fonds, Locle, Les Brenets, Les Ponts, Fleuvier (Neuchâtel), Bienne, Porrentruy, Saint Imier (Bern), Granges (Soleure), Waldenberg (Basel), and Schaffhausen are all important seats of the craft. The condensed-milk industry of Switzerland is also well known. The exports in 1875 amounted to 4,261,800 kilos [9,397,269 ℔], and in 1883 to 12,086,900 [26,651,614½ ℔]. A similar article is Nestlé's infants' food from Vevey. Swiss cheese (Emmenthal and Gruyère) has a widespread reputation; the export increased from 5,093,100 kilos [11,230,285½ ℔] in 1851 to 25,959,400 [57,241,577 ℔] in 1883. The production of beer in Switzerland was 6,160,000 gallons in 1867 and 20,240,000 in 1882; in the latter year 289,564 gallons were exported. The distilleries (1006) produce about 990,000 gallons of pure alcohol annually. Allusion can only be made here to the great chemical industries of the country, its potteries, paper-mills, engineering works, gun-factories, etc.

Wood-carving was one of the most ancient as it is now one of the best known, of the minor arts of Switzerland. The great seat of the modern industry is the Bernese Oberland, where the peasants during the long evenings of winter for centuries devoted themselves to producing artistic articles in wood. It was regularly organized by Christian Fischer in Brienz (1825), and is now mainly in the hands of a company, founded in 1881, which associates capitalists and workmen in the profits. In 1870 1139 men and 56 women were employed throughout Switzerland in this department; in 1880 the numbers were 1202 and 105.[1]

Wooden houses.

Owing to the original abundance of timber it was almost the only material employed in the building of houses. There are practically three styles: the so-called block-house, in which the logs are laid one upon the other; the post-built house, in which upright posts and a strong framework are filled in with planks; and the "riegelhaus," in which a framework of wood is filled in with brick or stones. In the cantons of Zurich, Thurgau, and Schaffhausen the riegelhaus (the usual form in southern Germany) has—chiefly owing to the increased cost of timber—displaced the two other styles, which alone were in use there till the beginning of the 17th century.[2]

Health stations.

In Gsell-Fels's *Bäder u. klimatische Kurorte der Schweiz* (1880), 505 health stations are mentioned. In Aargau we have the hot springs of Baden and Schinznach (sulphur), the salt baths of Rheinfelden and Mumpf, the mineral waters of Wildegg and Birmensdorf. In Appenzell there are a number of places between 2000 and 3000 feet above the sea famous as whey-cure stations (Heiden, Gais, Appenzell, etc.), and various chalybeate springs (Weissbad, Gonten, Heinrichsbad). Basel contains salt baths at Schweizerhalle, Bienenberg, and Schauenburg. Bern is particularly rich in baths and sanatoriums (Lenk, Weissenburg, Heustrich, Gurnigel, Engistein, Blumenstein). Schwarzseebad is the chief mineral spring in Freiburg; Pfäffers-Ragatz in St. Gall is world-famous. The Stachelberger Schwefelbad in Glarus is much frequented. The Grisons have almost a superfluity of mineral waters, some of which (St. Moritz, Fideris) are exported in large quantities. Weissenstein in Soleure is one of the oldest sanatoriums in Switzerland. Lavey and Bex in Vaud are respectively famous for their sulphur and salt baths. In Valais, Saxon and Leukerbad are famous. The importance of altitude in the attractiveness of a health resort is shown in a table by Guyer, 230 of the hotels for foreign visitors being upwards of 3900 feet above the sea. Dr. F. Stöpel (*Industrie u. Handelspolitik der Schweiz*, 1876) reckoned the total receipts from foreign visitors at 120,000,000 francs.

Commerce.

The position taken by Switzerland in the trade and commerce of the world is remarkable when the various natural obstacles are considered—such as absence of raw material for her industries, costly and difficult means of transport, and restrictive customs established by neighboring countries. The following table shows the value in thousands of francs of the imports and exports for 1885 (the first year for which we have official returns):

	Imports.	Exports.		Imports.	Exports.
Germany	249,262	157,620	Russia	21,318	9,431
France	179,195	139,670	United States	17,842	77,723
Italy	112,095	60,316	Egypt	12,217	2,186
Austria-Hungary	65,603	37,726	Holland	9,286	5,879
Great Britain and Ireland	51,604	99,396	Other countries	10,658	56,939
Belgium	26,372	13,076	Total	755,452	659,964

England is the great market for silver watches; Germany for gold watches and musical boxes; France for weaving machinery; Russia for mills; Italy for miscellaneous machinery; France for asphalt; France for butter; France, Italy, Germany, and the United States for cheese; Germany for silk; Germany for cattle; France for sheep and goats. Cotton manufactures find their way to France, Italy, Austria, Britain, Germany, Spain, India, etc.; leather to the United States and the Argentine Republic. The customs increased from 3,953,192 francs [$762,966.05] in 1850 to 21,342,403 [$4,119,083.78] in 1884.

Education.

By article 27 of the federal constitution of 1874, primary instruction, while left in the charge of the several cantons, is required to be sufficient, obligatory, gratuitous, unsectarian, and under public control of the state. The primary school age is up to twelve years, as far as this general law is concerned, but in some cantons this is raised to fourteen, fifteen, or sixteen years of age. The first school year also varies from five to seven in different cantons. Great variety indeed exists in the whole school organization of the several cantons; while the chief authority as regards the primary schools is in some cases vested in an educational department or educational council, or both, in others it is intrusted to an educational director with or without a council. Considering the difficulties caused in many regions by a sparse population and a rugged country, primary instruction is well carried out. Funds are provided by the state, the commune, and often by the private individual. Even in remote districts the school buildings are generally good. Bern has been especially active in building new schools. In 1882 218,191 boys and 215,889 girls attended the primary schools. Of these 311,271 had German as their mother tongue, 97,113 French, 19,864 Italian, and 5832 Romansch. The total number of male teachers was 5840, and of female teachers 2525; the average pay in money per male teacher was 1303 francs [$251.48], for female teachers 822 francs [$158.65]. The primary school property was valued at 137,534,597 francs [$26,544,177.22] (86,647,507 [$16,722,968.85] in 1871). The expense was 14,781,610 francs [$2,852,850.73] (8,708.174 [$1,680,677.58] in 1871). The communes contributed 8,349,697 francs [$1,611,491.52] and the state 2,825,722 [$545,364.35]. The expense per scholar was 34.1 [$6.58]. For the school children who are too poor to obtain proper food and clothing both public and private assistance is freely rendered. Besides the ordinary public primary schools, there are a considerable number of secondary schools (attended in 1882 by 11,155 boys and 8976 girls), preparatory (or intermediate) schools (9556, 2133), infant schools (10,864, 11,242), schools for adults (12,758, 1110), and private schools (6057, 4834). In 1882 there were in all 272,039 males and 244,896 females in receipt of education. Among the preparatory schools are the "colleges" or "gymnasiums" and the industrial schools, one of which exists in almost all the cantonal capitals as well as at Winterthur, Burgdorf, Porrentruy, Einsiedeln, Murten, and Brieg. In Grisons and Neuchâtel normal schools for the education of teachers are attached to the cantonal schools. Separate establishments for this purpose exist in the cantons of Zurich, Bern, Lucerne, Schwyz, Freiburg, Soleure, St. Gall, Aargau, Thurgau, Tessin, Vaud, and Valais. Among the more specialized institutions of the preparatory or middle class are the *Technitium* at Winterthur, the veterinary colleges at Zurich and Bern, the agricultural schools at Oberstrass and Rütli, and the school of dentistry at Geneva. In the four universities of Basel, Bern, Zurich, and Geneva, each with faculties of law, theology, medicine, and arts (philosophy), the average number of matriculated students per session of six months was, between 1876 (the first year of the Geneva university) and 1881, in theology 113, in law 188, in medicine 469, and in arts 288—a total of 1058, to which must be added 334 non-matriculated. Basel has a preponderance in theology, Bern in law, Zurich in arts. The great federal polytechnicum at Zurich (opened in 1855) comprises schools of architecture, civil and industrial engineering, industrial chemistry, forestry, and agriculture.[1]

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[1] See Rahn, *Gesch. der bildenden Künste in der Schweiz*; Salvisberg, *Die Holzschnitzerei des Berner Oberlandes*; and Davinet, *Bericht über Holzschnitzerei*, 1884.

[2] See Gladbach, *Die Holz-Architectur der Schweiz*, 1885; Graffenried and Stürler, *Architecture Suisse*; Hochstätter, *Schweizer Architektur*; Varin, *L'Arch. pittoresque en Suisse*; and Gladbach, *Der Schweizer Holzstyl*.

Libraries.

The public libraries of Switzerland are briefly described in vol. xiv. p. 527, as they existed in 1868 (*cf.* p. 550); for the learned societies, see SOCIETIES.

Finance.

The total revenue of the Confederation, which was only 22,049,353 francs [$4,255,525.13] in 1869, had increased to 44,308,000 [$8,551,444] on an average in 1879-1883, and reached 48.392,000 [$9,339,656] in 1885; the expenditure, which was 21,744,459 [$4,196,680.59] at the first date, had correspondingly increased to 43,312,510 [$8,359,314.43] in 1879-1883, and 46,278,685 [$8,931,786.20] in 1885.

Army.

In Switzerland there is no standing army, but every male citizen between twenty-four and forty-four years of age is bound to military service and drill. The federal forces consist of the *Auszug*, *Élite*, or regular army (men from twenty to thirty-two years old), and the landwehr (men thirty-two to forty-four years). The whole army was reorganized in 1874, when extensive functions were assigned to the military physician in connection with the recruiting and calling out of the soldiers. In the ten years 1875-84 there was one new recruit for 111 of the population (foreigners excepted); 49 per cent of the total were declared fit for service, 19 per cent. remanded, and 32 per cent. declared unfit. In the long run, about 61.1 per cent. of the young men of the country passed the standard. In 1886 the regulars numbered 117,179 and the landwehr 84,046.[2]

Railways.

Railway construction, which began in 1844, proceeded in earnest after the new legislation of 1852, and by the close of 1862 718 miles had been constructed; by 1872 the ordinary lines reached a total of 1459 miles, with 5 miles of special lines; for 1882 the corresponding figures were 2667 and 81. The annual railway profits increased from 105,599,970 francs [$20,380,794.21] in 1870-74 to 179,151,112 [$34,576,164.61] in 1880-84. Tramways began to be laid down in 1862, and rope railways in 1877. The railways are mostly in the northern plateau and connect with the systems of Northern Europe. The only Swiss line which crosses to the south of the Alps is the St. Gotthard (see RAILWAYS). The proposed Simplon railway has already been carried up the Rhone valley as far as Brieg. The mountainous character of the country and the special exigencies of its traffic have successfully stimulated to some striking efforts of railway engineering. Thus the Rigi railway rises from the Lake of Lucerne to a height of 5739 feet, with a maximum gradient of 250 per thousand; that of the Rorschach-Heiden line is 50 per thousand.

Roads.

Switzerland is famous for its well-made and well-kept carriage-roads. Some of those that traverse the mountain-passes have been constructed at great expense. One of the most remarkable is the mule-path down an almost perpendicular rock from the Gemmi Pass to Leukerbad, made in 1737-40.

Post-Office.

Bern has been the seat of the international Postal Union since 1874 (see POST-OFFICE, vol. xix. p. 600). The federalization of the national post-office dates from 1848,—the different cantons having previously conducted their postal business according to very different methods. It is to be noted that this department charges itself with the conveyance of passengers as well as mails,—these numbering 831,839 in 1880 and 754,365 in 1885. For other details see the table given in vol. xix. p. 601.

Telegraphs.

The length of telegraph lines increased from 1920 kilometres [1193.5 miles] in 1852 to 6874 [4271.36 miles] in 1884 (wires from 1920 to 16,618 kilometres [1193.5 to 10,326.09 miles]), and the number of despatches from 2876 in 1852 to 1,127,311 in 1884, the total receipts for the latter year being 2,555,687 francs [$493,247.59].

Banks.

In Switzerland there are thirty-three legalized banks of issue; their average circulation of notes in 1885 was to the value of 123,431,000 francs [$23,822,183]. There are 325 savings banks proper (deposits 246,359,735 francs [$47,547,428.85] in 1882) and 162 other institutions which receive deposits (267,298,548 francs [$51,588,619.76] in 1882). Most of these are in the hands of companies or private merchants.

Besides the older but valuable works of Faber (1756), Fäsi (1765-68), Füssli (1770-72), Normann (1795-98), Durand (1795-96), Meister (1796), see *Hist. geogr. statistiche Gemälde der Schweiz* (a series of monographs, published by Huber and Co. of St. Gall and Bern); Hottinger, *Staatshaushalt der schweiz. Eidgen.*, 1847; Franscini, *Stat. della Svizzera*, Lugano, 1827 and 1847-49; Wirth, *Allgemeine Beschreibung der Schweiz;* Legoyt and Vogt, *La Suisse;* Prof. Egli's most convenient *Taschenbuch* (1878, etc.) and *Schweizerkunde;* Berlepsch, *Schweizerkunde*, 1875; and Furrer's comprehensive *Volkswirthshaft-Lexicon*. A statistical bureau was founded in 1860, a statistical society in 1864. Dr. Kummer gives a history of Swiss statistics in *Zeitschrift für schweiz. Stat.*, 1885, and his successor, Herr Milliet, to whom we are indebted for much of the above information, is engaged on a statistical handbook. (W. A. B. C.—H. A. W.)

PART II.—HISTORY.

The Swiss Confederation is made up of twenty-two small states, differing from each other in nearly every point,—religious, political, social, industrial, physical, and linguistic; yet it forms a nation the patriotism of whose members is universally acknowledged. History alone can supply us with the key to this puzzle; but Swiss history, while thus essential if we would thoroughly grasp the nature of the Confederation, is very intricate and very local. A firm hold on a few guiding principles is therefore most desirable, and of these there are three which we must always bear in mind. (1) The first to be mentioned is *the connection of Swiss history with that of the empire.* Swiss history is largely the history of the drawing together of bits of each of the imperial kingdoms (Germany, Italy, and Burgundy) for common defence against a common foe —the Hapsburgs; and, when this family have secured to themselves the permanent possession of the empire, the Swiss League little by little wins its independence of the empire, practically in 1499, formally in 1648. Originally a member of the empire, the Confederation becomes first an ally, then merely a friend. (2) The second is *the German origin and nature of the Confederation.* Round a German nucleus (the three Forest districts) there gradually gather other German districts; the Confederation is exclusively German; and it is not till 1803 and 1815 that its French- and Italian-speaking "subjects" are raised to political equality with their former masters, and that the Romansch-speaking Leagues of Rhætia (Graubünden) pass from the status of an ally to that of a member of the Confederation. Even now, though by the constitution three languages (German, French, and Italian) are recognized as official, the overwhelming majority of the population of the Confederation is German-speaking (2,030,792 out of 2,846,102 in 1880), and the capital was fixed at Bern by a law of 1848, having previously shifted between various German-speaking towns, while in olden days the diet always met in some German-speaking place. (3) Swiss history is *a study in federalism.* Based on the defensive alliances of 1291 and 1315 made between the three Forest districts, the Confederation is enlarged by the admission of other districts and towns, all leagued with the original three members, but not necessarily with each other. Hence great difficulties are encountered in looking after common interests, in maintaining any real union; the diet was merely an assembly of ambassadors with powers very strictly limited by their instructions, and there was no central executive authority. The Confederation is a *Staatenbund*, or permanent alliance of several small states. After the break-up of the old system in 1798 we see the idea of a *Bundesstaat*, or an organized state with a central legislative, executive, and judiciary, work its way to the front, an idea which is gradually realized in the constitutions of 1848 and 1874. The whole constitutional history of the Confederation is summed up in this transition to a federal state, which, while a single state in its relations with all foreign powers, in home matters carefully maintains the more or less absolute independence of its several members.

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[1] See especially C. Grob. *Statistik über der Unterrichtswesen in der Schweiz*, 7 parts, 1883, and Dr. H. Wettstein, *Bericht über Gruppe* 30, *Unterrichtswesen* (Zurich Exhibition), 1884.

[2] Details may be found in the *Almanach de Gotha*, 1887.

Swiss history falls naturally into five great divisions: I. the origins of the Confederation—up to 1291[1]; II. the shaking off dependence on the Hapsburgs—up to 1394 (1474); III. the shaking off dependence on the empire—up to 1499 (1648); IV. the period of religious divisions and French influence—up to 1814; V. the construction of an independent state as embodied in the constitutions of 1848 and 1874.

Early history of the Three Lands.

I. On August 1, 1292, the men of the valley of Uri ("homines vallis Uranie"), the free community of the valley of Schwyz ("universitas vallis de Switz"), and the association of the men of the lower valley or Nidwald ("communitas hominum intramontanorum vallis inferioris") formed an Everlasting League for the purpose of self-defence against all who should attack or trouble them, a league which is expressly stated to be a conformation of a former one ("antiquam confederationis formam juramento vallatam presentibus innovando"). This League was the foundation of the Swiss Confederation.

What were these districts? and why at this particular moment was it necessary for them to form a defensive league? The legal and political conditions of all differed. (*a*) In 853 Louis the German granted (*inter alia*) all his lands (and the rights annexed to them) situated in the "pagellus Uroniæ" to the convent of Sts. Felix and Regula in Zurich (the present Fraumünster), of which his daughter Hildegard was the first abbess, and gave to this district the privilege of exemption from all jurisdiction save that of the king (*Reichsfreiheit*). The abbey thus became possessed of the greater part of the valley of the Reuss between the present Devil's Bridge and the Lake of Lucerne, for the upper valley of Urseren belonged at that time to the abbey of Dissentis in the Rhine valley, and did not become permanently allied with Uri till 1410. The privileged position of the abbey tenants gradually led the other men of the valley to "commend" themselves to the abbey, whether they were tenants of other lords, or free men as in the Schächenthal. The meeting of all the inhabitants of the valley, for purposes connected with the customary cultivation of the soil according to fixed rules and methods, served to prepare them for the enjoyment of full political liberty in later days. The important post of "protector" (advocatus or vogt) of the abbey was given to one family after another by the emperor as a sign of trust; but, when, on the extinction of the house of Zäringen in 1218, the office was granted to the Hapsburgs, the protests of the abbey tenants, who feared the rapidly rising power of that family, and perhaps also the desire of the emperor to obtain command of the St. Gotthard pass (of which the first authentic mention occurs about 1236, when of course it could only be traversed on foot), led to the recall of the grant in 1231, the valley being thus restored to its original privileged position, and depending immediately on the emperor. (*b*) In Schwyz we must distinguish between the districts west and east of Steinen. In the former the land was in the hands of many nobles, amongst whom were the Hapsburgs; in the latter there was, at the foot of the Mythen, a free community of men governing themselves, and cultivating their land in common; both, however, were politically subject to the emperor's delegates, the counts of the Zürichgau, who after 1173 were the ever-advancing Hapsburgs. But in 1240 the free community of Schwyz obtained from the emperor Frederick II. a charter which removed them from the jurisdiction of the counts, placing them in immediate dependence on the emperor, like the abbey men of Uri. In a few years, however, the Hapsburgs contrived to dispense with this charter in practice. (*c*) In Unterwalden things were very different. The upper valley (Obwald or Sarnen, so called because of its position with regard to the Kernwald) formed part of the Aargau, the lower (Nidwald or Stanz) part of the Zürichgau, while in both the soil was owned by many ecclesiastical and lay lords, among them being the Hapsburgs and the Alsatian abbey of Murbach. Hence in this district there were no privileged tenants, no free community, no centre of unity, and this explains why Obwald and Nidwald won their way upward so much more slowly than their neighbors in Uri and Schwyz. Thus the early history and legal position of these three districts was very far from being the same. In Uri the Hapsburgs, save for a brief space, had absolutely no rights: while in Schwyz, Obwald, and Nidwald they were also, as counts of the Zürichgau and of the Aargau, the representatives of the emperor.

The League of 1291.

The Hapsburgs had been steadily rising for many years from the position of an unimportant family in the Aargau to that of a powerful clan of large landed proprietors in Swabia and Alsace, and had attained a certain political importance as counts of the Zürichgau and Aargau. In one or both qualities the cadet or Lauffenburg line, to which the family estates in the Forest districts round the Lake of Lucerne had fallen on the division of the inheritance in 1232, seemed to have exercised their legal rights in a harsh manner. In 1240 the free men of Schwyz obtained protection from the emperor; in 1244 the Hapsburgs built the castle of New Hapsburg on a promontory jutting out into the lake not far from Lucerne, with the object of enforcing their real or pretended rights. It is, therefore, not a matter for surprise that, when, after the excommunication and deposition of Frederick II. by Innocent IV. at the council of Lyons in 1245, the head of the cadet line of Hapsburg sided with the pope, the men of the Forest districts should rally round the emperor. Schwyz joined Sarnen, Nidwald helped Lucerne; the castle of New Hapsburg was reduced to its present ruined state; and in 1248 the men of Schwyz, Sarnen, and Lucerne were threatened by the pope with excommunication if they persisted in upholding the emperor and defying their hereditary lords the counts of Hapsburg. The rapid decline of Frederick's cause soon enabled the Hapsburgs to regain their authority in these districts. Yet these obscure risings have a double historical interest, for they are the foundation in fact (so far as they have any) of the legendary stories of Hapsburg oppression told of and by a later age, and these fleeting alliances are doubtless what is represented by the "antiqua confederatio" of 1291, Schwyz already taking the lead, while Uri, secure in its privileged position, contented itself with giving a moral support to its neighbors. After this temporary check the power of the Hapsburgs continued to increase rapidly. In 1273 the head of the cadet line sold all his lands and rights in the Forest districts to the head of the elder or Alsatian line, Rudolph, who a few months later was elected to the imperial throne, in virtue of which he acquired for his family in 1282 the duchy of Austria, which now for the first time became connected with the Hapsburgs. Rudolph recognized the privileges of Uri but not those of Schwyz; and, as he now united in his own person the characters of emperor, count of the Zürichgau and of the Aargau, and landowner in the Forest districts (a name occurring first in 1289), such a union of offices might be expected to result in a confusion of rights. On April 16, 1291, Rudolph bought from the abbey of Murbach in Alsace (of which he was "advocate") all its rights over the town of Lucerne and the abbey estates in Unterwalden. It thus seemed probable that the other Forest districts would be shut off from their natural means of communication with the outer world by way of the lake. Rudolph's death, on July 15 of the same year, cleared the way, and a fortnight later (August 1) the Everlasting League was made between the men of Uri, Schwyz, and Nidwald (the words "et vallis superioris," *i.e.*, Obwald, were inserted later on the original seal of Nidwald) for the purpose of self-defence against a common foe. We do not know the names of the delegates of each valley who concluded the treaty, nor the place where it was made, nor have we any account of the deliberations of which it was the result. The common seal—that great outward sign of the right of a corporate body to act in its own name without needing to ask the permission of any external authority—appears first in Uri in 1243, in Schwyz in 1281; in Nidwald not till this very document of 1291; yet, despite the great differences in their political status, they all joined in concluding this League, and confirmed it by their separate seals, thereby laying claim on behalf of their union to an independent existence. Besides promises of aid and assistance in the case of attack, they agree to punish great criminals by their own authority, but advise that, in minor cases and in all civil cases, each man should recognize the "judex" to whom he owes suit, engaging that the confederates will, in case of need, enforce the decisions of the "judex." At the same time they unanimously refuse to recognize any "judex" who has bought his charge or is a stranger to the valleys. All disputes between the parties to the treaty are, as far as possible, to be settled by a reference to arbiters, a principle which remained in force for over six hundred years. "Judex" is a general term for any local official, especially the chief of the community, whether named by the lord or by the community; and, as earlier in the same year Rudolph had promised the men of Schwyz not to force upon them a "judex" belonging to the class of serfs, we may conjecture from this very decided protest that the chief source of disagreement was in the matter of the jurisdictions of the lord and the free community, and that some recent event in Schwyz led it to insist on the insertion of this provision. It is stipulated also that every man shall be bound to obey his own lord "convenienter," or so far as is fitting and right.

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[1] For the legendary origin, see TELL

Morgarten and the League of 1315.

II. In the struggle for the empire, which extended over the years following the conclusion of the League of 1291, we find that the Confederates support without exception the anti-Hapsburg candidate. On October 16, 1291, Uri and Schwyz ally themselves with Zurich, and join the general rising in Swabia against Albert, the new head of the house of Hapsburg. It soon failed, but hope revived when in 1292 Adolf of Nassau was chosen emperor. In 1297 he confirmed to the free men of Schwyz their charter of 1240, and, strangely enough, confirmed the same charter to Uri, instead of their own of 1231. It is in his reign that we have the first recorded meeting of the "landsgemeinde" (or assembly) of Schwyz (1294), that of Uri being heard of as early as 1275. But in 1298 Albert of Hapsburg himself was elected to the empire. His rule was strict and severe, though not oppressive. He did not indeed confirm the charters of Uri or of Schwyz, but he did not attack the ancient rights of the former, and in the latter he exercised his rights as a landowner and did not abuse his political rights as emperor or as count. In Unterwalden we find that in 1304 the two valleys were joined together under a common administrator, a great step forwards to permanent union. The stories of Albert's tyrannical actions in the Forest districts are not heard of till two centuries later, though no doubt the union of offices in his person was a permanent source of alarm to the Confederation. It was in his time too that the "terrier" (or list of manors and estates, with enumeration of all quit rents, dues, etc., payable by the tenants to their lords) of all the Hapsburg possessions in Upper Germany was begun, and it was on the point of being extended to Schwyz and Unterwalden when Albert was murdered (1308) and the election of Henry of Luxemburg roused the free men to resist the officials charged with the survey. Despite his promise to restore to the Hapsburgs all rights enjoyed by them under his three predecessors (or maintain them in possession), Henry confirmed, on June 3, 1309, to Uri and Schwyz their charters of 1297, and, for some unknown reason, confirmed to Unterwalden all the liberties granted by his predecessor, though as a matter of fact none had been granted. This charter, and the nomination of one imperial bailiff to administer the three districts, had the effect of placing them all (despite historical differences) in an identical political position, and that the most privileged yet given to any of them,—the freedom of the free community of Schwyz. A few days later the Confederates made a fresh treaty of alliance with Zurich; and in 1310 the emperor placed certain other inhabitants of Schwyz on the same privileged footing as the free community. The Hapsburgs were put off with promises; and, though their request (1311) for an inquiry into their precise rights in Alsace and in the Forest districts was granted, no steps were taken to carry out this investigation. Thus in Henry's time the struggle was between the empire and the Hapsburgs as to the recognition of the rights of the latter, *not* between the Hapsburgs and those dependent on them as landlords or counts.

On Henry's death in 1313 the electors hesitated long between Frederick the Fair of Hapsburg and Louis of Bavaria. The men of Schwyz seized this opportunity for making a wanton attack on the great abbey of Einsiedeln, with which they had a long-standing quarrel as to rights of pasture. The abbot caused them to be excommunicated, and Frederick (the choice of the minority of the electors), who was the hereditary "advocate" of the abbey, placed them under the ban of the empire. Louis, to whom they appealed, removed the ban; on which Frederick issued a decree by which he restored to his family all their rights and possessions in *the three valleys* and Urseren, and charged his brother Leopold with the execution of this order. The Confederates hastily concluded alliances with Glarus, Urseren, Art, and Interlaken to protect themselves from attack on every side. Leopold collected a brilliant army at the Austrian town of Zug in order to attack Schwyz, while a body of troops was to take Unterwalden in the rear by way of the Brünig pass. On November 15, 1315, Leopold, with from 15,000 to 20,000 men, moved forward along the shore of the Lake of Egeri, intending to assail the village of Schwyz by climbing the steep hillside above the southern end of the lake, through the narrow pass of Morgarten between the mountain and the lake. At the summit of the pass waited the valiant band of the Confederates, from 1300 to 1500 strong. The march up the rugged and slippery slope threw the Austrian army into disarray, which become a rout and mad flight when huge boulders and trunks of trees were hurled from above by their foes, who charged down on them, and drove them into the lake. No fewer than 1500 Austrians fell; their brilliant cavalry had completely failed before the onset of the lightly armed Swiss footmen. Leopold fled in hot haste to Winterthur, and the attack by the Brünig was driven back by the men of Unterwalden. On December 9, 1315, representatives of the victorious highlanders met at Brunnen, on the Lake of Lucerne, not far from Schwyz, and renewed the Everlasting League of 1291. In their main lines the two documents are very similar, the later being chiefly an expansion of the earlier. That of 1315 is in German (in contrast to the 1291 League, which is in Latin), and has one or two striking clauses largely indebted to a decree issued by Zurich on July 24, 1291. None of the three districts or their dependents is to recognize a new lord without the consent and counsel of the rest (this is probably meant to provide for an interregnum in or disputed election to the empire, possibly for the chance of the election of a Hapsburg); strict obedience in all lawful matters is to be rendered to the rightful lord in each case, unless he attacks or wrongs any of the Confederates, in which case they are to be free from all obligations; no negotiations, so long as the "Länder" have no lord, are to be entered on with outside powers, save by common agreement of all. Louis solemnly recognized and confirmed the new League in 1316, and in 1318 a truce was concluded between the Confederates and the Hapsburgs, who treat with them on equal terms. The lands and rights annexed belonging to the Hapsburgs in the Forest districts are fully recognized as they existed in the days of Henry of Luxemburg and freedom of commerce is granted. But there is not one word about the *political* rights of the Hapsburgs as counts of the Zürichgau and Aargau. This distinction gives the key to the whole history of the relations between the Confederates and Hapsburgs; the rights of the latter as landowners are fully allowed, and till 1801 they possessed estates within the Confederation; it is their political rights which are always contested by the Swiss, who desire to rule themselves, free from the meddling of any external power.

The League of eight members.

As early as 1320 we find the name "Swiss" (derived from Schwyz, which had always been the leader in the struggle) applied to the Confederation as a whole, though it was not till after Sempach (1386) that it came into popular use, and it did not form the official name of the Confederation till 1803. This is in itself a proof of the great renown which the League won by its victory at Morgarten. Another is that as years go by we find other members admitted to the privileges of the original alliance of the three Forest districts. First to join the League (1332) was the neighboring town of Lucerne, which had grown up round the monastery of St. Leodegar (whence the place took its name), perhaps a colony, certainly a cell of the great house of Murbach in Alsace, under the rule of which the town remained till its sale in 1291 to the Hapsburgs. This act of Lucerne was opposed by the house of Austria, but, despite the decision of certain chosen arbitrators in favor of the Hapsburg claims, the town clung to the League with which it was connected by its natural position, and thus brought a new element into the pastoral association of the Forest districts, which now surrounded the entire Lake of Lucerne. Next, in 1351, came the ancient city of Zurich, which in 1218, on the extinction of the house of Zäringen, had become a free imperial city in which the abbess of the Fraumünster (the lady of Uri) had great influence, though from 1240 the citizens elected the council which she had previously named. In 1336 there had been a great civic revolution, headed by Rudolph Brun, which had raised the members of the craft guilds to a position in the municipal government of equal power with that of the patricians, who, however, did not cease intriguing to regain their lost privileges, so that Brun, after long hesitation, decided to throw in the lot of the city with the League rather than with Austria. In this way the League now advanced from the hilly country to the plains, though the terms of the treaty with Zurich did not bind it so closely to the Confederates as in the other cases (the right of making alliances apart from the League being reserved, though the League was to rank before these), and hence rendered it possible for Zurich now and again to incline towards Austria in a fashion which did great hurt to its allies. In 1352 the League was enlarged by the admission of Glarus and Zug. Glarus belonged to the monastery of Säckingen on the Rhine (founded by the Irish monk Fridolin), of which the Hapsburgs were "advocates," claiming therefore many rights over the valley, which refused to admit them, and joyfully received the Confederates who came to its aid; but it was placed on a lower footing than the other members of the League, being bound to obey their orders. Three weeks later the town and district of Zug, attacked by the League and abandoned by their Hapsburg masters, joined the Confederation, forming a transition link between the civic and rural members of the League. The immediate occasion of the union of these two districts was the war begun by the Austrian duke against Zurich, which was ended by the Brandenburg peace of 1352, by which Glarus and Zug were to be restored to the Hapsburgs, who also regained their rights over Lucerne; Zug was won for good by a bold stroke of the men of Schwyz in 1364, but it was not till the day of Näfels (1388) that Glarus recovered its lost freedom. These temporary losses and the treaty made by Brun of Zurich with Austria in 1356 were, however, far outweighed by the entrance into the League in 1353 of the famous town of Bern, which, founded in 1191 by Berthold V. of Zäringen, and endowed with great privileges, had become a free imperial city in 1218 on the extinction of the Zäringen dynasty. Founded for the purpose of bridling the turbulent feudal nobles around, many of whom had become citizens, Bern beat them back at Dornbühl (1298), and made a treaty with the Forest districts as early as 1323. In 1339, at the bloody fight of Laupen, she had broken the power of the nobles forever, and in 1352 had been forced by a treaty with Austria to take part in the war against Zurich, but soon after the conclusion of peace entered the League as the ally of the three Forest districts, being thus only indirectly joined to Lucerne and Zurich. The special importance of the accession of Bern was that the League now began to spread to the west, and was thus brought into connection for the first time with the French-speaking land of Savoy. The League thus numbered eight members, the fruits of Morgarten, and no further members were admitted till 1481, after the Burgundian war. But, in order to thoroughly understand the nature of the League, it must be remembered that, while each of the five new members was allied with the original nucleus,—the three Forest districts,—these five were not directly allied to one another: Lucerne was allied with Zurich and Zug; Zurich with Lucerne, Zug, and Glarus; Glarus with Zurich; Zug with Lucerne and Zurich; Bern with no one except the three original members. The circumstances under which each entered the League can alone explain the very intricate relations at this time of its eight members.

Sempach.

After a short interval of peace the quarrels with Austria broke out afresh; all the members of the League, save the three Forest districts and Glarus, joined the great union of the South German cities; but their attention was soon called to events nearer home. Lucerne fretted much under the Austrian rule, received many Austrian subjects among her citizens, and refused to pay custom duties to the Austrian bailiff at Rothenburg, on the ground that she had the right of free traffic. An attack on the custom-house at Rothenburg, and the gift of the privileges of burghership to the discontented inhabitants of the little town of Sempach a short way off, so irritated Leopold III. (who then held all the possessions of his house outside Austria) that, unmindful of the defeat of his uncle at Morgarten in 1315, he collected a great army, with the intention of crushing his rebellious town. Lucerne meanwhile had summoned the other members of the League to her aid, and, though Leopold's feint of attacking Zurich caused the troops of the League to march at first in that direction, they discovered their mistake in time to turn back and check his advance on Lucerne. From 1500 to 1600 men of Uri, Schwyz, Unterwalden, and Lucerne opposed the 6000 which made up the Austrian army. The decisive fight took place on July 9, 1386, near Sempach, on a bit of sloping meadow-land, cut up by streams and hedges, which forced the Austrian knights to dismount. The great heat of the day, which rendered it impossible to fight in armor, and the furious attacks of the Confederates, finally broke the Austrian line after more than one repulse and turned the day (see WINKELRIED). Leopold, with a large number of his followers, was slain, and the Hapsburg power within the borders of the Confederation finally broken. Glarus at once rose in arms against Austria, but it was not till the expiration of the truce made after Sempach that Leopold's brother, Albert of Austria, brought an army against Glarus, and was signally defeated at Näfels (not far from Glarus) on April 9, 1388, by a handful of Glarus and Schwyz men, the troops of the other Confederates arriving too late.

Freedom from the political claims of the Hapsburgs.

In 1389 a peace for seven years was made, the Confederates being secured in all their conquests; an attempt made in 1393 by Austria by means of Schöno, the chief magistrate of Zurich and leader of the patrician party, to stir up a fresh attack failed owing to a rising of the burghers, who sympathized with the Confederates, and on July 16, 1394, the peace was prolonged for twenty years (and again in 1412 for fifty years), various stipulations being made by which the hundred years' struggle of the League to throw off all political dependence on the Hapsburgs was finally crowned with success. Glarus was freed on payment of 200 pounds annually (in 1389–1395 it bought up all the rights of Säckingen); Zug too was released from Austrian rule. Schwyz was given the town of Einsiedeln (the "advocatia" of the great abbey following in 1397); Lucerne got the Entlibuch, Sempach, and Rothenburg, the last-named being mortgaged only; Bern and Solothurn were confirmed in their conquests. Above all, the Confederation as a whole was relieved from the overlordship of the Hapsburgs, to whom, however, all their rights and dues as landed proprietors were expressly reserved,—Bern, Zurich, and Solothurn guaranteeing the maintenance of these rights and dues, with power in case of need to call on the other Confederates to support them by arms. Thus the distinction always made by the Confederates between the Hapsburgs as rulers and as land-owners was once more upheld; and, though that powerful family entertained hopes of recovering its former rights, so that technically the treaties of 1389, 1394, and 1412 were but truces, it finally and forever renounced all its feudal rights and privileges within the Confederation by the "Everlasting Compact" of 1474.

It is probable that Bern did not take any active share in the Sempach war because she was bound by the treaty of peace made with the Austrians in 1368; and Solothurn, allied with Bern, was doubtless a party to the treaty of 1394 (though not yet in the League), because of its sufferings in 1382 at the hands of the Kyburg line of the Hapsburgs, whose possessions (Thun, Burgdorf, etc.) in 1384 fell into the hands of the two allies.

We may mention here the foray (known as the English or Gugler war) made in 1374–75 by Enguerrand de Coucy (husband of Isabella, daughter of Edward III. of England) and his freebooters (many of them Englishmen and Welshmen), called "Gugler" from their pointed steel caps, with the object of obtaining possession of certain towns in the Aargau (including Sempach), which he claimed as the dowry of his mother Catherine, daughter of the Leopold who was defeated at Morgarten. He was put to rout in the Entlibuch by the men of Bern, Freiburg, Schwyz, and Unterwalden in December, 1375. This victory, which gave rise to the first great Swiss war song, was commemorated with great rejoicings as lately as 1875.

Struggles in Appenzell, St. Gall, and Valais.

III. The great victory at Sempach, not merely vastly increased the fame of the Everlasting League but also enabled it to extend both its influence and its territory. The 15th century is the period when both the League and its several members took the aggressive, and the expansion of their power and lands cannot be better seen than by comparing the state of things at the beginning and at the end of this century. The pastoral highlands of Appenzell (Abbatis Cella) and the town of St. Gall had long been trying to throw off the rights exercised over them by the great abbey of St. Gall, founded in the 7th century by the Irish monk of that name. The Appenzellers in particular had offered a stubborn resistance, and the abbot's troops had been beaten back by them in 1403 on the heights of Vögelinseck, and again in 1405 in the great fight on the pass of the Stoss[1] (which led up into the highlands), in which the abbot was backed by the duke of Austria. Schwyz had given them some help, and in 1411 Appenzell was placed under the protection of the League (save Bern), with which in the next year the city of St. Gall made a similar treaty to last ten years. So too in 1416–17 several of the "tithings" of the Upper Wallis or Valais (*i.e.*, the upper stretch of the Rhone valley), which in 1388 had beaten the bishop and the nobles in a great fight at Visp, became closely associated with Lucerne, Uri, and Unterwalden. It required aid in its final struggle against the great house of Raron, the count-bishop of Sitten (or Sion), and the house of Savoy, which held Lower Wallis,—the Forest districts, on the other hand, wishing to secure themselves against Raron and Savoy in their attempt to permanently conquer the Val d'Ossola on the south side of the Simplon pass. Bern, however, supported its burgher, the lord of Raron; but, by a peace made in 1420, the powers of the bishop and the lord of Raron were greatly diminished: the latter house soon after sold all its lands and rights, and migrated to the district of Toggenburg. Such were the first links which bound these lands with the League; but they did not become full members for a long time—Appenzell in 1513, St. Gall in 1803, Wallis in 1815.

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[1] The tales of the heroic defence of Uli Rottach of Appenzell, and of the appearance of a company of Appenzell women disguised as warriors which turned the battle, are told in connection with this fight, but do not appear till the 17th and 18th centuries, being thus quite unhistorical, so far as our genuine evidence goes.

Space will not allow us to enumerate all the small conquests made in the first half of the 15th century by every member of the League; suffice it to say that each increased and rounded off its territory, but did not give the conquered lands any political rights, governing them as "subject lands," often very harshly. The same phenomenon of lands which had won their own freedom playing the part of tyrant over other lands which joined them more or less by their voluntary action is seen on a larger scale in the case of the conquest of the Aargau, and in the first attempts to secure a footing south of the Alps.

In 1412 the treaty of 1394 between the League and the Hapsburgs had been renewed for fifty years; but when in 1415 Duke Frederick of Austria helped Pope John XXII. to escape from Constance, where the great council was then sitting, and the emperor Sigismund placed the duke under the ban of the empire, summoning all members of the empire to arm against him, the League hesitated, because of their treaty of 1412, till the emperor declared that all the rights and lands of Austria in the League were forfeited, and that their compact did not release them from their obligations to the empire. In the name, therefore, of the emperor, and by his special command, the different members of the League overran the extensive Hapsburg possessions in the Aargau. The chief share fell to Bern, but certain districts (known as the *Freie Aemter*) were joined together and governed as bailiwicks held in common by all the members of the League (save Uri, busied in the south, and Bern, who had already secured the lion's share of the spoil for herself). This is the first case in which the League as a whole took up the position of rulers over districts which, though guaranteed in the enjoyment of their old rights, were nevertheless politically unfree. As an encouragement and a reward, Sigismund had granted in advance to the League the right of criminal jurisdiction ("haute justice" or "Blutbann"), which points to the fact that they were soon to become independent of the empire, as they were of Austria. But all through the 15th century it must be carefully borne in mind that the members of the League were constantly recognized as and acknowledged themselves to be members of the empire.

First Italian conquests.

As the natural policy of Bern was to seek to enlarge its borders at the expense of Austria, and later of Savoy, so we find that Uri, shut off by physical causes from extension in other directions, as steadily turned its eyes towards the south. In 1410 the valley of Urseren was finally joined to Uri; though communications were difficult, and carried on only by means of the "stiebende Brücke," a wooden bridge suspended by chains over the Reuss, along the side of a great rocky buttress (pierced in 1707 by the tunnel known as the Urnerloch), yet this enlargement of the territory of Uri gave it complete command over the St. Gotthard pass, long commercially important, and now to serve for purposes of war and conquest. Already in 1403 Uri and Obwald had taken advantage of a quarrel with the duke of Milan as to custom dues at the market of Varese to occupy the long narrow valley on the south of the pass called the Val Leventina; in 1410 the men of the same two lands, exasperated by the insults of the local lords, called on the other members of the League, and all jointly (except Bern) occupied the Val d'Ossola, on the south side of the Simplon pass. But in 1414 they lost this to Savoy, and, with the object of getting it back, obtained in 1416–17 the alliance of the men of Upper Wallis, then fighting for freedom, and thus regained the valley, despite the exertions of the great Milanese general Carmagnola. In 1419 Uri and Obwald bought from its lord the town and district of Bellinzona. This rapid advance, however, did not approve itself to the duke of Milan, and Carmagnola reoccupied both valleys; the Confederates were not at one with regard to these southern conquests; a small body pressed on in front of the rest, but was cut to pieces at Arbedo near Bellinzona in 1422. A bold attempt in 1425 by a Schwyzer, Peter Rissi by name, to recover the Val d'Ossola caused the Confederates to send a force to rescue these adventurers; but the duke of Milan intrigued with the divided Confederates, and finally in 1426, by a payment of a large sum of money and the grant of certain commercial privileges, the Val Leventina, the Val d'Ossola, and Bellinzona were restored to him. Thus the first attempt of Uri to acquire a footing south of the Alps had failed, but the wish to recover its lost conquests still continued, and a later attempt was more successful, leading to the inclusion in the Confederation of what has been called "Italian Switzerland."

The first civil war.

The original contrasts between the social condition of the different members of the League became more marked when the period of conquest began, and led to quarrels and ill-feeling in the matter of the Aargau and the Italian conquests which a few years later ripened into a civil war, brought about by the dispute as to the succession to the lands of Frederick, count of Toggenburg, the last male representative of his house. Count Frederick's predecessors had greatly extended their domains, so that they took in not only the Toggenburg or upper valley of the Thur, but Uznach, Sargans, the Rhine valley between Feldkirch and Sargans, the Prättigau, and the Davos valley. He himself, the last great feudal lord on the left bank of the Rhine, had managed to secure his vast possessions by making treaties with several members of the League, particularly Zurich (1402) and Schwyz (1417),—from 1428 inclining more and more to Schwyz (then ruled by Ital Reding), being disgusted with the arrogant behavior of Stüssi, the burgomaster of Zurich. His death (April 30, 1436) was the signal for the breaking out of strife. The Prättigau and Davos valley formed the League of the Ten Jurisdictions in Rhætia (see below), while Frederick's widow sided with Zurich against Schwyz for different portions of the great inheritance which had been promised them. After being twice defeated, Zurich was forced in 1440 to buy peace by certain cessions (the Upper March) to Schwyz, the general feeling of the Confederates being opposed to Zurich, several of them going so far as to send men and arms to Schwyz. Zurich, however, was bitterly disappointed at these defeats, and had recourse to that policy which she had adopted in 1356 and 1393—an alliance with Austria (concluded in 1442), which now held the imperial throne in the person of Frederick III. Though technically within her rights according to the terms on which she had joined the League in 1351, this act of Zurich caused the greatest irritation in the Confederation, and civil war at once broke out, especially when the Hapsburg emperor had been solemnly received and acknowledged in Zurich. In 1443 the Zurich troops were completely defeated at St. Jakob on the Sihl, close under the walls of the city, Stüssi himself being slain. Next year the city itself was long besieged. Frederick, unable to get help elsewhere, procured from Charles VII. of France the despatch of a body of Armagnac free lances (the Ecorcheurs), who came, 30,000 strong, under the dauphin Louis, plundering and harrying the land, till, at the very gates of the free imperial city of Basel (which had made a twenty years' alliance with Bern), by the leper house of St. Jakob on the Birs (August 26, 1444), the desperate resistance of a small body of Confederates (1200 to 1500) till cut to pieces, checked the advance of the freebooters, who sustained such tremendous losses that, though the victors, they hastily made peace, and returned whence they had come. Several small engagements ensued, Zurich long declining to make peace because the Confederates required, as the result of a solemn arbitration, the abandonment of the Austrian alliance. At length it was concluded in 1450, the Confederates restoring almost all the lands they had won from Zurich. Thus ended the third attempt of Austria to conquer the League by means of Zurich, which used its position as an imperial free city greatly to the harm of the League, and was the cause of the first civil war which distracted the League.

Constitution of the League, c. 1450.

These fresh proofs of the valor of the Confederates, and of the growing importance of the League, did not fail to produce important results. In 1452 the "Confederates of the Old League of Upper Germany" (as they styled themselves) made their first treaty of alliance with France, a connection which was destined to exercise so much influence on their history. Round the League there began to gather a new class of allies (known as "Zugewandte Orte," or associated districts), more closely joined to it, or to certain members of it, than by a mere treaty of friendship, yet not being admitted to the rank of a full member of the League. Of these associates three, the abbot (1451) and town of St. Gall (1454), and the town of Bienne (Biel), through its alliance (1352) with Bern, were given seats and votes in the diet, being called "socii"; while others, known as "confœderati," were not so closely bound to the League, such as Wallis (1416–17), Schaffhausen (1454), Mühlhausen (1466), Rothweil (1463).[1] Appenzell, too, in 1452, rose from the rank of a "protected district" into the class of associates, outside which were certain places "protected" by several members of the League, such as Gersau (1359), the abbeys of Engelberg (*c.* 1421) and Einsiedeln (1397–1434), and the town of Rapperschwyl (1458). The relation of the "associates" to the League may be compared with the ancient practice of "commendation"; they were bound to obey orders in the matter of declaring war, making alliances, etc.

In 1439 Sigismund succeeded his father Frederick in the Hapsburg lands in Alsace, the Thurgau, and Tyrol, and, being much irritated by the constant encroachments of the Confederates, in particular by the loss of Rapperschwyl (1458), declared war against them, but fared very badly. In 1460 the Confederates overran the Thurgau, and occupied Sargans. Winterthur was only saved by an heroic defence. Hence in 1461 Sigismund had to give up his claims on those lands and renew the peace for fifteen years, while in 1467 he sold Winterthur to Zurich. Thus the whole line of the Rhine was lost to the Hapsburgs, who retained (till 1802) in the territories of the Confederates the Frickthal only. The Thurgovian bailiwicks were governed in common as "subject" lands by all the Confederates except Bern. The touchiness of the now rapidly advancing League was shown by the eagerness with which in 1468 its members took up arms against certain small feudal nobles who were carrying on a harassing guerilla warfare with their allies Schaffhausen and Mühlhausen. They laid siege to Waldshut, and to buy them off Sigismund in August, 1468, engaged to pay 10,000 gulden [$4860] as damages by June 24, 1469; in default of payment the Confederates were to keep forever the Black Forest, Waldshut, and certain other Black Forest towns on the Rhine. A short time before (1467) the League had made treaties of friendship with Philip the Good, duke of Burgundy, and with the duke of Milan. All was now prepared for the intricate series of intrigues which led up to the Burgundian War,—a great epoch in the history of the League, as it created a common national feeling, enormously raised its military reputation, and brought about the close connection with certain parts of Savoy which finally (1803–15) were admitted into the League.

The Burgundian War.

Sigismund did not know where to obtain the sum he had promised to pay. In this strait he turned to Charles the Bold (properly the Rash), duke of Burgundy, who was then beginning his wonderful career, and aiming at restoring the kingdom of Burgundy. For this purpose Charles wished to marry his daughter and heiress to Maximilian, son of the emperor, and first cousin of Sigismund, in order that the emperor might be induced to give him the Burgundian crown. Hence he was ready to meet Sigismund's advances. On May 9, 1469, Charles promised to give Sigismund 50,000 florins [$243,000], receiving as security for repayment Alsace, the Breisgau, the Sundgau, the Black Forest, and the four Forest towns on the Rhine (Rheinfelden, Säckingen, Lauffenburg, and Waldshut); in addition, Charles took Sigismund under his protection, specially against the Swiss, and agreed to give him aid in a war if he was attacked by them. It was not unnatural for Sigismund to think of attacking the League, but Charles's engagement to him is quite inconsistent with the friendly agreement made between Burgundy and the League as late as 1467. The emperor then on his side annulled Sigismund's treaty of 1468 with the Swiss, and placed them under the ban of the empire. Charles committed the mortgaged lands to Peter von Hagenbach, who proceeded to try to establish his master's power there by such harsh and severe measures as to cause all the people to murmur, then rise against him.

The Swiss in these circumstances began to look towards Louis XI. of France, who had confirmed the treaty of friendship made with them by his father in 1452. Sigismund had applied to him early in 1469 to help him in his many troubles, and to give him aid against the Swiss, but Louis had point-blank refused. Anxious to secure their neutrality in case of his war with Charles, he made a treaty with them on August 13, 1470, to this effect. All the evidence goes to show that Sigismund was not a tool in the hands of Louis, and that Louis, at least at that time, had no definite intention of involving Charles and the Swiss in a war, but wished only to secure his own flank.

Sigismund in the next few years tried hard to get from Charles the promised aid against the Swiss (the money was paid punctually enough by Charles on his behalf), who put him off with various excuses. Charles on his side, in 1471–72, tried to make an alliance with the Swiss, his efforts being supported by a party in Bern headed by Adrian von Bubenberg. Probably Charles wished to use both Sigismund and the Swiss to further his own interests, but his shifty policy had the effect of alienating both from him. Sigismund, disgusted with Charles, now inclined towards Louis, whose ally he formally became in the summer of 1473,—a change which was the real cause of the emperor's flight from Treves in November, 1473, when he had come there expressly to crown Charles. The Confederates on their side were greatly moved by the oppression of their friends and allies in Alsace by Hagenbach, and tried in vain (January, 1474) to obtain some redress from his master. Charles's too astute policy had thus lost him both Sigismund and the Swiss. They now looked upon Louis, who, thoroughly aware of Charles's ambition, and fearing that his disappointment at Treves would soon lead to open war, aimed at a master stroke—no less than the reconciliation of Sigismund and the Swiss. This on the face of it seemed impracticable, but common need and Louis's dexterous management brought it to pass, so that on March 30, 1474, the Everlasting Compact was signed at Constance, by which Sigismund finally renounced all Austrian claims on the lands of the Confederates, and guaranteed them in quiet enjoyment of them; they, on the other hand, agreed to support him if Charles did not give up the mortgaged lands when the money was paid down. The next day the Swiss joined the league of the Alsatian and Rhine cities, as also did Sigismund. Charles was called on to receive the money contributed by the Alsatian cities, and to restore his lands to Sigismund. He, however, took no steps. Within a week the oppressive bailiff Hagenbach was captured, and a month later (May 9, 1474) he was put to death, Bern alone of the Confederates being represented. On October 9 the emperor, acting of course at the instance of Sigismund, ordered them to declare war against Charles, which took place on October 25, Bern acting in the name of the Confederates, and alleging that they made war solely by order of the emperor and not as principals. Next day Louis formally ratified his alliance with the Confederates, promising money and pensions, the latter to be increased if he did not send men. Throughout these negotiations and later, Bern directs Swiss policy, though all the Confederates are not quite agreed. She was specially exposed to attack from Charles and Charles's ally (since 1468) Savoy, and her best chance of extending her territory lay towards the west and south. A forward policy was thus distinctly the best for Bern, and this was the line supported by the French party under Nicholas von Diesbach, Von Bubenberg opposing it, though not with any idea of handing over Bern to Charles. The Forest districts, however, were very suspicious of this movement to the west, by which Bern alone could profit, though the League as a whole might lose; then, too, Uri had in 1440 finally won the Val Leventina, and she and her neighbors favored a southerly policy—a policy which was crowned with success after the gallant victory won at Giornico in 1478 by a handful of men from Zurich, Lucerne, Uri, and Schwyz over 12,000 Milanese troops, though the main body of the Confederates was already on its way home. Thus Uri gained for the first time a permanent footing south of the Alps, not long before Bern had won its first conquests from Savoy.

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[1] To the class of "confœderati" belonged in later times Neuchâtel (1495–98), the Leagues of Rhætia (1497–98), Geneva (1519–36), and the bishop of Basel (1579).

The war in the west was begun by Bern and her allies (Freiburg, Solothurn, etc.) by marauding expeditions across the Jura, in which Héricourt (November, 1474) and Blamont (August, 1475) were taken, both towns being held of Charles by the "sires" de Neuchâtel, a cadet line of the counts of Montbéliard. It is said that in the former expedition the white cross was borne (for the first time) as the ensign of the Confederates, but not in the other. Meanwhile Yolande, the duchess of Savoy, had, through fear of her brother Louis XI. and hatred of Bern, finally joined Charles and Milan (January, 1475), the immediate result of which was the capture, by the Bernese and friends (on the way back from a foray on Pontarlier in the Free County of Burgundy or Franche Comté) of several places in Vaud, notably Granson and Échallens, both held of Savoy by a member of the house of Challon, princes of Orange (April, 1475), as well as Orbe and Jougne, held by the same, but under Burgundy. In the summer Bern seized on the Savoyard district of Aigle. Soon after (October–November, 1475) the same energetic policy won for her the Savoyard towns of Morat, Avenches, Estavayer, and Yverdun; while (September) the Upper Wallis, which had conquered all Lower or Savoyard Wallis, entered into alliance with Bern for the purpose of opposing Savoy by preventing the arrival of Milanese troops. Alarmed at their success, the emperor and Louis deserted (June–September) the Confederates, who thus, by the influence of Louis and Bernese ambition, saw themselves led on and then abandoned to the wrath of Charles, and very likely to lose their new conquests. They had entered on the war as "helpers" of the emperors, and now became principals in the war against Charles, who raised the siege of Neuss, made an alliance with Edward IV. of England, received the surrender of Lorraine, and hastened across the Jura (February, 1476) to the aid of his ally Yolande. On February 21 Charles laid siege to Granson, and after a week's siege the garrison of Bernese and Freiburgers had to surrender, and, by way of retaliation for the massacre of the garrison of Estavayer in 1475, of the 412 men two only were spared in order to act as executioners of their comrades. This hideous news met a large body of the Confederates gathered together in great haste to relieve the garrison, and going to their rendezvous at Neuchâtel, where both the count and town had become allies of Bern in 1406. An advance body of Bernese, Freiburgers, and Schwyzers, in order to avoid the castle of Vauxmarcus (seized by Charles), by the Lake of Neuchâtel, on the direct road from Neuchâtel to Granson, climbed over a wooded spur to the north, and attacked (March 2) the Burgundian outposts. Charles drew back his force in order to bring down the Swiss to the more level ground where his cavalry could act, but his rear misinterpreted the order, and when the main Swiss force appeared over the spur the Burgundian army was seized with a panic and fled in disorder. The Swiss had gained a glorious victory, and regained their conquest of Granson, besides capturing very rich spoil in Charles's camp, parts of which are preserved to the present day in various Swiss armories. Such was the famous battle of Granson. Charles at once retired to Lausanne, and set about reorganizing his army. He resolved to advance on Bern by way of Morat (or Murten), which was occupied by a Bernese garrison under Von Bubenberg, and laid siege to it on June 9. The Confederates had now put away all jealousy of Bern, and collected a large army. The decisive battle took place on the afternoon of June 22, after the arrival of the Zurich contingent under Hans Waldmann. English archers were in Charles's army, while with the Swiss was René, the dispossessed duke of Lorraine. After facing each other many hours in the driving rain, a body of Swiss, by outflanking Charles's van, stormed his palisaded camp, and the Burgundians were soon hopelessly beaten, the losses on both sides (a contrast to Granson) being exceedingly heavy. Vaud was reoccupied by the Swiss, Savoy having overrun it on Charles's advance; but Louis now stepped in and procured the restoration of Vaud to Savoy, save Granson, Morat, Orbe, and Échallens, which were to be held by the Bernese jointly with the Freiburgers, Aigle by Bern alone,—Savoy at the same time renouncing all its claims over Freiburg. Thus French-speaking districts first became permanently connected with the Confederation, hitherto purely German, and the war had been one for the maintenance of recent conquests, rather than a purely defensive one against an encroaching neighbor desirous of crushing Swiss freedom. Charles tried in vain to raise a third army; René recovered Lorraine, and on January 5, 1477, under the walls of Nancy, Charles's wide-reaching plans were ended by his defeat and death, many Swiss being with René's troops. The wish of the Bernese to overrun Franche Comté was opposed by the older members of the Confederation. and finally, in 1479, Louis, by very large payments, secured the abandonment of all claims on that province, which was annexed to the French crown.

Internal disputes in the League.

These glorious victories really laid the foundation of Swiss nationality; but soon after them the long-standing jealousy between the civic and rural elements in the Confederation nearly broke it up. This had always hindered common action save in case of certain pressing questions. In 1370, by the "Parsons' ordinance" (Pfaffenbrief), agreed on by all the Confederates except Bern and Glarus, all residents, whether clerics or laymen, in the Confederation who were bound by oath to the duke of Austria were to swear faith to the Confederation, and this oath was to rank before any other; no appeal was to lie to any court spiritual or lay (except in matrimonial and purely spiritual questions) outside the limits of the Confederation, and many regulations were laid down as to the suppression of private wars and keeping of the peace on the high roads. Further, in 1393, the "Sempach ordinance" was accepted by all the Confederates and Solothurn; this was an attempt to enforce police regulations and to lay down "articles of war" for the organization and discipline of the army of the Confederates, minute regulations being made against plundering,—women, monasteries, and churches being in particular protected and secured. But save these two documents common action was limited to the meeting of two envoys from each member of the Confederation and one from each of the "socii" in the diet, the powers of which were greatly limited by the instructions brought by each envoy, thus entailing frequent reference to his Government, and included foreign relations, war and peace, and common arrangements as to police, pestilence, customs duties, coinage, etc. The decisions of the majority did not bind the minority save in the case of the affairs of the bailiwicks ruled in common. Thus everything depended on common agreement and goodwill. But disputes as to the division of the lands conquered in the Burgundian war, and the proposal to admit into the League the towns of Freiburg and Solothurn, which had rendered such good help in the war, caused the two parties to form separate unions, for by the latter proposal the number of towns would have been made the same as that of the "Länder," which these did not at all approve. Suspended a moment by the campaign in the Val Leventina, these quarrels broke out after the victory of Giornico; and at the diet of Stanz (December, 1481), when it seemed probable that the failure of all attempts to come to an understanding would result in the disruption of the League, the mediation of Nicholas von der Flüe[1] (or Bruder Klaus), a holy hermit of Sachseln in Obwald, though he did not appear at the diet in person, succeeded in bringing both sides to reason, and the third great ordinance of the League—the "compact of Stanz"—was agreed on. By this the promise of mutual aid and assistance was renewed, especially when one member attacked another, and stress was laid on the duty of the several Governments to maintain the peace, and not to help the subjects of any other member in case of a rising. The treasure and movables captured in the war were to be equally divided amongst the combatants, the territories and towns amongst the members of the League. As a practical proof of the reconciliation, on the same day the towns of Freiburg and Solothurn were received as full members of the Confederation, united with all the other members, though on less favorable terms than usual, for they were forbidden to make alliances, save with the consent of all or of the greater part of the other members. Both towns had long been allied with Bern, whose influence was greatly increased by their admission. Freiburg, founded in 1178 by Berthold IV. of Zäringen, had on the extinction of that great dynasty (1218) become a free imperial city, but had bowed successively to Kyburg (1249), Austria, the sons of Rudolph (1277), and Savoy (1452); when Savoy gave up its claims in 1477 Freiburg once more became a free imperial city. She had become allied with Bern as early as 1243. The ancient Roman city of Solothurn (or Soleure) had been associated with Bern from 1351, but had in vain sought admission into the League in 1411. Both the new members had done much for Bern in the Burgundian war, and it was for their good service that she now procured them this splendid reward, in hopes perhaps of aid on other important and critical occasions.

The compact of Stanz strengthened the bonds which joined the members of the Confederation; and the same centralizing tendency is well seen in the attempt (1483–89) of Hans Waldmann, the burgomaster of Zurich, to assert the rule of his city over the neighboring country districts, to place all power in the hands of the guilds (whereas by Brun's constitution the patricians had an equal share), to suppress all minor jurisdictions, and to raise a uniform tax. But this idea of concentrating all powers in the hands of the Government aroused great resistance, and led to his overthrow and execution. Peter Kistler succeeded (1470) better at Bern in a reform on the same lines, but not of such a sweeping character.

Practical freedom from the empire.

The early history of each member of the Confederation, and of the Confederation itself, shows that they always professed to belong to the empire, trying to become immediately dependent on the emperor in order to prevent the oppression of middle lords, and to enjoy practical liberty. The empire itself had now become very much of a shadow; cities and princes were gradually asserting their own independence, sometimes breaking away from it altogether. Now, by the time of the Burgundian war the Confederation stood in a position analogous to that of a powerful free imperial city. As long as the emperor's nominal rights were not enforced, all went well; but, when Maximilian, in his attempt to reorganize the empire, erected in 1495 at Worms an imperial chamber which had jurisdiction in all disputes between members of the empire, the Confederates were very unwilling to obey it, partly because they could maintain peace at home by their own authority, and partly because it interfered with their practical independence. Again, their refusal to join the "Swabian League" formed in 1488 by the lords and cities of South Germany to keep the public peace, gave further offence, as well as their fresh alliances with France. Hence a struggle was inevitable, and the occasion by reason of which it broke out was the seizure by the Tyrolese authorities in 1499 of the Münsterthal, which belonged to the "Gotteshausbund," one of the three leagues which had gradually arisen in Rhætia. These were the "Gotteshausbund" in 1367 (taking in all the dependents of the cathedral church at Chur living in the Oberhalbstein and Engadine), the "Oberer or Grauer Bund" in 1395 and 1424 (taking in the abbey of Dissentis and many counts and lords in the Vorder Rhein valley, though its name is not derived, as often stated, from the "gray coats" of the first members, but from "grawen" or "grafen," as so many counts formed part of it), and the "League of the Ten Jurisdictions" (Zehngerichtenbund), which arose in the Prättigau and Davos valley (1436) on the death of Count Frederick of Toggenburg, but which, owing to certain Austrian claims in it, was not quite so free as its neighbors. The first and third of these became allied in 1450, but the formal union of the three dates only from 1524, as documentary proof is wanting of the alleged meeting at Vazerol in 1471, though practically before 1524 they had very much in common. In 1497 the Oberer Bund, in 1498 the Gotteshausbund, made a treaty of alliance with the Everlasting League or Swiss Confederation, the Ten Jurisdictions being unable to do more than show sympathy, owing to Austrian influence, which was not bought up till 1649–52. Hence this attack on the Münsterthal was an attack on an "associate" member of the Swiss Confederation, Maximilian being supported by the Swabian League; but its real historical importance is the influence it had on the relations of the Swiss to the empire. The struggle lasted several months, the chief fight being that "an der Calven" or "auf der Malserheide" (May 22, 1499), in which Benedict Fontana, a leader of the Gotteshausbund men, performed many heroic deeds before his death. But, both sides being exhausted, peace was made at Basel on September 22, 1499. By this the matters in dispute were referred to arbitration, and the emperor annulled all the decisions of the imperial chamber against the Confederation; but nothing was laid down as to its future relations with the empire. No further real attempt, however, was made to enforce the rights of the emperor, and the Confederation became a state allied with the empire, enjoying practical independence, though not formally freed till 1648. Thus, 208 years after the origin of the Confederation, it had got rid of all Austrian claims (1394 and 1474), as well as all practical subjection to the emperor. But its further advance towards the position of an independent state was long checked by religious divisions within, and by the enormous influence of the French king on its foreign relations.

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[1] [He (1417-87) was of Unterwalden, a soldier and councillor. At fifty he turned hermit of most ascetic sort; canonized in 1669.—Am. Ed.]

With the object of strengthening the northern border of the Confederation, two more full members were admitted in 1501—Basel and Schaffhausen—on the same terms as Freiburg and Solothurn. The city of Basel had originally been ruled by its bishop, but in the 14th century it became a free imperial city; before 1501 it had made no permanent alliance with the Confederation, though in continual relations with it. Schaffhausen had grown up round the Benedictine monastery of All Saints, and became in the 13th century a free imperial city, but was pledged to Austria from 1330 to 1415, in which last year the emperor Sigismund delared all Duke Frederick's rights forfeited in consequence of his abetting the flight of Pope John XXII. It had become an "associate" of the Confederation in 1454.

The League enlarged to thirteen members.

A few years later, in 1513, Appenzell, which in 1411 had become a "protected" district, and in 1452 an "associate" member of the Confederation, was admitted as the thirteenth full member; and this remained the number till the fall of the old Confederation in 1798. Round the three original members had gathered first five others, united with the three, but not necessarily with each other; and then gradually there grew up an outer circle, consisting of five more, allied with all the eight old members, but tied down by certain stringent conditions. Constance, which seemed called by nature to enter the League, kept aloof, owing to a quarrel as to the criminal jurisdiction in the Thurgau, which had been pledged to it before the district was conquered by the Confederates. Neuchâtel in 1495–98 became permanently allied with several members of the Confederation.

Conquests in Italy.

In the first years of the 16th century the influence of the Confederates south of the Alps was largely extended. The system of giving pensions, in order to secure the right of enlisting men within the Confederation, and of capitulations, by which the different members supplied troops, was originated by Louis XI. in 1474, and later followed by many other princes. Though a tribute to Swiss valor and courage, this practice had very evil results, of which the first fruits were seen in the Milanese (1500–1516). Both Charles VIII. (1484) and Louis XII. (1499 for ten years) renewed Louis XI.'s treaty. The French attempts to gain Milan were largely carried on by the help of Swiss mercenaries, some of whom were on the opposite side; and, as brotherly feeling was still too strong to make it possible for them to fight against one another, Ludovico Sforza's Swiss troops shamefully betrayed him to the French at Novara (1500). In 1500, too, the three Forest districts occupied Bellinzona at the request of its inhabitants, and in 1503 Louis XII. was forced to cede it to them. He, however, often held back the pay of his Swiss troops, and treated them as mere hirelings, so that when the ten years' treaty came to an end Matthew Schinner, bishop of Sitten (or Sion), induced them to join (1510) the pope, Julius II., then engaged in forming the Holy League to expel the French from Italy. But when, after the battle of Ravenna, Louis XII. became all-powerful in Lombardy, 20,000 Swiss poured down into the Milanese and occupied it, Schmid, the burgomaster of Zurich, naming Maximilian (Ludovico's son) duke of Milan, in return for which he ceded to the Confederates Locarno, Val Maggia, Mendrisio, and Lugano (1512), while the Rhætian leagues received Chiavenna, Bormio, and the Valtelline. (The former districts, with Bellinzona and the Val Leventina, were in 1803 made into the canton of Ticino, the latter were held by Rhætia till 1797.) In 1513 the Swiss completely defeated the French at Novara, and in 1514 Pace was sent by Henry VIII. of England to give pensions and get soldiers. Francis I. at once on his accession (1515) began to prepare to win back the Milanese, and, successfully evading the Swiss awaiting his descent from the Alps, beat them in a pitched battle at Marignano near Milan (September 13, 1515), which broke the Swiss power in North Italy, so that in 1516 a peace was made with France,—Wallis, the Rhætian leagues, and St. Gall being included on the side of the Confederates. Provisions were made for the neutrality of either party in case the other became involved in war, and large pensions were promised. This treaty was extended by another in 1521 (to which Zurich, then under Zwingli's influence, would not agree, holding aloof from the French alliance till 1614), by which the French king might, with the consent of the Confederation, enlist any number of men between 6000 and 16,000, paying them fit wages, and the pensions were raised to 3000 francs [$579] annually to each member of the Confederation. These two treaties were the starting point and foundation of later French interference with Swiss affairs, which became more and more oppressive, and was not finally thrown off till 1814.

The Reformation.

IV. In 1499 the Swiss had practically renounced their allegiance to the emperor, the temporal chief of the world according to mediæval theory; and in the 16th century a great number of them did the same by the world's spiritual chief, the pope. The scene of the revolt was Zurich and the leader Ulrich Zwingli. But we cannot understand Zwingli's career unless we remember that he was almost more a political reformer than a religious one. In his former character his policy was threefold. He bitterly opposed the French alliance and the pension and mercenary system, for he had seen its evils with his own eyes when serving as chaplain with the troops in the Milanese in 1512 and 1515. Hence in 1521 his influence kept Zurich back from joining in the treaty with Francis I. Then, too, at the time of the Peasant Revolt (1525), he did what he could to lighten the harsh rule of the city over the neighboring rural districts, and succeeded in getting serfage abolished. Again he had it greatly at heart to secure for Zurich and Bern the chief power in the Confederation, because of their importance and size; he wished to give them extra votes in the diet, and would have given them two-thirds of the "common bailiwicks" when these were divided. In his character as a religious reformer we must remember that he was a humanist, and deeply read in classical literature, which accounts for his turning the canonries of the Grossmünster into professorships, reviving the old school of the Carolinum, and relying on the arm of the state to carry out religious changes. His theology sprang from a single ruling principle—the absolute and unlimited sovereignty of God. Hence his profound respect for the letter of the Bible led him to "legalism" and extreme Sabbatarianism. Hence his view of the incarnation bordered on Unitarianism, and sacraments were mere signs of that which is already given, hence too sprang his denial of man's free will and his belief in absolute election and reprobation. Nay, God, being the absolute Author of all things, is the Author of evil, though he is not immoral, for He is above law, and what is morally wrong for man is not so for God. Zwingli began to preach the new views as early as 1516, long before and quite independently of Luther; but it was only when at the end of 1518 he was called to Zurich as parish priest that he began to make any noise, and in fact it was even later (1522), when his admirers allowed themselves to eat fish in Lent, that disturbances arose, and the diet forbade all preaching which would disturb the public peace. But, after succeeding at two public disputations, his views rapidly gained ground at Zurich, which long, however, stood quite alone, the other Confederates issuing an appeal to await the decision of the asked-for general council, and proposing to carry out by the arm of the state certain small reforms, while clinging to the old doctrines. Zwingli had to put down the extreme wing of the Reformers—the Anabaptists—by force. Quarrels too arose as to allowing the new views in the "common bailiwicks." The disputation at Baden (1526) was in favor of the maintainers of the old faith; but that at Bern (1528) resulted in securing for the new views the support of that great town, and so matters began to take another aspect. In 1528 Bern joined the union formed in 1527 in favor of religious freedom by Zurich and Constance (*Christliches Burgrecht*), and her example was followed by Schaffhausen, St. Gall, Basel, and Mühlhausen. This attempt to virtually break up the League was met in February, 1529, by the offensive and defensive alliance made with King Ferdinand of Hungary (brother of the emperor) by the three Forest districts, with Lucerne and Zug, followed (April, 1529) by the "Christliche Vereinigung," or union between these five members of the League. Zurich was greatly moved by this, and, as Zwingli held that for the honor of God war was as necessary as iconoclasm, war seemed imminent; but Bern held back; and the first peace of Kappel was concluded (June, 1529), by which the Hungarian alliance was annulled and the principle of "religious parity" (or freedom) was admitted in the case of each member of the League and in the "common bailiwicks." This was at once a victory and a check for Zwingli. He tried to make an alliance with the Protestants in Germany, but failed at the meeting at Marburg (October, 1529) to come to an agreement with Luther on the subject of the eucharist, and the division between the Swiss and the German Reformations was stereotyped. Zwingli now developed his views as to the greater weight which Zurich and Bern ought to have in the League. Quarrels too went on in the "common bailiwicks," for the members of the League who clung to the old faith had a majority of votes in matters relating to these districts. Zurich tried to cut off supplies of food from reaching the Catholic members (contrary to the wishes of Zwingli), and on the death of the abbot of St. Gall, disregarding the rights of Lucerne, Schwyz, and Glarus, who shared with her the office of protectors of the abbey, suppressed the monastery, giving the rule of the land and the people to her own officers. Bern in vain tried to moderate this aggressive policy, and the Catholic members of the League indignantly advanced towards Zurich. Near Kappel, on October 11, 1531, Zurich vanguard under Göldli was (perhaps owing to his treachery) surprised, and despite reinforcements the men of Zurich were beaten, among the slain being Zwingli himself. Another defeat completed the discomfiture of Zurich, and by the second peace of Kappel (November, 1531) the principle of "parity" was recognized, not merely in the case of each member of the League and the "common bailiwicks," *but also in that of each parish or "commune."* Thus everywhere the rights of a minority were protected from the encroachments of the majority. The "Christliches Burgrecht" was abolished, and Zurich condemned to pay heavy damages. Bullinger succeeded Zwingli, but this treaty meant that neither side could now try to convert the other wholesale. The League was permanently split into two religious camps: the Catholics, who met at Lucerne, numbered, besides the five already mentioned, Freiburg, Solothurn, Appenzell (Inner Rhoden), and St. Gall (with Wallis), thus commanding seventeen votes (out of twenty-nine) in the diet; the Evangelicals were Zurich, Bern, Basel, Schaffhausen, Appenzell (Ausser Rhoden) (with Graubünden), who met at Aarau; while Thurgau and Glarus were divided.

Conquest of Vaud by Bern.

Bern had her eyes always fixed upon the Savoyard lands to the southwest, in which she had got a footing in 1475, and now made zeal for religious reforms the excuse for resuming her advance policy. In 1526 William Farel, a preacher from Dauphiné, had been sent to reform Aigle, Morat, and Neuchâtel. In 1532 he came to Geneva, an ancient city of which the rule had long been disputed by the prince-bishop, the burgesses, and the house of Savoy, the latter holding the neighboring districts. She had become in 1519 the ally of Freiburg, in 1526 that of Bern also; and in 1530, by their influence, a peace was made between the contending parties. (In 1531 Bonivard, the prior of St. Victor, for joining a rising in favor of political liberty, was imprisoned in the castle of Chillon, remaining there till 1536). The religious changes introduced by Farel greatly displeased Freiburg, which abandoned the alliance (1534), and in 1535 the Reformation was firmly planted in the city. The duke of Savoy, however, took up arms against Bern (1536), who overran Gex, Vaud, and the independent bishopric of Lausanne, as well as the Chablais to the south of the lake. Geneva was only saved by the unwillingness of the citizens. Bern thus ruled north and south of the lake, and carried matters with a high hand. Shortly after this John Calvin, a refugee from Picardy, was, when passing through Geneva, detained by Farel to aid him, and, after an exile from 1538–1541, owing to opposition of the papal party, and of the burghers, who objected to Bernese rule, he set up his wonderful theocratic government in the city, pushing Zwingli's principles to their ultimate conclusions (see SERVETUS) (1553), and in 1555 expelling many who upheld municipal liberty, replacing them by French, English, Italians, and Spaniards as new burghers, whose names are still frequent in Geneva (*e.g.*, Candolle, Mallet, Diodati). His theological views led to disputes with the Zurich Reformers, which were partly settled by the *Consensus Tigurinus* of 1549, and more completely by the *Helvetic Confession* of 1566, which formed the basis of union between the two parties.

By the time of Calvin's death (1564) the old faith had begun to take the offensive; the reforms made by the council of Trent urged on the Catholics to make an attempt to recover lost ground. Emmanuel Philibert, duke of Savoy, the hero of St. Quentin (1557), and one of the greatest generals of the day, with the support of the Catholic members of the League, demanded the restoration of the districts seized by Bern in 1536, and on October 30, 1564, the treaty of Lausanne confirmed the decision of the other Confederates sitting as arbitrators (according to the old constitutional custom). By this treaty Gex, the Genevois, and the Chablais were to be given back, while Vevey, Chillon, Lausanne, Yverdun were to be kept by Bern, who engaged to maintain the old rights and liberties of Vaud, which in 1565 were further placed under the special protection of France. Thus Bern lost the lands south of the lake, in which St. Francis of Sales, the exiled prince-bishop of Geneva, at once proceeded to carry out the restoration of the old faith. In 1555 Bern and Freiburg, as creditors of the debt-laden count, divided the county of Gruyères, thus getting fresh French-speaking subjects. In 1558 Geneva renewed her alliance with Bern, and in 1584 she made one with Zurich.

The Counter Reformation.

The decrees of the council of Trent had been accepted fully by the Catholic members of the League, so far as relates to dogma, but not as regards discipline or the relations of church and state, the sovereign rights and jurisdiction of each state being always carefully reserved. The Counter Reformation, however, or reaction in favor of the old faith, was making rapid progress in the Confederation, mainly through the indefatigable exertions of Charles Borromeo, from 1560 to 1584 archbishop of Milan (in which diocese the Italian bailiwicks were included), and nephew of Pius IV., supported at Lucerne by Ludwig Pfyffer, who, having been (1562–1570) the chief of the Swiss mercenaries in the French wars of religion, did so much till his death (1594) to further the religious reaction at home that he was popularly known as the "Swiss king." In 1574 the Jesuits, the great order of the reaction, were established at Lucerne; in 1579 a papal nuncio came to Lucerne; Charles Borromeo founded the "Collegium Helveticum" at Milan for the education of forty-two young Swiss, and the Catholic members of the League made an alliance with the bishop of Basel; in 1581 the Capuchins were introduced to influence the more ignorant classes. Most important of all was the Golden or Borromean League, concluded (October 5, 1586) between the seven Catholic members of the Confederation (Uri, Schwyz, Unterwalden, Lucerne, Zug, Freiburg, and Solothurn) for the maintenance of the true faith in their territories, each engaging to punish backsliding members and to help each other if attacked by external enemies notwithstanding any other leagues, old or new. This league marks the final breaking up of the Confederation into two great parties, which greatly hindered its progress. The Catholic members had a majority in the diet, and were therefore able to refuse admittance to Geneva, Strasburg, and Mühlhausen. Another result of these religious differences was the breaking up of Appenzell into two bits (1597), each sending one representative to the diet—"Inner Rhoden" remaining Catholic, "Ausser Rhoden" adopting the new views. We may compare with this the action of Zurich in 1555, when she received the Protestant exiles from Locarno and the Italian bailiwicks into her burghership, and Italian names are found there to this day (*e.g.*, Orelli, Muralt). The duke of Savoy made several vain attempts to get hold of Geneva, the last (in 1602) being known as the "Escalade."

In the Thirty Years' War the Confederation remained neutral, being bound both to Austria (1474) and to France (1516), and neither religious party wishing to give the other an excuse for calling in foreign armies. But the troubles in Rhætia threatened entanglements. Austria wished to secure the Münsterthal (belonging to the League of the Ten Jurisdictions), and Spain wanted the command of the passes leading from the Valtelline (conquered by the leagues of Rhætia in 1512), the object being to connect the Hapsburg lands of Tyrol and Milan. In the Valtelline the rule of the Three Leagues was very harsh, and Spanish intrigues easily brought about the massacre of 1620, by which the valley was won, the Catholic members of the Confederation stopping the troops of Zurich and Bern. In 1622 the Austrians conquered the Prättigau, over which they still had certain feudal rights. French troops regained the Valtelline in 1624, but it was lost once more in 1629 to the imperial troops, and it was not till 1635 that the French, under Rohan, finally succeeded in holding it. The French, however, wished to keep it permanently; hence new troubles arose, and in 1637 the natives, under George Jenatche, with Spanish aid drove them out, the Spaniards themselves being forced to resign it in 1639. It was only in 1649–52 that the Austrian rights in the Prättigau were finally bought up by the league of the Ten Jurisdictions, which thus gained its freedom.

In consequence of Ferdinand II.'s edict of restitution (1629), by which the *status quo* of 1552 was reestablished—the high-water mark of the Counter Reformation—the abbot of St. Gall tried to make some religious changes in his territories, but the protest of Zurich led to the Baden compromise of 1632, by which in the case of disputes on religious matters arising in the "common bailiwicks," the decision was to be, not by a majority, but by means of friendly discussion—a logical application of the doctrine of religious parity—or by arbitration.

Formal freedom from the empire.

But by far the most important event in Swiss history in this age is the formal freeing of the Confederation from the empire. Basel had been admitted a member of the League in 1501, two years after the Confederation had been practically freed from the jurisdiction of the imperial chamber, though the city was included in the new division of the empire into "circles" (1521), which did not take in the older members of the Confederation. Basel, however, refused to admit this jurisdiction; the question was taken up by France and Sweden at the congress of Münster, and formed the subject of a special clause in the treaties of Westphalia, by which the city of Basel and the other "Helvetiorum cantones" were declared to be "in the possession of almost entire liberty and exemption from the empire, and *nullatenus* subject to the imperial tribunals." This was intended to mean exemption from all obligations to the empire (with which the Confederation was connected hereafter simply as a friend), and to be a definitive settlement of the question. Thus by the events of 1499 and 1648 the Confederation had become an independent European state, which, by the treaty of 1516, stood as regards France in a relation of neutrality.

In 1668, in consequence of Louis XIV.'s temporary occupation of the Franche Comté, an old scheme for settling the number of men to be sent by each member of the confederation to the joint army, and the appointment of a council of war in war time, that is, an attempt to create a common military organization, was accepted by the diet, which was to send two deputies to the council, armed with full political powers. This agreement, known as the *Defensionale*, is the only instance of joint and unanimous action in this miserable period of Swiss history, when religious divisions crippled the energy of the Confederation.

French influence, religious divisions, and rise of an aristocracy.

Throughout the 17th and 18th centuries the Confederation was practically a dependency of France. In 1614 Zurich for the first time joined in the treaty, which was renewed in 1663 with special provisions as regards the Protestant Swiss mercenaries in the king's pay and a promise of French neutrality in case of civil war in the League. The Swiss had to stand by while Louis XIV. won Alsace (1648), Franche Comté (1678), and Strasburg (1681). But, as Louis inclined more and more to an anti-Protestant policy, the Protestant members of the League favored the Dutch military service; and it was through their influence that in 1707 the "states" of the principality of Neuchâtel, on the extinction of the Longueville line of these princes, decided in favor of the king of Prussia (representing the overlords—the house of Challon-Orange) as against the various French pretenders claiming from the Longueville dynasty by descent or by will. In 1715 the Catholic members of the League, in hopes of retrieving their defeat of 1712 (see below), agreed, while renewing the treaty and capitulations, to put France in the position of the guarantor of the League, with rights of interfering, in case of attack from within or from without, whether by counsel or arms. This last clause was simply the surrender of Swiss independence, and was strongly objected to by the Protestant members of the Confederation, so that in 1777 it was dropped, when all the Confederates made a fresh defensive alliance, wherein their sovereignty and independence were expressly set forth. Thus France had succeeded to the position of the empire with regard to the Confederation, save that her claims were practically asserted and voluntarily admitted.

Between 1648 and 1798 the Confederation was distracted by religious divisions, and feelings ran very high. A scheme to set up a central administration fell through in 1655, through jealousy of Bern and Zurich, the proposers. In 1656 a question as to certain religious refugees, who were driven from Schwyz and took refuge at Zurich, brought about the first Villmergen war, in which the Catholics were successful.

and procured a clause in the treaty asserting very strongly the absolute sovereignty in religious as well as in political matters of each member of the League within its own territories. Later, the attempt of the abbot of St. Gall to enforce his rights in the Toggenburg swelled into the second Villmergen war (1712), which turned out very ill for the defeated Catholics. Zurich and Bern were henceforth to hold in severalty Baden, Rapperschwyl, and part of the "common bailiwicks" of the Aargau, both towns being given a share in the government of the rest, and Bern in that of Thurgau and Rheinthal, from which as well as from that part of Aargau she had been carefully excluded in 1415 and 1460. The only thing that prospered was the principle of "religious parity," which was established by every treaty.

The diet had few powers; the Catholics had the majority there; the sovereign rights of each member of the League and the limited mandate of the envoys effectually checked all progress. Zurich, as the leader of the League, managed matters when the diet was not sitting, but could not enforce her orders. The Confederation was little more than a collection of separate atoms, and it is really marvellous that it did not break up through its own weakness.

In these same two centuries, the chief feature in domestic Swiss politics is the growth of an aristocracy: the power of voting and the power of ruling are placed in the hands of a small class. This is chiefly seen in Bern, Lucerne, Freiburg, and Solothurn, where there were not the primitive democracies of the Forest districts nor the government by guilds as at Zurich, Basel, and Schaffhausen. It was effected by refusing to admit any new burghers, a practice which dates from the middle of the 16th century, and is connected (like the similar movement in the smaller local units of the "communes" in the rural districts) with the question of poor relief after the suppression of the monasteries. Outsiders (Hintersässen or Niedgelassene) had no political rights, however long they might have resided, while the privileges of burghership were strictly hereditary. Further, within the burghers, a small class succeeded in securing the monoply of all public offices, which was kept up by the practice of co-opting, and was known as the "patriciate." So in Bern, out of 360 burgher families, 80 (in 1776 18 only) formed the ruling oligarchy; and, though to foreigners the government seemed admirably managed, yet the last thing that could be said of it was that it was democratic. In 1749 Henzi made a fruitless attempt to overthrow this oligarchy, like Fatio at Geneva in 1707. The harsh character of Bernese rule (and the same holds good with reference to Uri and the Val Leventina) was shown in the great strictness with which Vaud was kept in hand: it was ruled as a conquered land by a benevolent despot, and we can feel no surprise that Davel in 1723 tried to free his native land, or that it was in Vaud that the principles of the French Revolution were most eagerly welcomed. Another result of this aristocratic tendency was the way in which the cities despised the neighboring country districts, and managed gradually to deprive them of their equal political rights and to levy heavy taxes upon them. These and other grievances (the fall in the price of food after the close of the Thirty Years' War, the lowering of the value of the coin, etc.), combined with the presence of many soldiers discharged after the great war, led to the great Peasant Revolt (1653) in the territories of Bern, Solothurn, Lucerne, and Basel, interesting historically as being the first popular rising since the old days of the 13th and 14th centuries, and because reminiscences of legends connected with those times led to the appearance of the "three Tells," who greatly stirred up the people. The rising was put down at the cost of much bloodshed, but the demands of the peasants were not granted. Yet during this period of political powerlessness a Swiss literature first arises: Gessner and Tschudi in the 16th century are succeeded by Scheuchzer, Hallar, Lavater, Bodmer, De Saussure, Rousseau, J. von Müller; the taste for Swiss travel is stimulated by the publication of Ebel's guide-book, based on the old *Deliciæ;* industry throve greatly. The residence of such brilliant foreign writers as Voltaire and Gibbon within or close to the territories of the Confederation helped on this remarkable intellectual revival. Political aspirations were not, however, wholly crushed, and found their centre in the Helvetic Society, founded in 1762 by Balthasar and others.

Effects of the French Revolution on the Confederation.

The Confederation and France had been closely connected for so long that the outbreak of the French Revolution could not fail to affect the Swiss. The Helvetian Club, founded at Paris in 1790 by several exiled Vaudois and Freiburgers, was the centre from which the new ideas were spread in the western part of the Confederation, and risings directed or stirred up. In 1790 Lower Wallis rose against the oppressive rule of the upper districts; in 1792 Porrentruy defied the prince-bishop of Basel, despite the imperial troops he summoned, declared the "Rauracian" republic, and three months later became the French department of the Mont Terrible; Geneva was only saved (1792) from France by a force sent from Zurich and Bern; and the massacre of the Swiss guard at the Tuileries on August 10, 1792, aroused intense indignation. The rulers, however, unable to enter into the new ideas, contented themselves with suppressing them by force, *e.g.*, Zurich in the case of Stäfa (1795). St. Gall managed to free itself from its abbot (1795–97), but the Leagues of Rhætia so oppressed their subjects in the Valtelline that in 1797 Bonaparte (after conquering the Milanese from the Austrians) joined them to the Cisalpine republic. The diet was distracted by party struggles, and the fall of the old Confederation was not far distant. The rumors of the vast treasures stored up at Bern, and the desire of securing a bulwark against Austrian attack, specially turned the attention of the Directory towards the Confederation; and this was utilized by the heads of the reform party in the Confederation,—Ochs, the burgomaster of Basel, and La Harpe,[1] who had left his home in Vaud through disgust at Bernese oppression, both now wishing for aid from outside in order to free their land from the rule of the oligarchy. Hence, when La Harpe, at the head of twenty-two exiles from Vaud and Freiburg, called (November 20, 1797) on the Directory to protect the liberties of Vaud, which France by the treaty of 1565 was bound to guarantee, his appeal found a ready answer. In 1798 French troops occupied Mülhausen and Bienne (Biel), as well as those parts of the lands of the prince-bishop of Basel (St. Imier and the Münsterthal) as regards which he had been since 1579 the ally of the Catholic members of the Confederation. Another army entered Vaud (February, 1798), when the "Lemanic republic" was proclaimed, and the diet broke up in dismay without taking any steps to avert the coming storm. Brune and his army occupied Freiburg and Solothurn, and, after fierce fighting at Neueneck, entered (March 5) Bern, deserted by her allies, and distracted by quarrels within. With Bern, the stronghold of the aristocratic party, fell the old Confederation. The Revolution triumphed throughout the Confederation. Brune, on March 19, put forth a wonderful scheme by which the Confederation with its "associates" and "subjects" was to be split into three republics—the Tellgau (*i.e.*, the Forest districts), the Rhodanic (*i.e.*, Vaud, Wallis, the Bernese Oberland, and the Italian bailiwicks), and the Helvetic (*i.e.*, the north and east portions); but the Directory disapproved of this (March 23) and on March 29 the Helvetic republic, one and indivisible, was proclaimed. This was accepted by ten out of the thirteen members of the old Confederation, as well as the constitution drafted by Ochs. By the new scheme the territories

The Helvetic Republic.

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[1] [This tutor (1754-1838) of Czar Alexander I. retired on a life pension to Switzerland in 1793 as a French revolutionist.—Am. Ed.]

of the Everlasting League were split up into twenty-three (later nineteen, Rhætia only coming in in 1799) administrative districts, called "cantons," a name now officially used in Switzerland for the first time, though it may be found employed by foreigners in the French treaty of 1452, in Comines and Machiavelli, and in the treaties of Westphalia (1648). A central Government was set up, with its seat at Lucerne, comprising a senate and a great council, together forming the legislature, with an executive of five directors chosen by the legislature, and having four ministers as subordinates or "chief secretaries." A supreme court of justice was set up; a status of Swiss citizenship was recognized; and absolute freedom to settle in any canton was given, the political "communes" being now composed of all residents, and not merely of the burghers. For the first time an attempt was made to organize the Confederation as a single state, but the change was too sweeping to last, for it largely ignored the local patriotism which had done so much to create the Confederation, though more recently it had made it politically powerless. The three Forest districts rose in rebellion against the invaders and the new constitutions which destroyed their ancient prerogatives; but the valiant resistance of the Schwyzers, under Alois Reding, on the heights of Morgarten (April and May), and that of the Unterwaldners (September), were put down by French armies. The proceedings of the French, however, soon turned into disgust and hatred the joyful feelings with which they had been hailed as liberators. Geneva was annexed to France (1798); Gersau, after an independent existence of over 400 years, was made a mere district of Schwyz; immense fines were levied and the treasury at Bern pillaged; the land was treated as if it had been conquered. The new republic was compelled to make a very close offensive and defensive alliance with France, and its directors were practically nominated from Paris. In 1799 Zurich, the Forest cantons, and Rhætia became the scene of the struggles of the Austrians (welcomed with joy) and Russians against the French. The manner too in which the reforms were carried out alienated many, and, soon after the Directory gave way to the Consulate in Paris (18 Brumaire or November 10, 1799), the Helvetic directory (January, 1800), was replaced by an executive committee.

The Act of Mediation.

The scheme of the Helvetic republic had gone too far in the direction of centralization; but it was not easy to find the happy mean, and violent discussions went on between the "unitary" (headed by Ochs and La Harpe) and "federalist" parties. Many drafts were put forward, and one actually submitted to but rejected by a popular vote (May 20, 1802). In July, 1802, the French troops were withdrawn from Switzerland by Bonaparte, ostensibly to comply with the treaty of Amiens, really to show the Swiss that their best hopes lay in appealing to him. The Helvetic Government was gradually driven back by armed force, and the federalists seemed getting the best of it, when (October 4) Bonaparte offered himself as mediator, and summoned many of the chief Swiss statesmen to Paris to discuss matters with him (the "Consulta"—December, 1802). He had long taken a very special interest in Swiss matters, and in 1802 had given to the Helvetic republic the Frickthal (ceded to France in 1801 by Austria), the last Austrian possession within the borders of the Confederation. On the other hand, he had made (November, 1802) Wallis into an independent republic. In the discussions he pointed out that Swiss needs required a federal constitution and a neutral position guaranteed by France. Finally (February 19, 1803) he laid before the Consulta the Act of Mediation which he had elaborated, and which they had perforce to accept—a document which formed a new departure in Swiss history, and the influence of which is visible in the present constitution.

Throughout "Switzerland" is used for the first time as the official name of the Confederation. The thirteen members of the old Confederation before 1798 are set up again, and to them are added six new cantons, —two (St. Gall and Graubünden or Grisons) having been formerly "associates," and the four others being made up of the subject lands conquered at different times,—Aargau (1415), Thurgau (1460), Ticino or Tessin (1440, 1500, 1512), and Vaud (1536). In the diet, six cantons which had a population of more than 100,000 (viz., Bern, Zurich, Vaud, St. Gall, Graubünden, and Aargau) were given two votes, the others having but one apiece, and the deputies were to vote freely within limits, though not against their instructions. Meetings of the diet were to be held alternately at Freiburg, Bern, Solothurn, Basel, Zurich, and Lucerne,—the Government of each of these cantons becoming, by virtue of the presence of the diet, the executive of the Confederation, its chief magistrate being named the "landamman of Switzerland." The "landsgemeinden," or popular assemblies, were restored in the democratic cantons, the cantonal governments in other cases being in the hands of a "great council" (legislative) and the "small council" (executive),—a property qualification being required both for voters and candidates. No canton was to form any political alliances abroad or at home. The "communes" were given larger political rights, the burghers who owned and used the common lands becoming more and more private associations. There was no Swiss burghership, as in 1798, but perfect liberty of settlement in any canton. There were to be no privileged classes or subject lands. A very close alliance with France (on the basis of that of 1516) was concluded. The whole constitution and organization were far better suited for the Swiss than the more symmetrical system of the Helvetic republic; but, as it was guaranteed by Bonaparte, and his influence was predominant, the whole fabric was closely bound up with him, and fell with him. Excellent in itself, the constitution set forth in the Act of Mediation failed by reason of its setting.

The pact of 1815.

For ten years Switzerland enjoyed peace and prosperity under the new constitution. Pestalozzi and Fellenberg worked out their educational theories; K. Escher of Zurich embanked the Linth, and was thence called "von der Linth"; the central Government prepared many schemes for the common welfare. On the other hand, the mediator (who became emperor in 1804) lavishly expended his Swiss troops, the number of which could only be kept up by a regular blood tax, while the "Berlin decrees" raised the price of many articles. In 1806 the principality of Neuchâtel was given to Marshal Berthier; Tessin was occupied by French troops from 1810 to 1813, and in 1810 Wallis was made into the department of the Simplon, so as to secure that pass. At home, the liberty of moving from one canton to another (though given by the constitution) was, by the diet in 1805, restricted by requiring ten years' residence, and then not granting political rights in the canton or a right of profiting by the communal property. As soon as Napoleon's power began to wane (1812–13), the position of Switzerland became endangered. Despite the personal wishes of the czar (a pupil of La Harpe's), the Austrians, supported by the reactionary party in Switzerland, and without any real resistance on the part of the diet, as well as the Russian troops, crossed the frontier on December 21, 1813, and a few days later the diet was induced to declare the abolition of the 1803 constitution, guaranteed, like Swiss neutrality, by Napoleon. Bern headed the party which wished to restore the old state of things, but Zurich and the majority stood out for the nineteen cantons. The powers exercised great pressure to bring about a meeting of deputies from all the nineteen cantons at Zurich (April 6, 1814, "the long diet"), but party strife was so bitter that many questions had to be referred to the congress at ting at Vienna. The congress decided (March 20th, 1815) that Wallis, Neuchâtel, and Geneva should be raised from the rank of "associates" to that of full members of the confederation (thus making up the familiar twenty-two), and as compensation gave Bern the town of Bienne (Biel) and all (save a small bit which went to Basel) of the territories of the prince-bishop of Basel ("the Bernese Jura"); but the Valtelline was granted to Austria, and Mühlhausen was not freed from France.

The diet accepted this decision, and on August 7, 1815, the new constitution was sworn to by all the cantons save Nidwald, the consent of which was only obtained by armed force, a delay for which she paid by seeing Engelberg and the valley above (acquired by Nidwald in 1798) given to Obwald. By the new constitution the sovereign rights of each canton were fully recognized, and a return made to the lines of the old constitution, though there were to be no subject lands, and political rights were not to be the exclusive privilege of any class of citizens. Each canton had one vote in the diet, where an absolute majority was to decide all matters save foreign affairs, when a majority of three-fourths was required. The management of current business, etc., shifted every two years between the Governments of Zurich, Bern, and Lucerne (the three "Vororte"). The monasteries were guaranteed in their rights and privileges; and no canton was to make any alliance contrary to the rights of the Confederation or of any other canton. Provision was made for a federal army. Finally the congress, on November 20, 1815, placed Switzerland and parts of North Savoy (Chablais, Faucigny, and part of the Genevois) under the guarantee of the great powers, who engaged to maintain their neutrality, thus freeing Switzerland from her 300 years' subservience to France, and compensating in some degree for the reactionary nature of the new Swiss constitution when compared with that of 1803.

Attempts at reform.

V. The cities at once secured for themselves in the cantonal great councils an overwhelming representation over the neighboring country districts, and the agreement of 1805 as to migration from one canton to another was renewed by twelve cantons. For some time there was little talk of reforms, but in 1819 the Helvetic Society definitely became a political society, and the foundation in 1824 of the Marksmen's Association enabled men from all cantons to meet together. A few cantons (notably Tessin) were beginning to make reforms, when the influence of the July revolution (1830) in Paris and the sweeping changes in Zurich led the diet to declare (December 27) that it would not interfere with any reforms of cantonal constitutions provided they were in agreement with the pact of 1815. Hence for the next few years great activity in this direction was displayed, and most of the cantons reformed themselves, save the most conservative (*e.g.*, Uri, Glarus) and the advanced who needed no changes (*e.g.*, Geneva, Graubünden). Provision was always made for revising these constitutions at fixed intervals, for the changes were not felt to be final, and seven cantons—Zurich, Bern, Lucerne, Solothurn, St. Gall, Aargau, and Thurgau—joined together to guarantee their new free constitutions (Siebener Concordat of March 17, 1832). Soon after, the question of revising the federal pact was brought forward by a large majority of cantons in the diet (July 17), whereon, by the league of Sarnen (November 14), the three Forest cantons, with Neuchâtel, the city of Basel, and Wallis, agreed to maintain the pact of 1815 and to protest against the separation of Basel in two halves (for in the reform struggle Schwyz and Basel had been split up, though the split was permanent only in the latter case). A draft constitution providing for a federal administration distinct from the cantons could not secure a majority in its favor; a reaction against reform set in, and the diet was forced to sanction (1833) the division of Basel into the "city" and "country" divisions (each with half a vote in the diet), though fortunately in Schwyz the quarrel was healed. Religious quarrels further stirred up strife in connection with Aargau, which was a canton where religious parity prevailed, later in others. In Zurich the extreme pretensions of the radicals and freethinkers (illustrated by offering a chair of theology in the university to Strauss because of his recent *Life of Jesus*) brought about a great reaction in 1839, when Zurich was the "Vorort." In Aargau the parties were very evenly balanced, and, when in 1840, on occasion of the revision of the constitution, the radicals had a popular majority, the aggrieved clerics stirred up a revolt (1840), which was put down, but which gave their opponents (headed by A. Keller) the excuse for carrying a vote in the great council to suppress the eight monasteries in the canton. This was flatly opposed to the pact of 1815, which the diet by a small majority decided must be upheld, though after many discussions it determined (August 31, 1843) to accept the compromise by which four only were to be suppressed, and declared that the matter was now settled. On this the seven Catholic cantons—Uri, Schwyz, Unterwalden, Lucerne, Zug, Freiburg, and Wallis—formed (September 7, 1843) a "Sonderbund" or separate league, which (February, 1844), issued a manifesto demanding the reopening of the question and the restoration of *all* the monasteries. Like the radicals in former years the Catholics went too far and too fast, for in October, 1844, the clerical party in Lucerne (in the majority since 1841, and favoring the reaction in Wallis) officially invited in the Jesuits and gave them high posts, an act which created all the more sensation because Lucerne was the "Vorort." Twice (December, 1844, and March, 1845,) parties of Free Lances tried to capture the city. In December, 1845, the Sonderbund turned itself into an armed confederation, ready to appeal to war in defence of the rights of each canton. The radicals carried Zurich in 1845 and Bern in 1846, but a majority could not be secured in the diet till Geneva (October, 1846), and St. Gall (May, 1847), were won by the same party. On July 20, 1847, the diet, by a small majority, declared that the Sonderbund was contrary to the federal pact, which on August 16 it was resolved to revise, while on September 3 it was decided to invite each canton to expel the Jesuits. Most of the great powers favored the Sonderbund, but England took the contrary view. On October 29 the deputies of the unyielding cantons left the diet, which ordered on November 4 that its decree should be enforced by arms. The war was short (November 11–29), mainly owing to the ability of Dufour, and the loss of life trifling. One after another the rebellious cantons were forced to surrender, and, as the Paris revolution of February, 1848, occupied all the attention of the great powers (who by the constitution of 1815 should have been consulted in the revision of the pact), the Swiss were enabled to settle their own affairs quietly. Schwyz and Zug abolished their "landsgemeinden," and the seven were condemned to pay the costs of the war (ultimately defrayed by subscription), which had been waged rather on religious than on strict particularist or states-right grounds. The diet meanwhile debated the draft constitution drawn up by Kern of Thurgau and Druey of Vaud, which in the summer of 1848 was accepted by fifteen and a half cantons, the minority consisting of the three Forest cantons, Wallis, Zug, Tessin, and Appenzell (Inner Rhoden), and it was proclaimed on September 12.

Constitution of 1848.

The new constitution inclined rather to the Act of Mediation than to the system which prevailed before 1798. A status of "Swiss citizenship" was set up, closely joined to cantonal citizenship: a man settling in a canton not being his birthplace got cantonal citizenship after two years, but was excluded from all local rights in the "commune" where he might reside. A federal or central Government was set up, to which the cantons gave up a certain part of their sovereign rights, retaining the rest. The federal legislature (or assembly) was made up of two houses—the council of states (Stände Rath), composed of two deputies from each canton, whether small or great[1] (44 in all), and the national council (National Rath), made up of deputies (now 145 in number) elected for three years, in the proportion of one for every 20,000 souls or fraction over 10,000, the electors being all Swiss citizens. The federal council or executive (Bundesrath) consisted of seven members elected by the federal assembly; they are jointly responsible for all business, though for sake of convenience there are various departments, and their chairman is called the president of the Confederation. The federal judiciary (Bundesgericht) is made up of eleven members elected by the federal assembly for three years; its jurisdiction is chiefly confined to civil cases, in which the Confederation is a party (if a canton, the federal council may refer the case to the federal tribunal), but takes in also great political crimes,—all constitutional questions, however, being reserved for the federal assembly, A federal university and a polytechnic school were to be founded; the latter only has as yet been set up, and is fixed at Zurich. All military capitulations were forbidden in the future. Every canton must treat Swiss citizens who belong to one of the Christian confessions like their own citizens, for the right of free settlement is given to all such, though they acquired no rights in the "commune." All Christians were guaranteed the exercise of their religion, but the Jesuits and similar religious orders were not to be received in any canton. German, French, and Italian were recognized as national languages.

The constitution as a whole marked a great step forwards; though very many rights were still reserved to the cantons, yet there was a fully organized central government. Almost the first act of the federal assembly was to exercise the power given them of determining the home of the federal authorities, and on November 28, 1848, Bern was chosen, though Zurich still ranks as the first canton in the Confederation.

By this early settlement of disputes Switzerland was protected from the general revolutionary movement of 1848, and in later years her political history has been uneventful, though she has felt the weight of the great European crisis in industrial and social matters.

Events since 1848.

The position of Neuchâtel, as a member of the Confederation (as regards its government only) and as a principality ruled by the king of Prussia, whose rights had been expressly recognized by the congress of Vienna, was uncertain. She had not sent troops in 1847, and, though in 1848 there was a revolution there, the prince did not recognize the changes. Finally, a royalist conspiracy in September, 1856, to undo the work of 1848 caused great excitement and anger in Switzerland, and it was only by the mediation of Napoleon III. and the other powers that the prince renounced (1857) all his rights, save his title, which his successor (the German emperor) has also dropped. Since that time Neuchâtel has been an ordinary member of the Confederation. In 1859–60 the cession of Savoy (part of it neutralized in 1815) to France aroused considerable indignation, and in 1862 the long-standing question of frontiers in the Vallée de Dappes was finally arranged with France. In 1871 many French refugees, especially Bourbaki's army, were most hospitably received and sheltered. The growth of the Old Catholics after the Vatican council (1870) caused many disturbances in western Switzerland, especially in the Bernese Jura. The attack was led by Bishop Lachat of Basel, whose see was suppressed by several cantons in 1873. The Old Catholics have been recognized by nine cantons and the see of Basel set up again, though Bern does not recognize it. The appointment by the pope of the abbé Mermillod as "apostolic vicar" of Geneva, which was separated from the diocese of Freiburg, led to Monseigneur Mermillod's banishment from Switzerland (1872), but in 1883 he was raised to the vacant see of Freiburg and allowed by the federal authorities to return, though Geneva still refuses to recognize him. Perhaps the latest event of importance to Switzerland was the opening of the St. Gotthard tunnel, which was begun in 1871 and ended in 1880; by it the Forest cantons seem likely to regain the importance which was theirs in the early days of the Confederation.

Revised constitution of 1874.

From 1848 onwards the cantons continually revised their constitutions, always in a democratic sense, though after the Sonderbund War Schwyz and Zug abolished their "landsgemeinde." The chief point was the introduction of the *referendum*, by which laws made by the cantonal legislature may (facultative *referendum*), or must (obligatory *referendum*) be submitted to the people for their approval, and this has obtained such general acceptance that Freiburg alone does not possess the *referendum* in either of its two forms, Tessin having accepted it in its optional form in 1883. It was therefore only natural that attempts should be made to revise the federal constitution of 1848 in a democratic and centralizing sense, for it had been provided that the federal assembly, on its own initiative or on the written request of 50,000 Swiss electors, could submit the question of revision to a popular vote. In 1866 the restriction of certain rights (mentioned above) to Christians only was swept away; but the attempt at final revision in 1872 was defeated by a small majority, owing to the efforts of the anti-centralizing party. Finally, however, another draft was better liked, and on April 19, 1874, the new constitution was accepted by the people—14½ cantons against 7½ (those of 1848 without Tessin, but with Freiburg and Lucerne) and 340,199 votes as against 198,013. This constitution is that now in force, and is simply an improved edition of that of 1848. The federal tribunal (now of nine members only) was fixed (by federal law) at Lausanne, and its jurisdiction enlarged, especially in constitutional disputes between cantons and the federal authorities, though jurisdiction in administrative matters (*e.g.*, educational, religious, election, commercial) is given to the federal council, a division of functions which is very anomalous, and does not work well. A system of free elementary education was set up, and many regulations made on ecclesiastical matters. A man settling in another canton was, after a residence of three months only, given all cantonal and communal rights, save a share in the common property (an arrangement which as far as possible kept up the old principle that the "commune" is the true unit out of which cantons and the Confederation are built), and the membership of the "commune" carries with it cantonal and federal rights. The *referendum* was introduced in its "facultative" form; *i.e.*, all federal laws must be submitted to popular vote on the demand of 30,000 Swiss electors or of eight cantons. If the revision of the federal constitution is demanded by one of the two houses of the federal assembly, or by 50,000 Swiss citizens, the question of revision must be submitted to a popular vote, as also the draft of the revised constitution,—these provisions, contained already in the constitution of 1848, forming a species of "obligatory *referendum*." It was supposed that this plan would lead to radical and sweeping changes; but as a matter of fact there have been (1874–86) about one hundred and seven federal laws and resolutions passed by the assembly, of which nineteen were by the *referendum* submitted to popular vote, thirteen being rejected, while six only were accepted,—the rest becoming law, as no *referendum* was demanded. There has been a very steady opposition to all schemes aiming at increased centralization. By the constitutions of 1848 and 1874 Switzerland has ceased to be a mere union of independent states joined by a treaty, and has become a single state with a well-organized central Government, to which have been given certain of the rights of the independent cantons, but increased centralization would destroy the whole character of the Confederation, in which the cantons are not administrative divisions but living political communities. Swiss history teaches us, all the way through, that Swiss liberty has been won by a close union of many small states, and we cannot doubt that it will be best preserved by the same means, and not by obliterating all local peculiarities, nowhere so striking and nowhere so historically important as in Switzerland.

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[1] The method of election and length of term of office were left to the cantonal Governments; at present (1887), in eleven cantons (or half cantons) the people, in fourteen the "great council," elect; twelve elect for one year and twelve for three, Wallis holding to the mean of two years.

Chronological Table of Chief Events.

1291. First League of the Three Lands.
1815. Morgarten.
1853. The Eight Orte complete.
1386. Sempach.
1888. Näfels.
1394. Hapsburgs give up rights.
1444. St. Jakob an der Birs.
1474. Everlasting Compact.
1476. Granson and Morat.
1481. Compact of Stans.
1499. Practical Freedom from the Empire.
1513. The Thirteen complete.
1516. Alliance with France.
1531. Kappel.
1586. Golden League.
1648. Formal Freedom from the Empire.
1798. The Helvetic Republic.
1803. Act of Mediation—19 Cantons.
1815. Federal Pact—22 Cantons.
1847. Sonderbund War.
1848. Federal Constitution.
1874. Revised Constitution.

General Authorities.—For the early history, the works of Huber, Rilliet, and Von Wyss (see TELL) may be consulted; for general political history those of Daguet, Dändliker (large and small versions), Henne am Rhyn, Oechsli, Strickler, Vulliemin; and, for constitutional history those of Blumer, Bluntschli, Dubs, Meyer, and Orelli. Of those named, the works of Rilliet, Dändliker (the small version), Strickler, Dubs, and Orelli are best suited for foreign readers. Books on local history and on special periods abound, and many very valuable essays are hidden in the publications of the numerous cantonal historical societies. Of modern English works relating to Switzerland the most noteworthy are G. Grote, *Seven Letters concerning the Politics of Switzerland* [the Sonderbund War of 1847] (originally published 1847, reprinted 1876), and E. A. Freeman, "Review of Kirk's 'Charles the Bold,'" in *Historical Essays*, first series, 1872, pp. 335–370, and *Historical Geography of Europe*, 1881. The great *Historisch-Geographischer Atlas der Schweiz*, by Vögelin, Meyer von Knonau, and Von Wyss (Zurich, 1870), is almost indispensable to any serious student of Swiss history. Gerster's small maps are appended to Oechsli's history, and also published separately. (W. A. B. C.)

PART III.—LITERATURE.

It can hardly be said of Switzerland that she possesses a truly national literature. She has a literature in French and a literature in German, but these literatures are not the expression of a common intellectual life, for the German and French cantons have always been to some extent dominated by different ideas and sympathies. Political union has been only in part associated with the deeper union which relates to purely ideal interests. Even the difference between the French and the German literatures of Switzerland does not give a complete conception of the diversity of thought and sentiment which exists in the country. Switzerland has also produced Italian writers and writers who use the Romansch dialect of the Grisons. The Romansch and Italian branches of her literature are not, however, sufficiently important to deserve more than passing notice.

During the struggles against the Hapsburgs the members of the Confederation were too seriously occupied in defending their political rights and in adding to their territory to be very eager for the satisfaction of intellectual needs. They produced some vigorous war songs, but in other respects they were content with such literature as might happen to reach them from neighboring countries. At the time of the Reformation there was much intellectual activity in Switzerland, but it related chiefly to the controversy of the Protestants with the Church of Rome; and Zwingli, Bullinger, and the other Reformers of the German cantons were not, like Luther, wise enough to write important treatises in the language of the people. They wrote chiefly in Latin, reserving the use of German for sermons and hymns. One good writer of this period whose interest was not confined to theology was François Bonnivard, who, although a native of Savoy, had, as prior of the monastery of St. Victor, been associated with Geneva before the Reformation. He was one of the most resolute of those who opposed the ambition of Charles III., duke of Savoy; and it is he whose sufferings in the service of his adopted country have been immortalized by Byron in "The Prisoner of Chillon." After his release from imprisonment he became a Protestant, and wrote in French several important books, the chief of which is his *Chroniques de Genève*, This work is written in a bright and animated style, and is especially valuable for its account of events with which the author himself was connected. Another vigorous writer of the 16th century was Ægidius Tschudi, who remained loyal to the Roman Church. He devoted himself with enthusiasm to the study of history. The only result of his labors given to the world in his lifetime was *Die uralt wahrhafftig alpisch Rhätia*, but several other works have since been published, the most important being his *Chronicum Helveticum* and his *Hauptschlüssel zu verschiedenen Alterthümern*.

Bonnivard.

Tschudi.

After the Reformation a respect for learning was maintained by the university of Basel, the Carolinum of Zurich, and various other educational institutions in the leading towns of the Confederation; but for a long time Switzerland took little part in the literary movement of Europe. Theology was still generally thought to be the only subject worthy of study by serious minds, and theologians continued to write their books in Latin (as, for example, C. Gessner of Zurich). In this respect their example was followed by men of science. In the few instances in which scholars belonging to German cantons wished to appeal to readers who were not specialists, they wrote in French, for Switzerland was so intimately associated in politics with France that the French language was spoken by the educated classes in all parts of the country. French literature was the only modern literature of which they had any real knowledge.

Early in the 18th century there were many signs of an intellectual awakening both in the German and in the French districts. The literary activity manifested in the German cantons was indirectly connected with the fact that they had been gradually acquiring a stronger sense of political independence. They had been alienated from France by the arrogance of the French Government, and had been forced to consider whether it might not be possible for Switzerland to defend her own interests without foreign patronage. Here and there scholars began to interest themselves in Swiss history, and to take pride in the achievements of the forefathers of the republic; and, in proportion as patriotic sentiment increased, thoughtful men became less inclined to take all their ideas from the country to which alone they had hitherto looked for intellectual guidance. They studied with greater earnestness the literatures of Greece and Rome, and some of them turned to English literature, with which they had not up to this time had the slightest acquaintance. These influences gave a powerful impetus to the best aspirations of the German population of Switzerland, and it was not in literature only that important results were achieved. Members of the family of Bernoulli at the university of Basel had already been doing great work in mathematics; and now the fame of Switzerland as a country favorable to the development of science was extended by many investigators, the best known of whom were Euler, Haller, Scheuchzer, and Muralt.

Bodmer and Breitinger. The writer who first gave expression to the most characteristic literary conceptions of his time in Switzerland was J. J. Bodmer, a native of Zurich. He was a good classical scholar, and in youth had made himself familiar with some of the masterpieces of English, French, and Italian literature. In 1721, in association with his friend Breitinger, a learned Protestant clergyman in Zurich, he began to issue the *Discurse der Maler*, written in imitation of the style of the English essayists. In this periodical the two friends criticized freely the works of some popular German versifiers, and they wrote with so much force and confidence that they soon exercised considerable influence not only in Switzerland but in Germany. When the value of their work was beginning to be recognized, a high place was taken among German men of letters by Gottsched, a professor at Leipsic. He was an ardent admirer of the classic drama of France, and gathered around him a number of enthusiastic disciples, known as the Saxon school. For some time he was on friendly terms with the Swiss critics, with whom he agreed in condemning the wild extravagance of Lohenstein and his imitators. But when Bodmer and Breitinger went on to praise English literature, and to call attention especially to the splendid qualities of Milton, Gottsched denounced their opinions as utterly false and misleading. The result was that a bitter controversy broke out between the Saxon and Swiss schools, Bodmer and Breitinger presenting an elaborate statement of critical doctrine, the former in *Vom Wunderbaren in der Poesie* (1740), the latter in *Kritische Dichtkunst* (1740). The controversy was followed with great interest by many readers, and, although it was by and by almost forgotten, it helped to prepare the way for the outburst of German literature begun by Klopstock, Wieland, and Lessing. The theories of all the combatants were to some extent crude and even grotesque, but Bodmer and Breitinger did excellent service by the vigor with which they protested against the notion that poetry is merely the work of the understanding acting in subjection to rigid rules, and by their enthusiastic appreciation of great English writers. Bodmer also opened fresh sources of inspiration by editing a part of the *Nibelungenlied* and some poems of the Minnesinger,—undertakings in which he anticipated the labors of the Romantic school. He wrote an epic, the *Noachide*, and several dramas, but his work as a poet is feeble and unimportant in comparison with his achievements as an editor and critic.

Haller. A. von Haller, who made his fame chiefly as a man of science (see vol. xi. p. 354), ranked in literature also among the foremost men of his day. His poems are too directly didactic to give much pleasure to modern readers, but in some of them—especially *Die Alpen*—there are passages of striking force and beauty. Haller knew the Alps not merely from books but by having visited them, and to him belongs the credit of having revealed that they appeal powerfully to the imagination, and of having associated them with great thoughts and aspirations. He wrote several prose romances, but outside of Switzerland these works, which had many readers at the time of their publication, are now practically forgotten.

Gessner. A Swiss writer of the 18th century, who, as a poet, became more famous even than Haller was Solomon Gessner. At Berlin and Hamburg he came under the influence of Ramler and Hagedorn, and after his return to his native town Zurich, where he lived as an artist, he published a series of idyllic poems which excited universal admiaation. The most popular of his writings was his prose idyl, *Der Tod Abel's* (1758). This work was translated into many languages, and was received with not less favor in Germany, France, and England than in Switzerland. There is not much serious thought in Gessner's works, and his sentiment sometimes degenerates into sentimentalism, but a permanent place is secured for him in literature by his simple, lucid style and by the delicate grace of his sketches of ideal scenery. These qualities were warmly appreciated by Lessing and afterwards by Goethe.

Salis-Seewis. Of the German Swiss poets who were born after Gessner had become famous the best were J. G. Salis-Seewis and J. M. Usteri. Salis-Seewis was acquainted with Goethe, Schiller, Herder, and Wieland, but he was not so much influenced by them as by a greatly inferior poet, Matthison, whose ideas and methods closely resembled his own. There is little variety of sentiment in the poems of Salis-Seewis, but their uniformity of tone is prevented from being tiresome by his perfect sincerity and by the vividness of his diction. **Usteri.** Usteri wrote at least one song—"Freut euch des Lebens"—which became popular among Germans of all classes, but his most important writings were some clever stories in the German dialect of Zurich.

Zimmermann. Philosophy, in the strict sense of the term, was not profoundly studied in the German cantons in the 18th century, but philosophical problems, especially those relating to ethics, were discussed in a popular style by a good many more or less able writers. Of these writers one of the most renowned was J. G. Zimmermann. His chief writings are *Ueber die Einsamkeit* (1755) and *Vom Nationalstolze* (1758). These works present a strange combination of cynicism and sentimentalism, but they profoundly impressed Zimmermann's contemporaries, and were translated into most European languages. **Sulzer.** J. G. Sulzer spent the greater part of his life in Berlin, where he was held in much esteem at the time when Lessing was beginning to make a name as a critic and dramatist. His principal work is his *Allgemeine Theorie der schönen Künste*, in which he tried to present a complete exposition of the laws of art, starting with the philosophical principles of Wolf, and combining them with critical doctrines derived from English and French writers. His style is somewhat cold and formal, and to later generations his governing thoughts have seemed meagre and unfruitful. **Hirzel.** H. K. Hirzel wrote *Das Bild eines wahren Patrioten* (1767) and various other works, in which he displayed a considerable power of expounding and illustrating great moral principles. He is remembered chiefly, however, by a charming description which he wrote of a day spent by Klopstock and himself with some friends on the Lake of Zurich,—a day celebrated by Klopstock in one of the finest of his early odes. **Lavater.** J. K. Lavater made some reputation as a poet, but he owed his fame chiefly to his *Physiognomische Fragmente* (1775–78), in which he sought to develop the idea that the face presents a perfect indication of character, and that physiognomy may therefore be treated as a science. His notions are arbitrary and rather mystical, but he expressed them with so much vigor and enthusiasm that he found many admirers and disciples. **Pestalozzi.** J. H. Pestalozzi was a less pretentious but infinitely more useful writer than Lavater. Early in life, mainly through the influence of Rousseau, he became impressed by the necessity of a radical change in the methods of popular education; and with splendid self-sacrifice he devoted his energies to the task of realizing his ideas and of inspiring others with a sense of their importance. His writings—of which *Lienhard und Gertrud* is the best—are not distinguished by any remarkable literary qualities, but his theories made his name famous all over the civilized world, and children in every good school may still be said to profit indirectly by his labors.

Iselin. In the 18th century the German cantons produced many writers on historical subjects. One of the most distinguished of them was I. Iselin, who, in his *Geschichte der Menschheit* (1768), offered suggestions akin to those which were afterwards set forth with wider knowledge and deeper insight by

The Tschudis. Herder. J. H. Tschudi and J. J. Tschudi, descendants of Ægidius Tschudi, also did much good work as historians. **Müller.** Greater than any of these—the foremost historical writer of Switzerland—was J. von Müller, whose writings marked an era in German literature. His masterpiece is his *Geschichte der schweizerischen Eidgenossenschaft* (1780). Müller had not an adequate appreciation of the laws of evidence in historical inquiry, but he was indefatigable in research, and no German historian of his time had so great a power of bringing out the significance of facts by his method of grouping them. His style, although sometimes obscure and rhetorical, was often made warm and glowing by his eager love of freedom and justice.

The literary movement of the French districts in the 18th century had little direct relation with that of the German cantons. It sprang chiefly from the influence of French refugees, who flocked in great numbers to western Switzerland after the revocation of the edict of Nantes. **Bourguet** The most energetic of the French writers of Switzerland in the first half of the 18th century was Bourguet, the son of a refugee. He travelled in Italy and Holland, and on his return to Geneva founded the *Bibliothèque Italique*, which appeared from 1729 to 1734. In carrying on this periodical, which extended to eighteen volumes, Bourguet was aided by a good many Swiss writers—among others by Abraham Ruchat and Loys de Bochat of Lausanne. Bourguet's colleagues also contributed articles to French periodicals of a similar kind in Holland, three of which—the *Bibliothèque Universelle et Historique*, the *Bibliothèque Choisie*, and the *Bibliothèque Ancienne et Moderne*—were conducted by Jean le Clerc, a native of Geneva. In 1732 Bourguet started at Neuchâtel the *Mercure Suisse*, which went on until 1784 and did much to stimulate the interest of its readers in science, literature, history, and archæology. The indefatigable editor and his colleagues did not confine themselves to journalistic work. One of his books—*Traité des Pétrifactions*—was an important contribution to geology; and Loys de Bochat wrote a careful book entitled *Mémoires Critiques sur l'Histoire Ancienne de la Suisse*. **Crousaz.** Ruchat was the author of *Histoire de la Reformation de la Suisse* and of *Délices de la Suisse*. The writings of J. P. de Crousaz, a friend of Bourguet, display no remarkable qualities, but two of them, his *Examen* of Pope's *Essay on Man* and his *Commentaire* on the same poem, have some interest for English readers. An English translation of the *Examen* by Mrs. Elizabeth Carter was published in 1739, and led to the intervention of Warburton, who considered it necessary to prove that the *Essay* was not in any way hostile to religion.

Rousseau. During the second half of the 18th century all Europe was reading the works of a Swiss writer, by far the most illustrious man of letters whom Switzerland has produced—J. J. Rousseau. He moved civilized mankind by many a doctrine which no one now holds to be true, but he owed his astonishing influence not so much to his fallacies as to his passionate zeal for the rights of the poor, to his enthusiasm for the free development of individual character, and to the power with which he reflected in his writings the beauty and the splendor of the external world. Of his own happiness he made shipwreck; but, if we judge his work simply by the practical results which sprang from it, he was perhaps the greatest literary force of modern times. His family was of French origin, but it had been so long settled at Geneva that it had become thoroughly Swiss, and to this fact were due some of the most striking characteristics of his genius. Free and republican Switzerland was the only Continental country whose institutions were favorable to the growth of the ideas with which Rousseau shook to its centre the political and social system of the 18th century.

Saussure. Of the other French writers of Switzerland in this age the most eminent was perhaps H. B. de Saussure, who, in his *Voyages dans les Alpes* (1776–79), presented in a lucid and attractive style the results of much careful observation. He was one of the founders of geology, and made important contributions to several other sciences. **Bonnet.** Another distinguished scientific writer of this time was Charles Bonnet, the author of several valuable works on natural history and psychology. His general conception of the order of the world he developed systematically in his *Contemplation de la Nature* (1764). **The De Lucs.** Much good work was also done by the brothers De Luc, one of whom, Jean-André de Luc, gave in *Lettres sur Quelques Parties de la Suisse* (1787) a very vivid picture of the physical, social, and political peculiarities of a portion of Switzerland.

Mme. de Charrière. Some clever books were written by Madame de Charrière, a native of Utrecht, who settled with her husband in the principality of Neuchâtel in 1771. Much interest was excited by her lively *Lettres Écrites de Lausanne* and by her *Lettres Neuchâteloises*, and both in Switzerland and in France there were many admirers of her *Mari Sentimental* and of the corresponding work *Lettres de Mistress Henley*. Samuel Constant, the father of Benjamin Constant, wrote *Camille* and some other romances in the form of letters; and *Contes Moraux*, in the style of Marmontel, were written by J. Senebier, who did better work as an investigator in physics and physiology.

Mallet. In the second half of the 18th century there were in French Switzerland many ardent students of history. One of the ablest of them was P. H. Mallet, who took as his special subject the antiquities of northern Europe, but wrote also works on the general history of Denmark, Brunswick, and Hesse. **Béranger.** Béranger was the author of a *Histoire de Genève;* and Lamberty, who had served as secretary of several legations in Holland and Germany, brought together in his *Mémoires* many interesting details about events of which he had personal knowledge. **Lamberty.** A good history of Switzerland to the 17th century was written by De Watteville, and Philibert dealt with the same subject in a work entitled *Les Révolutions de la Haute-Allemagne*, in which he brought the story down to 1468. **Haller.** G. E. von Haller wrote several excellent historical works, the most important of which was his *Bibliothek der Schweizergeschichte*.

From the latter part of the 18th century onwards French Switzerland has produced many influential writers, but they have been so intimately connected with France that their works properly belong to French literature. Necker, who played so great a part in France before the Revolution, was one of the greatest writers of his age on politics and finance; and his daughter Madame de Stael, whom, although she was born in Paris, Switzerland may also claim, stands in the front rank of women who have devoted themselves to literature. Her most brilliant work, *Corinne*, was perhaps of less real importance than *De l'Allemagne*, from which Frenchmen obtained for the first time authentic information as to the intellectual development of Germany. **B. Constant.** Benjamin Constant wrote a work on the source, forms, and history of religion; he was also the author of *Adolphe*, a romance, and adapted Schiller's *Wallenstein* for the French stage. But his principal work is the collection of his *Discours Prononcés à la Chambre des Députés*, in which he eloquently defends, from many points of view, the principles of constitutional government. **Sismondi.** De Sismondi displayed astonishing energy as a writer on history, literature, and political economy, and it is still necessary for students of the subjects on which he wrote to consult his works. His *Histoire des Français*, although planned on too vast a scale, is a wonderful monument of industry, learning, and literary skill, and not less valuable in their own way are his *Histoire de la Renaissance de la Liberté en Italie* and his *De la Littérature du Midi de l'Europe*. **Vinet.** A. Vinet, an eminent Protestant theologian, produced a great impression by his *Discours sur Quelques Sujets Religieux* and various other theological works, which are full of vigorous thought expressed in a clear, direct, and manly style. **Töpffer.** Among Swiss novelists R. Töpffer, author of *L'Heritage*, *Traversée*, and many other works, takes a distinguished place. His early writings attracted the attention of Goethe, who read them with pleasure; and Sainte-Beuve, in praising Töpffer's methods, gave utterance to the general opinion of educated Frenchmen. **The Cherbuliez.** The three brothers André, Antoine Elisée, and Joel Cherbuliez, and their sisters Adrienne and Madame Tourte-Cherbuliez, were all well-known writers; and Victor Cherbuliez, the son of André, is one of the brightest and most fertile novelists of the present day in France. He commands respect also as a writer on politics.

In the later literature of the German cantons there are not so many famous names as in the later literature of the French cantons. Of a group of writers who connected the influences of the 18th century with those of the 19th, **Albertini.** J. B. Albertini was the most original; but he appealed to a comparatively small class. He was a bishop in the church of the Moravian Brethren, and his poems give powerful expression to the deeply religious sentiment of his sect. **Appenzeller.** A romance by J. C. Appenzeller—*Gertrud von Wart* (1813)—was so popular that it was translated into French, Dutch, and English; but it has not maintained the high place which was for some time attributed to it. **Wyss.** J. R. Wyss edited the *Alpenrosen* from 1811 for about twenty years, and for this periodical he wrote many poems, taking his subjects chiefly from Swiss history and legends. He completed and published a story begun by his father, *Der Schweizerische Robinson*, translations of which have been widely circulated in France, Spain, England, and America. He also wrote "Rufst du, mein Vaterland," the great national song of Switzerland. **Fröhlich.** A. E. Fröhlich was a good writer of fables, **Henne.** and J. A. Henne made a considerable reputation, not only as a poet but as the writer of a work entitled *Manethos, die Origines unserer Geschichte und Chronologie*, in which he sought to prove the European origin of the Aryan race. **Meyer-Merian.** T. Meyer-Merian, author of the well-known song, "Ich ging so ganz alleine," was also a vigorous dramatist. **Bornhauser.** Dramatic and lyrical poems of some power were written by T. Bornhauser, but they were too plainly intended to serve a political party to have permanent significance. **Reber.** A more poetical writer was B. Reber, whose *Bilder aus den Burgunder-Kriegen* present a series of glowing pictures from one of the most splendid periods of Swiss history.

All these writers were surpassed by Albert Bitzius, known as Jeremias Gotthelf from the title **Bitzius.** of his first book. He was the vicar of Lützelflüh, and for many years found ample scope for his energies in quiet works of benevolence. *Der Bauerspiegel, oder Lebensgeschichte des Jeremias Gotthelf*, published in 1836, when he was nearly forty years of age, at once made his name famous, and it was followed by *Uli der Knecht*, *Uli der Pächter*, *Leiden und Freuden eines Schulmeisters*, and other powerful tales. The charm of his writings springs from the fact that they are an accurate representation of the thoughts, feelings, and habits of the people among whom he labored. Bitzius was a man of an ardent and impulsive temper, but a close observer, capable of penetrating far below the surface of life, and endowed with a remarkable faculty of reproducing his impressions in striking imaginative pictures. His style is often rough and careless, but his artistic defects are never serious enough to interrupt the free development of his fresh and vivid conceptions.

Another German writer of Switzerland whose name is well known beyond the limits of his own **Keller.** country is Gottfried Keller. He established his reputation by his romance *Der Grüne Heinrich* (1854), and afterwards he published *Die Leute von Seldwyla*, a series of tales of village life, and *Sieben Legenden*. He is also the author of some volumes of poems.

See E. H. Gaullieur, *Études sur l'Histoire Littéraire de la Suisse Française* (1856); J. C. Mörikofer, *Die schweizerische Literatur des achtzehnten Jahrhunderts* (1861); and R. Weber, *Die poetische Nationalliteratur der deutschen Schweiz* (1866-67).

(J. SI.)

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Visitors, foreign, 819.
Vital statistics, 817.
Wallis, 823, 831.
Watch-making, 818.
Waterfalls, 815.
Winds, 816.
Wood-carving, 818.
Wooden houses, 818.
Wyss, 838.
Zimmerman, 836.
Zug, 822.
Zurich, 822.
Zwingli, 828.

SWORD. *Origins and Early Forms.*—The sword is a hand-weapon of metal, distinct from all missile weapons on the one hand, and on the other hand from staff-weapons,—the pike, bill, halberd, and the like,—in which the metal head or blade occupies only a fraction of the effective length. The handle of a sword provides a grip for the hand that wields it, or sometimes for two hands: it may add protection, and in most patterns does so to a greater or less extent. But it is altogether subordinate to the blade. For want of a metal-headed lance or axe, which indeed were of later invention, a sharpened pole or a thin-edged paddle will serve the turn. A sword-handle without a blade is naught; and no true sword-blade can be made save of metal capable of taking an edge. There are so-called swords of wood and even stone to be found in collections of savage weapons. But these are really flattened clubs; and the present writer agrees with Gen. Pitt-Rivers in not believing that such modifications of the club have had any appreciable influence on the form or use of true swords. On this last point, however, the opinions of competent archæologists are so much divided that it must be regarded as fairly open. We will only remark that the occurrence in objects of human handiwork of a form, or even a series of forms, intermediate between two types is not conclusive evidence that those forms are historical links between the different types, or that there is any historical connection at all. In the absence of dates fixed by external evidence this kind of comparison will seldom take us beyond plausible conjecture. A traveller who had never seen velocipedes might naturally suppose, on a first inspection, that the tricycle was a modification of the old four-wheeled velocipede, and the bicycle a still later invention; he would perhaps regard the two-wheeled "Otto" as the historical link between tricycles and bicycles. But we know that in fact the order of development has been quite different.

It is more difficult as a matter of verbal definition to distinguish the sword from smaller hand-weapons. Thus an ordinary sword is four or five times as long as an ordinary dagger: but there are long daggers and short swords; neither will the form of blade or handle afford any certain test. The real difference lies in the intended use of the weapon; we associate the sword with open combat, the dagger with a secret attack or the sudden defence opposed to it. One might say that a weapon too large to be concealed about the person cannot be called a dagger. Again, there are large knives, such as those used by the Afridis and Afghans, which can be distinguished from swords only by the greater breadth of the blade as compared with its length. Again, there are special types of arms, of which the yataghan is a good example, which in their usual forms do not look much like swords, but in others that occur must be classed as varieties of the sword, unless we keep them separate by a more or less artificial theory, referring the type as a whole to a different origin.

Of the actual origin of swords we have no direct evidence. Neither does the English word nor, so far as we are aware, any of the equivalent words in other languages, Aryan or otherwise, throw any light on the matter. We only know that swords are found from the earliest times of which we have any record among all people who have acquired any skill in metal-work. There are two very ancient types, which we may call the straight-edged and the leaf-shaped. Assyrian monuments represent a straight and narrow sword, apparently better fitted for thrusting than cutting. Bronze swords of this form have actually been found in Etruscan tombs, and by Dr. Schliemann at Mycenæ, side by side with leaf-shaped specimens. We have also from Mycenæ some very curious and elaborately wrought blades, so broad and short that they must be

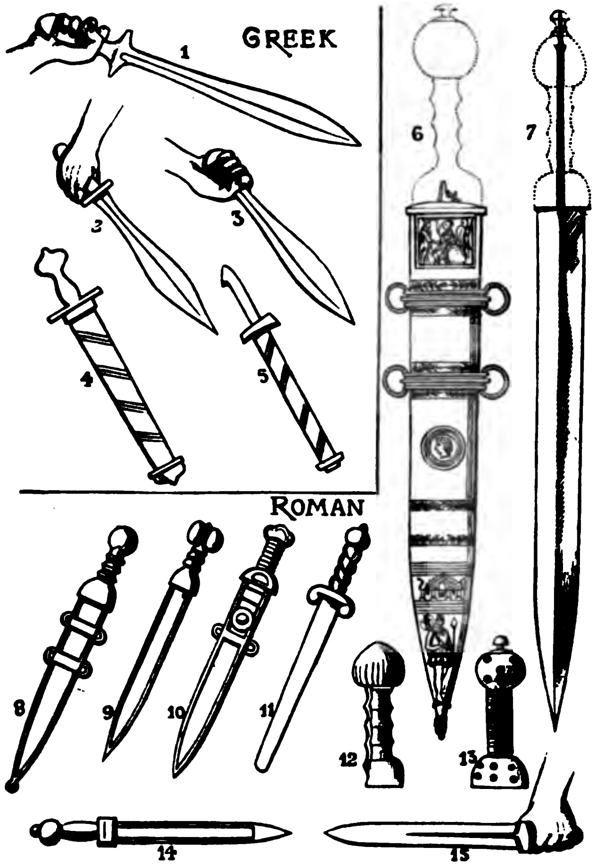

FIG. 1.—1–5, Greek swords of the classical type (Gerhard's *Griechische Vasenbilder*). 6–15, Roman swords from Lindenschmit, *Tracht und Bewaffnung des römischen Heeres während der Kaiserzeit*, Brunswick, 1882. 6, So-called "sword of Tiberius" from Mainz (Brit. Mus.); 7, Bonn (private collection), length, 765 mm.; 8, legionary (monument at Wiesbaden); 9, cavalry (monument at Mainz); 10, cavalry (monument at Worms); 12, 13, sword handles (Kiel and Mainz); 11, 14, 15, from Trajan's column.

called ornamental daggers rather than swords. The leaf-shaped blade is common everywhere among the remains of men in the "Bronze Period" of civilization, and this was the shape used by the Greeks in historical times, and is the shape familiar to us in Greek works of art. It is impossible, however, to say whether the Homeric heroes wore the leaf-shaped sword, as we see it, for example, on the Mausoleum sculptures, or a narrow straight-edged blade of the Assyrian-Mycenæan pattern. In any case, the sword holds a quite inferior position with Greek warriors of all times. We have not the means of pronouncing which pattern is the older. To a modern eye the Assyrian or Mycenæan sword looks fitter for thrusting than cutting. The leaf-shaped sword, so far as we know from works of art, was used with a downright cutting blow, regardless of the consequent exposure of the swordsman's body; this, however, matters little when defence is left to a shield or armor, or both. The use of the sword as a weapon of combined offence and defence—swordsmanship as we now understand it—is quite modern. If the sword was developed from a spearhead or dagger, one would expect it to have been a thrusting weapon before it was a cutting one. But when we come to historical times we find that the effective use of the point is a mark of advanced skill and superior civilization. The Romans paid special attention to it, and Tacitus tells us how Agricola's legionaries made short work of the clumsy and pointless arms of the Britons when battle was fairly joined.[1] The tradition was preserved at least as late as the time of Vegetius, who, as a technical writer, gives details of the Roman soldier's sword exercise. Asiatics to this day treat the sword merely as a cutting weapon, and most Asiatic swords are incapable of being handled in any other way.

Historical Types.—The normal types of swords which we meet with in historical times, and from which all forms now in use among civilized nations are derived, may be broadly classified as straight-edged or curved. In the straight-edged type, in itself a very ancient one, either thrusting or cutting qualities may predominate, and the blade may be double-edged or single-edged. The double-edged form was prevalent in Europe down to the 17th century. The single-edged blade, or backsword as it was called in England, is well exemplified in the Scottish weapons commonly but improperly known as claymores, and is now exclusively employed for military weapons. But these, with few exceptions, have been more or less influenced by the curved Oriental sabre. Among early double-edged swords the Roman pattern stands out as a workman-like and formidable weapon for close fight; the point was used by preference. In the Middle Ages the Roman tradition disappeared, and a new start was made from the clumsy barbarian arm which the Romans had despised. Gradually the broad and all but pointless blade was lightened and tapered, and the thrust, although its real power was unknown, was more or less practiced. St. Louis anticipated Napoleon in calling on his men to use the point; and the heroes of dismounted combats in the *Morte Darthur* are described as "foining" at one another. In the first half of the 16th century a well-proportioned and well-mounted cut-and-thrust sword was in general use, and great artistic ingenuity was expended, for those who could afford it, on the mounting and adornment. The growth and variations of the different parts of the hilt, curiously resembling those of a living species, would alone be matter enough for an archæological study. One peculiar form, that of the Scottish basket-hilt, derived from the Venetian pattern known as *schiavone*, has persisted to our own day without material change.

Quite different from the European models is the crescent-shaped Asiatic sabre, commonly called scimitar. We are not acquainted with any distinct evidence as to the origin of this in time or place. The fame of the Damascus manufacture of sword-blades is of great antiquity, as is also that of Khorásán, still the centre of the best Eastern work of this kind. Whoever first made these blades had conceived a very definite idea,—that of gaining a maximum of cutting power regardless of loss in other qualities,—and executed it in a manner not to be improved upon. The action of the curved edge in delivering a blow is to present an oblique and therefore highly acute-angled section of the blade to the object struck, so that in effect the cut is given with a finer edge than could safely be put on the blade in its direct transverse section. In a well-made sabre the setting of the blade with regard to the handle ("leading forward") is likewise ordered with a view to this result. And the cutting power of a weapon so

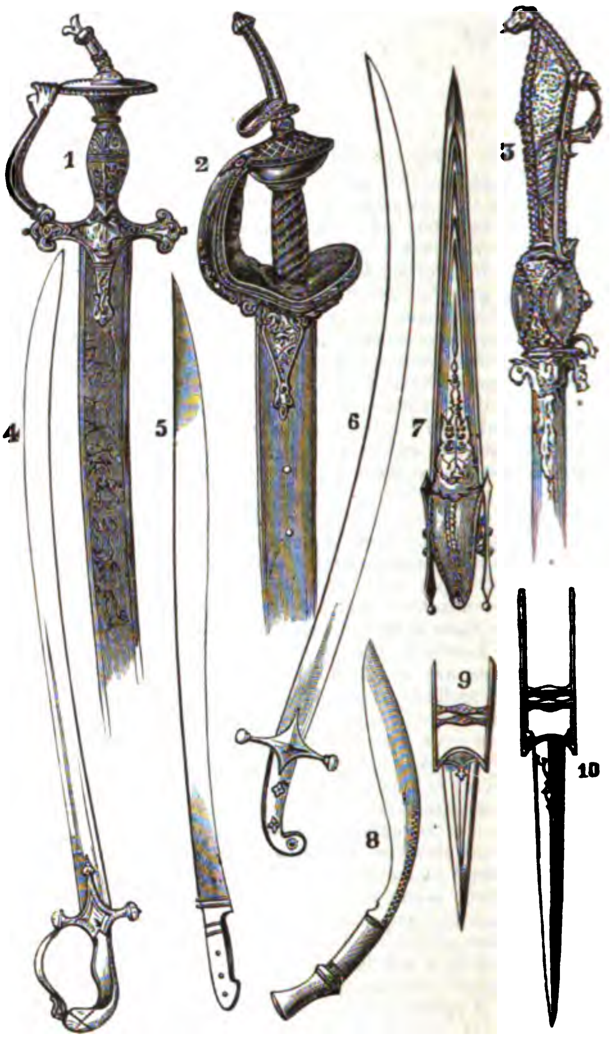

FIG. 2.—Oriental swords (reproduced by permission from Egerton's *Illustrated Handbook of Indian Arms*, published by the India Office, 1880). 1, 2. Decorated Persian arms; 3, gauntlet sword; 4, common type of talwár (Northwest Provinces); 5, yataghan type; 6, Persian talwár; 8, kukri (Nepal); 7, 9, 10, Mahratta, showing transition to gauntlet sword.

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[1] *Agric.*, 36: "Britannorum gladii sine mucrone complexum armorum et in aperto pugnam non tolerabant."

shaped and mounted is undoubtedly very great. But the use of the point is abandoned, and the capacities of defensive use (to which Orientals pay little or no attention) much diminished. These drawbacks have caused the scimitar type, after being in fashion for European light cavalry during the period of Napoleon's wars and somewhat longer, to be discarded in our own time. But, as long as Easterns adhere to their rigid grasp of a small handle and sweeping cut delivered from the shoulder, the Persian scimitar or Indian talwár will remain the natural weapon of the Eastern horseman. Indian and Persian swords are often richly adorned; but their appropriate beauty is in the texture of the steel itself, the "damascening" or "watering" which distinguishes a superior from a common specimen. This process, long obscure to Europeans, has in recent times been explained (see below).

There are special Asiatic varieties of curved blades of which the origin is more or less uncertain. Among these the most remarkable is perhaps the yataghan, a weapon pretty much coextensive with the Mohammedan world, though it is reported to be not common in Persia. It has been imported from Africa, through a French imitation, as the model of the sword-bayonets which have been common for about a generation in European armies; probably the French authorities caught at it to satisfy the sentiment, which lingered in Continental armies long after it had disappeared in England, that even the infantry soldier after the invention of the bayonet must have some kind of sword. A compact and formidable hand-weapon has thus been turned into a clumsy and top-heavy pike. If we try to make a bayonet that will cut cabbages, we may or may not get a useful chopper, but we shall certainly get a very bad bayonet. The double curve of the yataghan is substantially identical with that of the Goorkha knife (*kukri*), though the latter is so much broader as to be more like a woodman's than a soldier's instrument. It is doubtful, however, whether there is any historical connection. Similar needs are often capable of giving rise to similar inventions without imitation or communication. There are yet other varieties, belonging to widely spread families of weapons, which have acquired a strong individuality. Such are the swords of Japan, which are the highly perfected working out of a general Indo-Chinese type; they are powerful weapons and often beautifully made, but a European swordsman would find them ill-balanced and clumsy, and the Japanese style of sword-play certainly has nothing to teach us.

Other sorts of weapons, again, are so peculiar in form or historical derivation, or both, as to refuse to be referred to any of the normal divisions. The long straight gauntlet-hilted sword (*paṭá*) found both among the Mahrattas in the south of India, and among the Sikhs and Rajputs in the north, is an elongated form of the broad-bladed dagger with a cross-bar handle (*kaṭár*), as is shown by a transitional form, much resembling in shape and size of blade the mediæval English anlace, and furnished with a guard for the back of the hand. This last-mentioned pattern seems, however, to be limited to a comparatively small region. When once the combination of a long blade with the gauntlet hilt was arrived at, any straight blade might be so mounted; and many appear on examination to be of European workmanship—German, Spanish, or Italian. There are various other Oriental arms, notably in the Malay group, as to which it is not easy to say whether they are properly swords or not. The Malay "parang latok" is a kind of elongated chopper sharpened by being bevelled off to an edge on one side, and thus capable of cutting only in one direction. The anlace incidentally mentioned above seems to be merely an overgrown dagger; the name occurs only in English and Welsh; in which language first, or whence the name or thing came, is unknown (see *Philol. Soc. Dict.*, *s.v.*).

Modern European Developments.—In the course of the 16th century the straight two-edged sword of all work was lengthened, narrowed, and more finely pointed, till it became the Italian and Spanish rapier, a weapon still furnished with cutting edges, but used chiefly for thrusting. We cannot say how far this transition was influenced by the *estoc*, a mediæval thrusting weapon carried by horsemen rather as an auxiliary lance than as a sword. The Roman preference of the point was rediscovered under new conditions, and fencing became an art. Its progress was from pedantic complication to lucidity and simplicity, and the fashion of the weapon was simplified also. Early in the 18th century, the use of the edge having been finally abandoned in rapier-play, the two-edged blade was supplanted by the bayonet-shaped French

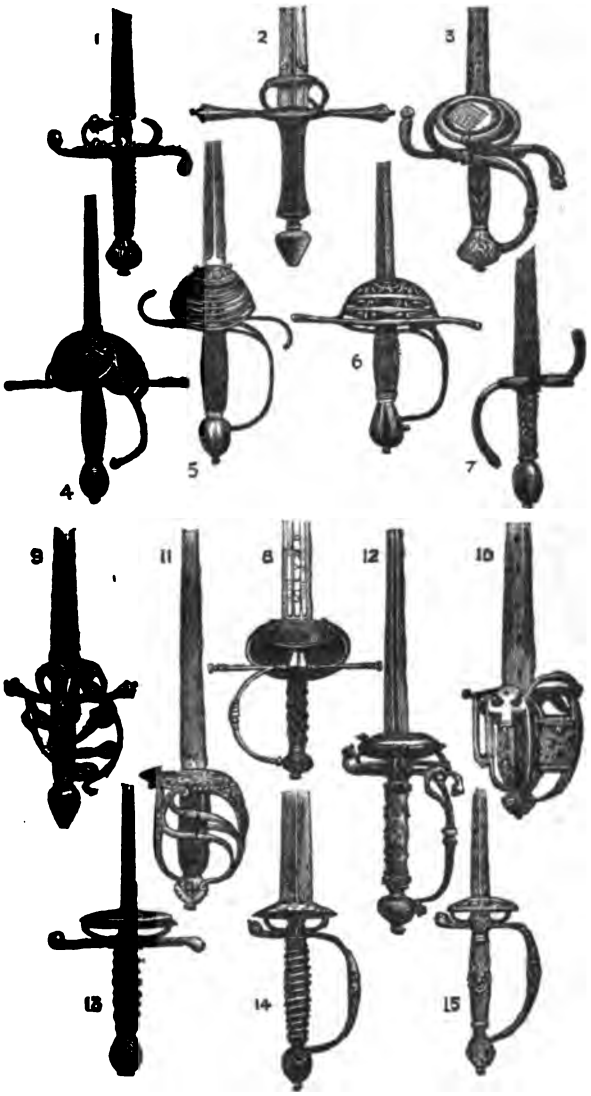


FIG. 3.—Typical European swords, 16th-18th centuries. Reproduced by permission from Mr. Egerton Castle's *Schools and Masters of Fence*. 1, Early 16th cent.; 2, German, *c.* 1550; 3, Italian rapier, third quarter 16th cent.; 4, Spanish rapier, late 16th cent.; 5, Italian, same period; 6, English, same period; 7, English musketeer's sword, early 17th cent.; 8, Spanish broadsword, early 17th cent.; 9, Venetian, *c.* 1550; 10, Italian, late 16th cent.; 11, English, time of Commonwealth; 12, French rapier, *c.* 1650; 13, German flamberg, early 17th cent.; 14, 15, small-swords, 1700-1750.

duelling sword, on which no improvement has since been made except in giving it a still simpler guard. The name of rapier is often but wrongly given to this by English writers. About the same time, or a little earlier, the primacy of the art passed from Italy to France, and there it still remains. It would take us too far to consider the history of fencing here; Mr. Egerton Castle's work will be found a trustworthy guide, and almost indispensable for those who wish really to understand the passages relating to sword-play in our Elizabethan literature, of which the fencing scene in *Hamlet* is the most famous and obvious example.

Meanwhile a stouter and broader pattern, with sundry minor varieties, continued in use for military purposes, and gradually the single-edged form or broadsword prevailed. The well-known name of Ferrara, peculiarly associated with Scottish blades, appears to have originally belonged to a Venetian maker, or family of makers, towards the end of the 16th century. The Spanish blades made at Toledo had by that time acquired a renown which still continues. Somewhat later Oriental example, imported probably by way of Hungary, induced the curvature found in most recent military sabres, which, however, is now kept within such bounds as not to interfere with the effective use of the point. An eccentric specialized variety—we may call it a "sport"—of the sabre is the narrow and flexible "schläger" with which German students fight their duels (for the most part not arising out of any quarrel, but set trials of skill), under highly conventional rules almost identical with those of the old English "backswording" practiced within living memory, in which, however, the swords were represented by sticks. These "schläger" duels cause much effusion of blood, but not often serious danger to life or limb.

There are plenty of modern books on sabre-play, but comparatively little attention has been given to its scientific treatment. It is said that the Italian school is better than the French, and the modern German and Austrian the best of all. Some of the English calvary regiments have good traditions, enriched of late years by the application of a knowledge of fencing derived from eminent French masters.

The Manufacture of Swords.—Mechanical invention has not been able to supersede or equal hand-work in the production of good sword-blades. The swordsmith's craft is still, no less than it was in the Middle Ages, essentially a handicraft, and it requires a high order of skill. His rough material is a bar of cast and hammered steel tapering from the centre to the ends, when this is cut in two, each half is made into a sword. The "tang" which fits into the handle is not part of the blade, but a piece of wrought iron welded on to its base. From this first stage to the finishing of the point it is all hammer-and-anvil work. Special tools are used to form grooves in the blade according to the regulation or other pattern desired, but the shape and weight of the blade are fixed wholly by the skilled hand and eye of the smith. Measuring tools are at hand, but are little used. Great care is necessary to avoid overheating the metal, which would produce a brittle crystalline grain, and to keep the surface free from oxide, which would be injurious if hammered in. In tempering the blade the workman judges of the proper heat by the color. Water is preferred to oil by the best makers, notwithstanding that tempering in oil is much easier. With oil there is not the same risk of the blade coming out distorted and having to be forged straight again (a risk, however, which the expert swordsmith can generally avoid); but the steel is only surface-hardened, and the blade therefore remains liable to bend. Machinery comes into play only for grinding and polishing and to some extent in the manufacture of hilts and appurtenances. The finished blade is proved by being caused to strike a violent blow on a solid block with the two sides flat, with the edge, and lastly with the back; after this the blade is bent flatwise in both directions by hand, and finally the point is driven through a steel plate about an eighth of an inch thick. In spite of all the care that can be used both in choice of material and in workmanship, about 40 per cent. of the blades thus tried fail to stand the proof, and are rejected. The process we have briefly described is that of making a really good sword; of course plenty of cheaper and commoner weapons are in the market, but they are hardly fit to trust a man's life to. It is an interesting fact that the peculiar skill of the swordsmith is in England so far hereditary that it can be traced back in the same families for several generations.

The best Eastern blades are justly celebrated, but they are not better than the best European ones; in fact, European swords are often met with in Asiatic hands, remounted in Eastern fashion. The "damascening" or "watering" of choice Persian and Indian arms is not a secret of workmanship, but is due to the peculiar manner of making the Indian steel itself, in which a crystallizing process is set up; when metal of this texture is forged out, the result is a more or less regular wavy pattern running through it. No difference is made by this in the practical qualities of the blade.

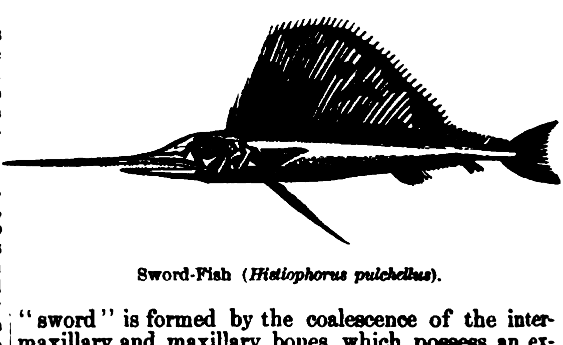
The following list of works is intended to guide the reader, if desired, to fuller acquaintance with the literature and authorities of the subject, and will, it is hoped, be found useful for that purpose, but it does not profess to be in itself sufficient even as a selection.

Archæology and General History.—R. F. Burton, *The Book of the Sword* (only one vol. published), London, 1884; Colonel Lane Fox (now Major-Gen. Pitt-Rivers), *Catalogue of Anthropological Collection, South Kensington Museum*, London, 1874; "Primitive Warfare," in *Journal* of the Royal United Service Institution, 1867, 1868, 1869. For special regions and periods, see Hon. Wilbraham Egerton, *Illustrated Handbook of Indian Arms*, published by the India office, London, 1880; Lindenschmit, *Tracht und Bewaffnung des römischen Heeres während der Kaiserzeit*, Brunswick, 1882; Drummond and Anderson, *Ancient Scottish Weapons*, Edinburgh and London, 1881. The more general treatises and handbooks on arms and armor, such as Grose, Meyrick, Hewitt, Lacombe, Demmin, may be consulted with advantage, but are not always to be trusted in details. "The Forms and History of the Sword." in *Proceedings* of the Royal Institution, 1883, by the present writer, gives further references and citations on various points.

Swordsmanship.—Egerton Castle, *Schools and Masters of Fence from the Middle Ages to the Eighteenth Century*, London, 1885 (including a critical bibliography); Vigeant, *Bibliographie de l'Escrime Ancienne et Moderne*, Paris, 1882; Gomard (assumed name of Possellier), *Théorie de l'Escrime*, Paris, 1845 (historical introduction); Grisier, *Les Armes et le Duel*, Paris, 1847 (preface by A. Dumas); Chapman, *Foil Practice*, London, 1861; *Notes and Observations on the Art of Fencing*, 1864; J. M. Waite, *Lessons in Sabre, etc.*, London [1881]. The French official *Manuel d'Escrime* (approved 1877) gives a very clear and concise summary of the modern school. Cordelois's *Leçons d'Armes* (Paris, 1872, 2d ed.) and Camille Prévost's *Théorie Pratique de l'Escrime* (Paris, 1886) are the latest and best treatises on the small-sword. There is forthcoming in England, in the "Badminton Series" a work on *Fencing* by W. H. Pollock and F. Craufurd Grove, to which is added *Bibliotheca Artis Dimicatoriæ*, a *Complete and General Bibliography of the Art of Fence*, by Egerton Castle.

Technology.—Wilkinson, *Engines of War*, London, 1841; Latham, "The Shape of Sword-Blades," *Journal* of the Royal U. S. Institution, 1862; Marey, *Mémoire sur les Armes Blanches*, Strasburg, 1841, transl. by Lieut.-Col. Maxwell, London, 1860. (F. PO.)

SWORD-FISH. Sword-fishes are a small family of spiny-rayed fishes (*Xiphiidæ*), the principal characteristic of which consists in the prolongation of the upper jaw into a long pointed sword-like weapon. The "sword" is formed by the coalescence of the intermaxillary and maxillary bones, which possess an extremely hard texture; it has the shape of a much elongate cone, more or less flattened throughout its whole length; the end is sharply pointed. It is smooth above and on the upper part of the sides, and rough below owing to the presence of innumerable rudimentary teeth, which have no function.



Sword-Fish (*Histiophorus pulchellus*).

The general form of the body is well proportioned, somewhat elongate, and such as is always found in fishes with great power of swimming, as, for instance, in the mackerel and tunny, and the tail terminates in a powerful bilobed caudal fin. A long fin occupies nearly the whole length of the back, whilst the anal fin is generally interrupted in the middle, and consequently appears to be double. The skin is very firm, partly naked, partly with small lanceolate scales deeply imbedded in the skin. The teeth of the lower jaw are, like those of the upper, merely rudimentary structures, which render the surface of the bone rough without possessing any special function.

Sword-fishes have been divided into three generic groups:

a. *Histiophorus*, with a high dorsal fin which can be spread out like a sail, and with ventral fins which are reduced to a pair of long styliform appendages.

b. *Tetrapturus*, with a dorsal fin of which the anterior rays only are elongate, the remainder of the fin being low or partly obsolete, and with styliform ventral fins as in the preceding genus.

c. *Xiphias*, with the dorsal fin shaped as in *Tetrapturus*, but without ventral fins.

Sword-fishes are truly pelagic fishes, which either singly or in pairs or in smaller or larger companies roam over the oceans of the tropical and subtropical zones of both hemispheres. Some species wander regularly or stray far into the temperate seas. Some of the tropical forms are the largest of Acanthopterygian fishes, and not exceeded in size by any other Teleostean; such species attain to a length of from 12 to 15 feet, and swords have been preserved more than 3 feet long and with a diameter of at least 3 inches at the base. The *Histiophori*, which inhabit chiefly the Indo-Pacific Ocean, but occur also in the Atlantic, seem to possess in their high dorsal fin an additional aid for locomotion. During the rapid movements of the fish this fin is folded downwards on the back, as it would impede the velocity of progress by the resistance it offers to the water; but, when the fish is swimming in a leisurely way, it is frequently seen with the fin erected and projecting out of the water, and when quietly floating on the surface it can sail by the aid of the fin before the wind, like a boat.

The food of the sword-fishes is the same as that of tunnies, and consists of smaller fish, and probably also in great measure of pelagic cuttle-fishes. It has been ascertained by actual observation that sword-fishes procure their food by dashing into a school of fishes, piercing and killing a number of them with their swords; and this kind of weapon would seem to be also particularly serviceable in killing large cuttle-fish, like the saw of saw-fishes, which is used for the same purpose. But the swords of the large species of *Histiophorus* and *Tetrapturus* are, besides, most formidable weapons of aggression. These fishes never hesitate to attack whales and other large cetaceans, and, by repeatedly stabbing them, generally retire from the combat victorious. That they combine in these attacks with the thresher-shark is an often-repeated story which has its foundation in the imagination of the observer, and which is fully disproved by the fact that the dentition of the thresher-shark is much too weak to make an impression on the skin of any cetacean. The cause which excites sword-fishes to such attacks is unknown; but they follow the instinct so blindly that they not rarely assail boats and ships in a similar manner, evidently mistaking them for cetaceans. They easily pierce the light canoes of the natives of the Pacific islands and the heavier boats of the professional sword-fish fishermen, often dangerously wounding the persons sitting in them. Attacks by sword-fishes on ocean-going ships are so common as to be included among sea-risks; they are known to have driven their weapon through copper-sheathing, oak-plank, and timber to a depth of nearly 10 inches, part of the sword projecting into the inside of the ship; and the force required to produce such an effect has been described by Prof. Owen in a court of law as equal to "the accumulated force of fifteen double-handed hammers," and the velocity as "equal to that of a swivel-shot," and "as dangerous in its effects as a heavy artillery projectile." Among the specimens of planking pierced by sword-fishes which are preserved in the British Museum there is one less than a foot square which incloses the broken ends of three swords, as if the fishes had had the object of concentrating their attack on the same vulnerable point of their supposed enemy. The part of the sword which penetrates a ship's side is almost always broken off and remains in the wood, as the fish is unable to execute sufficiently powerful backward movements to free itself by extracting the sword.

In the Mediterranean and on the Atlantic coasts of the United States the capture of sword-fishes forms a regular branch of the fishing-industry. The object of the fishery in the Mediterranean is the common European sword-fish (*Xiphias gladius*), the average weight of which is about one cwt., and which is abundant off the Sicilian coasts and on the opposite coast of Calabria. Two methods are employed,—that by harpoons, chiefly used for larger fish, and that by peculiarly constructed nets called *palamitare*. This fishery is very productive; a company of fishermen frequently capture from twenty to fifty fish in a single day, and the average annual catch in Sicily and Calabria is reported to be 140,000 kilogrammes (138 tons). The products of the fishery are consumed principally in a fresh state, but a portion is preserved in salt or oil. The flesh of the sword-fish is much preferred to that of the tunny, and always commands a high price. This species is occasionally captured on the British coast.

On the coast of the United States a different species, *Histiophorus gladius*, occurs; it is a larger fish than the Mediterranean sword-fish, attaining to a length of from 7 to 12 feet, and an average weight of 300 or 400 ℔. It is captured only by the use of the harpoon. From forty to fifty vessels, schooners of some 50 tons, are annually engaged in this fishery, with an aggregate catch amounting annually to about 3400 sword-fishes, of a value of $45,000. The flesh of this species is inferior in flavor to that of the Mediterranean species, and is principally consumed after having been preserved in salt or brine.

Useful and detailed information on the sword-fish fishery can be obtained from A. T. Tozzetti, "La Pesca nei Mari d'Italia e la Pesca all' Estero esercitata da Italiani," in *Catalogo Esposizione Internazionale di Pesca in Berlino*, 1880; also from *La Pesca del Pesce-Spada nello Stretto di Messina* (Messina, 1880), and from G. Brown Goode, "Materials for a History of the Sword-fish," in *Report of the Commissioner of Fish and Fisheries*, part viii., Washington, 1883.

(A. C. G.)

SYBARIS, a city of Magna Græcia, on the Gulf of Tarentum, between the rivers Crathis (Crati) and Sybaris (Coscile), which now meet three miles from the sea, but anciently had independent mouths, was the oldest Greek colony in this region. It was an Achæan colony founded by Isus of Helice (720 B.C.), but had among its settlers many Trœzenians, who were ultimately expelled. Placed in a very fertile, though now most unhealthy, region, and following a liberal policy in the admission of citizens from all quarters, the city became great and opulent, with a vast subject territory and divers daughter colonies even on the Tyrrhenian Sea (Posidonia, Laus, Scidrus). For magnificence and luxury the Sybarites were proverbial throughout Greece, and in the 6th century probably no Hellenic city could compare with its wealth and splendor. At length contests between the democrats and oligarchs, in which many of the latter were expelled and took refuge at Crotona, led to a war with that city, and the Crotoniats with very inferior forces were completely victorious. They razed Sybaris to the ground and turned the waters of Crathis to flow over its ruins (510 B.C.). Explorations undertaken by the Italian Government in 1879 have failed to lead to a precise knowledge of the site.

See *Academy*, vol. xvii. p. 73 (24th January, 1880); Lenormant, *La Grande-Grèce* (1881), i. 325 *sq.*; and THURII.

SYCAMORE. See FIG, vol. ix. p. 135, and MAPLE, vol. xv. p. 531.

SYDENHAM, a suburb of London, in the county of Kent, is finely situated chiefly on elevated ground about 7 miles south of Charing Cross, London. There is railway communication by the London, Brighton, and South Coast, the Mid Kent branch of the South-Eastern, and the London, Chatham, and Dover lines. Formerly Sydenham was a small hamlet of Lewisham, which rose into favor from its sylvan beauty, its pleasant situation, and its medicinal waters. These springs were discovered in 1640 on Sydenham common. The quality of the water resembled that of Epsom, and was regarded as efficacious in scorbutic and paralytic affections. After the construction of a railway the suburb grew into high repute as a residence, especially for the wealthier commercial and professional classes. The construction of the Crystal Palace (see LONDON, vol. xiv. p. 846) in 1854 greatly aided the prosperity of Sydenham, although the building is not within its boundaries. There is a public lecture hall and literary institute at Sydenham Hill, and a school of art, science, and literature in connection with the Crystal Palace. The charitable institutions include a home and infirmary for sick children and the South London dispensary for women. The population of the township (area, 1623 acres) was 19,065 in 1871, and 26,076 in 1881.

SYDENHAM, THOMAS (1624-1689), "the English Hippocrates," was born at Winford Eagle in Dorset in 1624, where his father was a gentleman of property and good pedigree. At the age of eighteen he was entered at Magdalen Hall, Oxford; after two years his college studies appear to have been interrupted, and he served for a time as an officer in the army of the Parliament. He completed his Oxford course in 1648, graduating as bachelor of medicine, and about the same time he was elected a fellow of All Souls College. It was not until nearly thirty years later (1676) that he graduated as M.D., not at Oxford, but at Pembroke Hall, Cambridge, where his eldest son was then an undergraduate. His interest in medicine seems to have been aroused at an early age. Nothing is known of Sydenham's life between 1648 and 1663; but it is probable that he spent part of the time at Oxford. It is said also (on the authority of one Desault, in a work published at Bordeaux in 1733) that he studied at Montpellier, although it is not so stated by himself in his dedicatory letter to Dr. Mapletoft, among the other autobiographical facts there given. In 1663 he passed the examinations of the College of Physicians for their license to practice in Westminster and 6 miles round; but it is probable that he had been settled in London for some time before that. This minimum qualification to practice was the single bond between Sydenham and the College of Physicians throughout the whole of his career. He seems to have been distrusted by the heads of the faculty because he was an innovator and something of a plain-dealer. In his letter to Mapletoft he refers to a class of detractors "qui vitio statim vertunt si quis novi aliquid, ab illis non prius dictum vel etiam inauditum, in medium proferat"; and in a letter to Robert Boyle, written the year before his death (and the only authentic specimen of his English composition that remains), he says, "I have the happiness of curing my patients, at least of having it said concerning me that few miscarry under me; but [I] cannot brag of my correspondency with some other of my faculty. . . . Though yet, in taking fire at my attempts to reduce practice to a greater easiness, plainness, and in the meantime letting the mountebank at Charing Cross pass unrailed at, they contradict themselves, and would make the world believe I may prove more considerable than they would have me." Sydenham attracted to him in warm friendship some of the most discriminating men of his time, such as John Locke and Robert Boyle. His first book, *Methodus Curandi Febres*, was published in 1666; a second edition, with an additional chapter on the plague, in 1668; and a third edition much enlarged and bearing the better-known title of *Observationes Medicæ*, in 1676. His next publication was in 1680 in the form of two *Epistolæ Responsoriæ*, the one, "On Epidemics," addressed to Brady, regius professor of physic at Cambridge, and the other "On the Lues Venerea," to Paman, public orator at Cambridge and Gresham professor in London. In 1682 he issued another *Dissertatio Epistolaris*, on the treatment of confluent smallpox and on hysteria, addressed to Dr. Cole of Worcester. The *Tractatus de Podagra et Hydrope* came out in 1683, and the *Schedula Monitoria de Novæ Febris Ingressu* in 1686. His last completed work, *Processus Integri*, is an outline sketch of pathology and practice; twenty copies of it were printed in 1692, and, being a compendium, it has been more often republished both at home and abroad than any other of his writings separately. A fragment on pulmonary consumption was found among his papers. His collected writings occupy about 600 pages 8vo in the original Latin.

Hardly anything is known of Sydenham's personal history in London. He died in an acute paroxysm of gout in December, 1689. He was buried in the church of St. James's, Piccadilly, where a mural slab was put up by the College of Physicians in 1810.

Although Sydenham was a highly successful practitioner and saw more than one new edition of his various tractates called for, besides foreign reprints, in his lifetime, his fame as the father of English medicine, or the English Hippocrates, was decidedly posthumous. For a long time he was held in vague esteem for the success of his cooling (or rather expectant) treatment of smallpox, for his laudanum (the first form of a tincture of opium), and for his advocacy of the use of Peruvian bark in quartan agues. There were, however, those among his contemporaries who understood something of Sydenham's importance in larger matters than details of treatment and pharmacy, chief among them being the talented Morton. But the attitude of the academical medicine of the day is doubtless shown forth in Lister's use of the term "sectaries" for Sydenham and his admirers, at a time (1694) when the leader had been dead five years. If there were any doubt that the opposition to him was quite other than political, it would be set at rest by the testimony of Dr. Andrew Brown,[1] who went from Scotland to inquire into Sydenham's practice, and has incidentally revealed what was commonly thought of it at the time, in his *Vindicatory Schedule concerning the New Cure of Fevers*. In the series of Harveian orations at the College of Physicians, Sydenham is first mentioned in the oration of Arbuthnot (1727), who styles him "æmulus Hippocrates." Boerhaave, the Leyden professor, was wont to speak of him in his class (which had always some pupils from England and Scotland) as "Angliæ lumen, artis Phœbum, veram Hippocratici viri speciem." Haller also marked one of the epochs in his scheme of medical progress with the name of Sydenham. He is indeed famous because he inaugurated a new method and a better ethics of practice, the worth and diffusive influence of which did not become obvious (except to those who were on the same line with himself, such as Morton) until a good many years afterwards. It remains to consider briefly what his innovations were.

First and foremost he did the best he could for his patients, and made as little as possible of the mysteries and traditional dogmas of the craft. All the stories told of him are characteristic. Called to a gentleman who had been subjected to the lowering treatment, and finding him in a pitiful state of hysterical upset, he "conceived that this was occasioned partly by his long illness, partly by the previous evacuations, and partly by emptiness. I therefore ordered him a roast chicken and a pint of canary." A gentleman of fortune who was a victim to hypochondria was at length told by Sydenham that he could do no more for him, but that there was living at Inverness a certain Dr. Robertson who had great skill in cases like his; the patient journeyed to Inverness full of hope, and, finding no doctor of the name there, came back to London full of rage, but cured withal of his complaint. Of a piece with this is his famous advice to Blackmore. When Blackmore first engaged in the study of physic he inquired of Dr. Sydenham what authors he should read, and was directed by that physician to *Don Quixote*, "which," said he, "is a very good book; I read it still." There were cases, he tells us, in his practice where "I have consulted my patient's safety and my own reputation most effectually by doing nothing at all." It was in the treatment of small-pox that his startling innovations in that direction made most stir. It would be a mistake, however, to suppose that Sydenham wrote no long prescriptions, after the fashion of the time, or was entirely free from theoretical bias. Doctrines of disease he had, as every practitioner must have; but he was too much alive to the multiplicity of new facts and to the infinite variety of individual constitutions to aim at symmetry in his theoretical views or at consistency between his practice and his doctrines; and his treatment was what he found to answer best, whether it were *secundum artem* or not. His fundamental idea was to take diseases as they presented themselves in nature and to draw up a complete picture ("krankheitsbild" of the Germans) of the objective characters of each. Most forms of ill-health, he insisted, had a definite type, comparable to the types of animal and vegetable species. The conformity of type in the symptoms and course of a malady was due to the uniformity of the cause. The causes that he dwelt upon were the "evident and conjunct causes," or, in other words, the morbid phenomena; the remote causes he thought it vain to seek after. Acute diseases, such as fevers and inflammations, he regarded as a wholesome conservative effort or reaction of the organism to meet the blow of some injurious influence operating from without; in this he followed the Hippocratic teaching closely as well as the Hippocratic practice of watching and aiding the natural crises. Chronic diseases, on the other hand, were a depraved state of the humors, mostly due to errors of diet and general manner of life, for which we ourselves were directly accountable. Hence, his famous dictum: "*acutos* dico, qui ut plurimum Deum habent authorem, sicut chronici ipsos nos." Sydenham's nosological method is essentially the modern one, except that it wanted the morbid anatomy part, which was first introduced into the "natural history of diseases" by Morgagni nearly a century later. In both departments of nosology, the acute and the chronic, Sydenham contributed largely to the natural history by his own accurate observation and philosophical comparison of case with case and type with type. The *Observationes Medicæ* and the first *Epistola Responsoria* contain evidence of a close study of the various fevers, fluxes, and other acute maladies of London over a series of years, their differences from year to year and from season to season, together with references to the prevailing weather,—the whole body of observations being used to illustrate the doctrine of the "epidemic constitution" of the year or season, which he considered to depend often upon inscrutable telluric causes. The type of the acute disease varied, he found, according to the year and season, and the right treatment could not be adopted until the type was known. There had been nothing quite like this in medical literature since the Hippocratic treatise, Περὶ ἀέρων, ὑδάτων, τόπων; and there are probably some germs of truth in it still undeveloped, although the modern science of epidemiology has introduced a whole new set of considerations. Among other things Sydenham is credited with the first diagnosis of scarlatina and with the modern definition of chorea (in *Sched. Monit.*). After smallpox, the diseases to which he refers most are hysteria and gout, his description of the latter (from the symptoms in his own person) being one of the classical pieces of medical writing. While Sydenham's "natural history" method has doubtless been the chief ground of his great posthumous fame, there can be no question that another reason for the admiration of posterity was that which is indicated by R. G. Latham, when he says, "I believe that the moral element of a liberal and candid spirit went hand in hand with the intellectual qualifications of observation, analysis, and comparison."

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[1] See Dr. John Brown's *Horæ Subsecivæ*, art. "Dr. Andrew Brown and Sydenham.

The most critrical biography is that by Dr. R. G. Latham prefixed to his translation of Sydenham's *Works* (2 vols., London, 1848, Syd. Soc.). Dr. John Brown's "Locke and Sydenham," in *Horæ subsecivæ*, Edinburgh, 1858, is more of the nature of eulogy. Many collected editions of his works have been published, as well as three English translations. Dr. W. A. Greenhill's Latin text (London, 1844, Syd. Soc.) is a model of editing and indexing. There have been foreign monographs on Sydenham by Goeden (Berlin, 1827), Rovers (Dort, 1838), F. Jahn (Eisenach, 1840), and Hvasser (Upsala, 1846). The most interesting summary of doctrine and practice by the author himself is the introduction to the 3d ed. of *Observationes Medicæ* (1676). (C. C.)

SYDNEY, the capital of New South Wales, and the oldest city in Australia, is situated on the east coast of that island-continent in 33° 51′ 41″ S. lat. and 151° 12′ 23.25″ (10h. 4m. 49.55s.) E. long. It lies on the southern shore of the magnificent harbor of Port Jackson, which in 1770 was named, though not discovered, by Captain Cook. He anchored and landed in Botany Bay, about 6 miles to the south, and on afterwards coasting to the north noted what looked like an inlet, to which he gave the name of Port Jackson, after Sir George Jackson, one of the secretaries to the admiralty. It may seem strange that so careful an observer as Cook should have passed close to one of the finest harbors in the world without recognizing its capacity; but the cliffs which guard the entrance are 300 feet in height, and no view of the land-locked basin can be seen from the masthead. Middle Head, which is posted right opposite the entrance, closes it in, and it is necessary to enter, turn to the south, and then to the west before the best part of the harbor discloses itself. This topographical peculiarity gives to the port its great shelter. When in 1788 Captain Phillip arrived at Botany Bay with the first convict fleet, he found its shallow waters and flat shores unsuited for the purposes of a settlement. Strangely enough he was also deterred by the want of water; yet it is on that very shore that the pumping-engine is situated by which Sydney has been supplied for many years. Going northwards, he turned in to examine Port Jackson inlet. Thither the fleet was instantly removed; and Sydney was founded, and Australian colonization started, on 26th January, 1788. Captain Phillip's choice of a site was determined by the existence of fresh water in a small stream running into Sydney Cove.

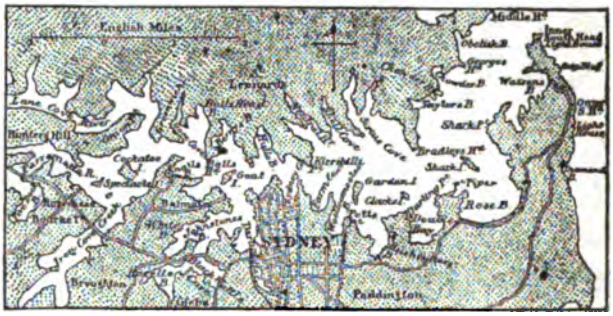

FIG. 1.—Harbor and environs of Sydney.

The port is flanked on both sides by a number of promontories—its characteristic feature—so that in addition to a broad central channel with deep water there is both on the north and the south side a series of sheltered bays with good anchorage. The entrance is a mile wide, with a minimum depth of 15 fathoms. Some little distance inside is a rock awash, known as the Sow and Pigs, between which and the nearest headlands on either side is an inner bar, with 20 feet of water at low tide; through this bar on the southern side a ship channel has been dredged giving 27 feet of water at neap tide. On the southern side there occur in succession Watson's Bay, Rose Bay, Double Bay, Rushcutter's Bay, Woolloomooloo Bay, Farm Cove, Sydney Cove, Darling Harbor, Johnstone's Bay, Blackwattle Bay, Iron Cove, Five Dock Bay, Hen and Chickens Bay, besides smaller inlets. On the northern side, beginning again at the Heads, there are North Harbor, Middle Harbor (with many subsidiary inlets), Chowder Bay, Sirius Cove, Mossman's Bay, Shell Cove, Neutral Bay, Careening Cove, Lavender Bay, Berry's Bay, Ball's Head Bay, Lane Cove, Tarban Creek, and other small bays. All these promontories and coves give a length of water frontage which is estimated at not less than 110 miles. Besides these, Botany Bay, though shallow and exposed and destitute of promontories, has a coast-line of about 18 miles. Into it debouches George's river, which is navigable to Liverpool, a distance of 14 miles from the mouth, and in which are several capacious bays.

The metropolitan area of Sydney really consists of a peninsula about 13 miles in length, lying between Parramatta and George's rivers. The sea frontage of this area, from the South Head of Port Jackson to the North Head of Botany Bay, is 12 miles in length, and consists alternately of bold cliffs and beautiful beaches. Two of the latter —Bondi and Coogee—are connected with the city by tramways, and are favorite places of holiday resort. Sydney occupies, therefore, a position enjoying singular natural advantages.

The city proper, as subsequently determined, takes in the water frontage from the head of Rushcutter's Bay on the east to the head of Blackwattle Bay on the west, giving a shore-line of 8 miles, of which 1⅝ are the frontage of the Domain and Botanic Gardens. The remainder is occupied for commercial purposes, and is held partly by the Government and partly by private owners. There are three large public wharfs—one, known as Circular Quay, embracing the greater part of Sydney Cove, seven-eighths of a mile in length. the second at the head of Darling Harbor, a quarter of a mile in extent, and the third at the head of Woolloomooloo Bay. The rest is occupied by private wharfs, the principal of which are on the east shore of Darling Harbor. A project is on foot for the resumption of the whole by the Government, and the making of a uniform quay, with a railway and a new street. The area of the city is 2670 acres, of which no part is more than a mile and a quarter distant from the water, whilst the average distance is three-quarters of a mile. The surface contour is undulating, the maximum elevation being 230 feet and the average 120. The soil is sandstone, covered more or less with shaly clay. Of the city area about 800 acres are devoted to public use. The largest reserve is Moore Park, lying to the south east of the city, nearly 500 acres in extent—originally a waste of sandhills. On it are the rifle range, the Agricultural Society's showground, and the principal cricket ground. The Inner and Outer Domains on the shore of the harbor contain about 130 acres. The former contains Government House, with its private garden and paddocks; the Outer Domain is a public park. The beautiful botanic gardens occupy the shore-line of Farm Cove, commanding the man-of-war anchorage. Hyde Park, the original race-course of the city, is about 49 acres in extent. At the north entrance is a statue of Prince Albert, and on its most elevated part is one of Captain Cook. Prince Alfred Park, on the southern boundary, of the city, originally called Cleveland Paddocks, occupies nearly 18 acres, and in it is the original exhibition building, now much used for concerts and festive gatherings. Belmore Park occupies 10 acres, and Cook and Phillip Parks each about the same area. The Fort Phillip reserve is a sort of acropolis, two of its rocky sides being escarped. Here, at an elevation of 146 feet, stands the astronomical observatory. Grose Farm, on the southwest of the city, was the site of one of the earliest attempts at Government farming. It is an undulating and elevated piece of land, and is divided amongst the university and the affiliated colleges of St. Paul, St. John, and St. Andrew, the Prince Alfred Hospital, and Victoria Park.

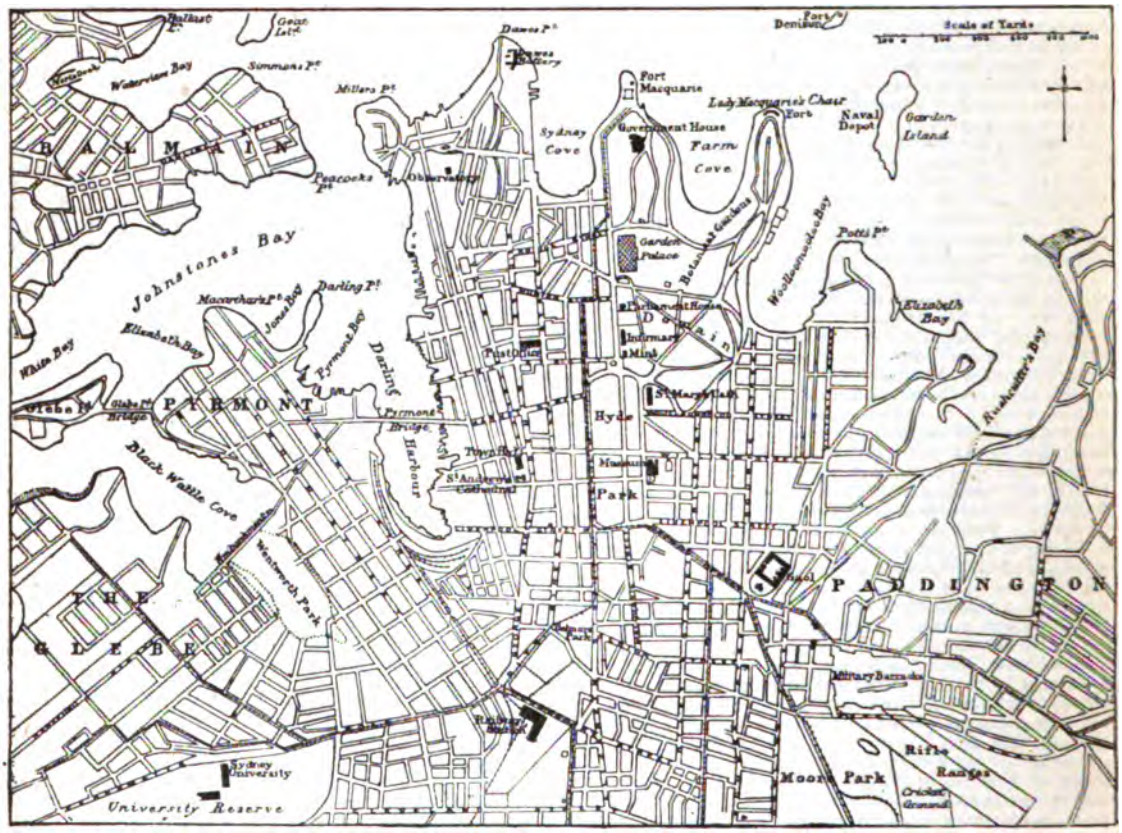

FIG. 2.—**Map of Sydney.**

The city started from the banks of the Tank stream at the head of Sydney Cove, and the chief business part is still in the limited area lying between Darling Harbor and the Domain and Hyde Park. The streets are irregular in width, some of them narrow and close together, while those leading down to Darling Harbor have a steep incline. Sydney has consequently more the look of an Old-World city than any other in Australia, and in its lack of spacious promenades and open squares and places, and in its poor opportunity for displaying its public buildings, it contrasts unfavorably with the more symmetrically planned sister cities of Australia. On the other hand, it has a charm which is all its own, as the glimpses of the harbor and the shipping obtainable from so many points give a delightful variety to the street vistas. The principal business street is George Street, 2 miles long, flanked with handsome commercial buildings. In this street are the post-office, the town-hall, the cathedral, and the main railway station.

Only second in importance is Pitt Street, which runs nearly parallel with it as far as the railway station.

The public and private buildings of Old Sydney are of a primitive order of architecture, but they are rapidly disappearing as the city is being rebuilt. With the exception of Government House, the university and affiliated colleges, and the registrar-general's office, all the non-ecclesiastical public buildings are in a classical style. Of the modern public buildings the museum, the post-office, the offices for the colonial secretary, the minister for public works, and the minister for lands, and the custom-house are the finest. The town-hall is a fine building, but a little too florid; the great hall, when finished, will be the largest in Australia. The Anglican cathedral in George Street is small. A Roman Catholic cathedral, on the east side of Hyde Park, replaces an earlier one that was burnt down, and will, when completed, be the finest ecclesiastical edifice in the city. The mint (an adaptation of an old hospital) is an imperial establishment, the cost of which is defrayed by the colonists. The annual value of the coinage from local gold is about £500,000 [$2,430,000], and this coinage has imperial currency. All the large public buildings are constructed of Sydney sandstone, which is abundant in quantity, though variable in quality. The best comes from the quarries in Pyrmont.

The length of streets, lanes, and public ways is about 100 miles. These are mostly macadamized, but wood paving has lately come much into favor. The saleyards for cattle and sheep (area 40 acres) are 7 miles off, at Homebush. The gross city revenue from all sources is about £376,000 [$1,827,360]. For municipal purposes the city is divided into eight wards, each returning three aldermen, and for parliamentary purposes into three electorates—east, west, and south—each returning four members. In 1881 the city population was 105,000. It was in 1886 officially estimated at 125,000. The population of the suburbs was officially estimated in 1884 at 150,000, making a total metropolitan population of 275,000. Communication with the suburbs[1] is maintained to a large extent by steam tramways, entirely in the hands of the Government. The whole district between Sydney and Parramatta is practically suburban for 2 miles on each side of the railway. The fashionable suburbs lie to the east of Sydney, the business extension of the city being more to the westward. The southern side is largely devoted to manufacturing operations, and population is rapidly extending in the direction of Botany Bay. The north shore of the harbor is outside the city limits, and the communication is by steam ferries. The north shore has deep water close in shore, but little level ground, the land rising rapidly to an elevation of 300 feet. Up this ascent the Government has constructed a cable tramway, and from the railway between Newcastle and Sydney, which crosses the Parramatta river 2 miles below the head of the navigation, there is to be a branch line of railway to the north shore, opposite the city.

Water was at first obtained from the so-called Tank stream; afterwards recourse was had to a lagoon on the southern slope of the dividing ridge between Port Jackson and Botany Bay, from which an artificial tunnel, known as Busby's Bore, brought the water into the city at the level of Hyde Park. When a further supply was wanted the same watercourse was utilized, the works being constructed at the point where it flowed into Botany Bay. A scheme is now (1886) in course of execution to bring water from the Upper Nepean, at a point 63 miles from Sydney. Two streams running in deep sandstone gorges are connected by a tunnel, and their united waters are brought in an open conduit. From the nature of the ground no large reservoir is possible near its source; but about 15 miles from Sydney, at Prospect, near Parramatta, a dam thrown across a valley makes a storage reservoir that will hold a year's supply. From that point the water is taken by open canal and piping to the existing reservoir in Crown Street, the limited area at a higher level being supplied by pumping. The delivery into the city will be over 150,000,000 gallons daily, and the cost of the whole works will exceed £1,500,000 [$7,290,000].

The old system of sewerage having several outfalls along the city front proved so objectionable that a new system has been designed, and is in course of execution, whereby the harbor will be preserved from all pollution. A great drain is carried from the city to the ocean at a projecting headland north of Bondi Bay known as Ben Buckler, where the sewage will go at once into deep water with a southerly current. The mouth of the sewer, though exposed to the beat of the ocean in very heavy weather, is 6 feet above high-water mark, and from that point it rises with a uniform inclination of 1 in 109, and in a nearly straight line, for a distance of 4 miles 25 chains. This main sewer, which throughout is one continuous monolith in concrete, passes in tunnels under the rocky ridges, and on concrete arches across the intervening flats. It diminishes in size from 8½ by 7½ feet to 5 feet 1 inch by 4 feet 1 inch, and at the upper end it bifurcates to accommodate two separate districts. It is of an oblate, oviform section, as nearly circular as is consistent with a minimum velocity of 2¼ feet a second. It drains an area of 4282 acres, and is calculated to discharge all the sewage when this area is populated as thickly as London, together with half an inch of rain per day. The bulk of the storm water is to pass off by surface drains. The sewage of the zone of land along the foreshore is to be lifted into the main sewer. From the southern slope of Sydney another large sewer runs southwards, and, crossing the mouth of Cook's River by a siphon, discharges its contents upon a sandy peninsula well suited for the purpose of a sewage farm.

The jurisdiction of the port of Sydney is in the hands of a marine board, of which three members are elected by the shipping interest, and three others and the president are nominated by the Government. They have the control of the pilot service, which is entirely a Government department. A new lighthouse has recently been erected on the South Head cliff, fitted with a powerful electric light, which is visible 27 miles off. The quarantine ground on North Head is isolated from the adjacent watering-place of Manly Beach by a fence and a broad belt of unoccupied land. Ships in quarantine anchor in a sheltered position off the beach, where a hospital ship is also stationed.

Port Jackson being the chief naval depot of Australasia and the headquarters of the admiral's station, the fortifications of the harbor have engaged the attention of successive Governments. The inner line of defence constructed by Sir William Denison has been superseded by more elaborate works. On the north side of the harbor Middle Head, George's Head, and Bradley's Head have powerful guns which cross fire with those on the South Head, completely commanding the entrance to the channel. There is also a very effective torpedo service. Garden Island, off the mouth of Woolloomooloo Bay, has been handed over to the imperial Government as a naval depôt; the man-of-war anchorage is close under its lee, and the colonial Government has constructed all necessary wharfs and storehouses. There is a Government dock at Cockatoo Island capable of accommodating the largest vessels, with a machine-shop close by. Adjoining this a new dock is being hewn out of the sandstone 600 feet in length and 108 feet wide; the depth of water over the sill at spring tide is to be 32 feet, and at neap tide 29 feet 6 inches, and the width at the entrance 84 feet. Mort's Dock and Engineering Company have a large dock at Waterview Bay capable of taking in all the ordinary mail steamers. There is also a patent slip, which can take up vessels of 1000 tons, and a second is in course of construction for vessels of 1500 tons. The graving-dock is 410 feet long. Besides this, there are other smaller patent slips, and a floating dock for the accommodation of smaller craft.

Sydney is in the centre of a great coal-basin, the eastern part of which is supposed to be under the sea; whether a workable seam exists under the city itself, and, if so, at what depth, is at present undetermined, borings of 2000 feet having as yet failed to strike the coal. The seams crop out at Lake Macquarie, north of Sydney, and dip to the south; they also rise to the surface at the south of Sydney, where they dip to the north. Twenty-four miles south of Sydney the seam has been found at a depth of 850 feet, and at about the same distance to the north at a depth of 600 feet. Coal is also brought into the city by railway from the Blue Mountains and from the Mittagong district, but it is inferior in quality to that mined on the coast.

The abundance and cheapness of coal, as well as the natural and commercial advantages of Sydney, have been favorable to certain lines of manufacturing industry, notwithstanding the high price of labor. In addition to the industries connected with shipping, those connected with the pastoral industry have also been developed, such as tanning, glue-making, meat-preserving, etc. The large railway works have, under the patronage of the Government, led to the manufacture of locomotives, and nearly all the rolling stock is made in the colonies. Omnibuses, cabs, carriages, buggies, drays, and carts are made in every variety and of excellent quality, as is also harness. Bootmaking is an extensive business; there are also manufactories of tobacco, sugar, kerosene, spirits, beer, tweed, paper, furniture, glass, pottery, and stoves, as well as a great variety of minor industries.

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[1] Paddington forms practically an eastern suburb of Sydney, with which there is constant omnibus communication. Victoria barracks are situated within its boundaries. Paddington is inhabited chiefly by the better classes, and possesses a number of public and private schools. A municipal constitution was granted it in April, 1860. The population of the borough in 1881 was 9608.

Public schools abound, with merely nominal fees. There is a high school for boys and girls. The grammar-school, with an attendance of 400 boys, receives from Government £1500 [$7290] a year, with the free use of the buildings. To the handsome university buildings a medical school is now being added. The great hall is the finest Gothic building in Australasia. The university is a teaching as well as examining institution, degrees being given in the four faculties of arts, medicine, law, and science. The university, which is governed by a senate elected by the graduates, has a Government endowment of £12,000 [$58,320] a year, and has been enriched by several donations and bequests (amounting to £250,000 [$1,215,000], of which about £180,000 [$874,800] by Mr. Challis). To it are attached three denominational affiliated colleges, one belonging to the Anglican Church, one to the Roman Catholic, and one to the Presbyterian; to each the Government contributed the land, £10,000 [$48,600] towards the building fund, and an annual stipend of £500 [$2430] a year for the principal. Technical education is conducted under the auspices of a board supported entirely at the cost of the Government. The pupils already number more than a thousand, and the attendance at the classes is steadily increasing. There is a good school of arts, with 400 members, and a good circulating library. The public free library is supported by the Government, and to it is attached a lending branch. The Royal Society has a roll of 500 members, meets periodically for the reading and discussion of scientific papers, publishes its transactions, and has a small library. The Linnæan Society is also well supported, and a Geographical Society has lately been started. The museum, in College Street, is managed by trustees and supported wholly at the cost of the Government. There is a small museum attached to the university, to which Mr. Macleay has bequeathed his collection, which is especially rich in natural history.

Sydney has many charitable institutions. It has three hospitals, the newest and largest, which is close to the university, having been built after the best European models. There are three large lunatic asylums in the suburbs; the latest is on the pavilion principle. The benevolent asylum, which is mainly supported by the Government, gives a large amount of outdoor assistance, takes in all waifs and strays, and acts as a lying-in hospital. Old men are provided for in an institution at Liverpool. At Randwick is an asylum for destitute children, which receives a large amount of Government support; and there are two orphan asylums at Parramatta; but the State children are now being boarded out under the auspices of a Government board. There are two soup-kitchens and refuges, supported by private contributions, and also a charity organization society. There is a home visiting and relief society, intended principally for those who have known better days, and a prisoners' aid society, besides numerous friendly societies. All the churches are well represented, and to each is attached one or more charitable agencies.

The climate of Sydney is mild and moderately equable. It resembles closely the climate of Toulon. The mean temperature is 62.6° Fahr. and the extreme range of the shade thermometer is from 106° to 36° Fahr. The sea-breeze which prevails during the summer comes from the northeast, and, while it tempers the heat, makes the air moist and induces langour. In winter the prevailing wind is from the west, and the air is dry and bracing. The annual rainfall is 50 inches. The hot northwest wind of summer sometimes sends the humidity down below 30°, and once it has been as low as 16°. In the cool westerly winds of winter it seldom falls to 55°, and never below 45°. The average humidity for the year is 74°. The mean tide is 3 feet 3 inches. (A. GA.)

SYENE (ASWÁN). See EGYPT, vol. vii. p. 679.

SYENITE. See GRANITE, vol. xi. p. 44.

SYLBURG, FRIEDRICH (1536–1596), an eminent Greek scholar, and one of the greatest figures in the annals of German philology, was the son of a farmer, and was born at Wetter near Marburg in 1536. Wetter had then an excellent school, taught by J. Foenilius and Justus Vulteius, and Sylburg also got help in his studies from the preacher J. Pincier, whose daughter he subsequently married. His studies were continued at Marburg and Jena, and then at Geneva (1559) and at Paris. Here his teacher was Henry Estienne (Stephens), to whose great Greek *Thesaurus* Sylburg afterwards made important contributions. Returning to Germany, he was for a time a schoolmaster at Neuhaus near Worms, and then head of a new gymnasium at Lich, where he edited a useful edition of Nicolas Cleynart's *Greek Grammar* (Frankfort, 1580), which was thrice reprinted during his lifetime. But the period of his important literary labors began when (having previously, in 1581, declined a call to the Greek chair at Marburg) he resigned his post at Lich and moved to Frankfort to act as corrector and editor of Greek texts for the enterprising publisher J. Wechel. To his Frankfort period belong the editions of Pausanias (1583), Herodotus (1584), Dionysius of Halicarnassus (2 vols., 1586—one of his best pieces of work), Aristotle (5 vols., 1587—dedicated to the landgraves of Hesse, from one of whom, Louis IV., he received a pension), the Greek and Latin sources for the history of the Roman emperors (3 vols., 1589–90), and the Περὶ συντάξεως of Apollonius. In 1591 he was attracted to Heidelberg by the treasures of the library, not yet scattered by the Thirty Years' War. Here he became librarian to the elector palatine and was untiring in collecting further MS. treasures. At the same time the series of editions which Wechel had begun to find too costly, was continued by the Heidelberg publisher Hieronymus Commelinus. At Heidelberg were printed Clement of Alexandria (1592), Justin Martyr (1593), the *Etymologicum Magnum* (1594), the *Scriptores de Re Rustica* (1595), the Greek gnomic poets (1596), Xenophon (1596), Nonnus (1596), and other works. All Sylburg's editions show great critical power and indefatigable industry. Indeed he wore himself out with work, and died on 16th February, 1596, "nimiis vigiliis ac typographicis laboribus consumptus," as his tombstone in the churchyard of St. Peter's in Heidelberg has it. There is a careful notice of his life by K. W. Justi in Strieder's *Hessische Gelehrten-Geschichte*, xviii. 481 *sq.*

SYLHET, a British district of India, in the province of Assam, lying between 25° 12′ and 23° 59′ N. lat. and 91° and 92° 38′ E. long., with an area of 5381 square miles. It is bounded on the N. by the Khási and Jaintia Hills district, on the E. by Cachar, on the S. by the state of Hill Tipperah and the district of Tipperah, and on the W. by the district of Maimansinh. Sylhet consists of the lower valley of the Surma or Barak river, and for the most part is a uniform level, broken only by scattered clusters of sandy hillocks called *tilás*, and intersected by a network of rivers and drainage channels. In the south eight low ranges of hills, spurs of the Tipperah Mountains, run out into the plain, the highest range being about 1500 feet above sea-level. There is also a small detached group in the centre of the district called the Ita Hills. Entering the district from Cachar, the Surma bifurcates into two branches: the main branch flows beneath the hills bordering the northeast part, while the minor branch, the Kusiára, flows in a southwesterly direction across the district; they again unite on the southwestern boundary and fall into the Meghna under the name of Dhaleswari. Both branches are navigable by large boats and support a busy traffic. The wild animals of the district comprise elephants, tigers, buffaloes, bison, and several varieties of deer. The climate of Sylhet is extremely damp and the rainfall is heavy, reaching an annual average of over 150 inches; the rainy season generally lasts from April to October.

In 1881 the population was returned at 1,969,009, of whom 999,785 were males and 969,224 females. Hindus numbered 949,353, Mohammedans 1,015,531, and hill tribes 3706. The only places with a population exceeding 5000 are Sylhet town (14,407) and Kashba Baniachang, a large village (24,061). Sylhet town, the administrative headquarters of the district, is situated on the right or north bank of the Surma, and besides the usual public offices contains a handsome church and the mosque of Sháh Jalál (a fakir whose miraculous powers contributed greatly to the Mussulman conquest of the country), which attracts pilgrims from great distances. Out of the total area 3080 square miles were returned as under cultivation in 1882–83 and 654 as cultivable.

The staple crop is rice, which yields three harvests during the year. There are immense forest tracts in the south-eastern parts of Sylhet. The chief industries are the weaving by Manipuri women of cotton cloths called *Manipuri khesh*, also handkerchiefs and mosquito curtains tastefully embroidered with silk. The manufacture of mats, ivory and shell carving, and other ornamental work are also pursued with much skill and elegance.

Sylhet with the rest of Bengal passed into the hands of the British in 1765. Previous to 1874 Sylhet formed an integral part of Bengal, being included in the Dacca division; but in September of that year it was annexed, together with the adjoining district of Cachar, to the chief-commissionership of Assam.

SYLT (probably from the Old Frisian *Silendi*, *i.e.*, "sealand") is the largest German island in the North Sea, being 40 square miles in area and nearly 23 miles long. It is, however, very narrow, generally about half a mile in width, except in the middle, where it sends out a peninsula 7 miles across. It belongs to the province of Schleswig-Holstein, and lies from 7 to 12 miles from the Schleswig coast. Its long and slender outline is highly suggestive of its former position as part of a continuous line of coast, now in great part swept away. The invasion of the sea has made considerable progress even within a comparatively recent period, and several hamlets were swallowed up in the 13th and 14th centuries. The process of gradual waste is still going on, though it is now obviated to some extent by the exertions of the Prussian Government, and counterbalanced by deposits of mud on the landward side. The central peninsula contains some "marshland" and moorland pasture, on which a few thousand sheep are grazed, but the rest of the island consists merely of dunes or sand-hills, which at places attain a height of from 100 to 150 feet. The inhabitants, about 3000 in number, are of Frisian origin, though a few in the extreme north of the island speak Danish. Their occupations are fishing, oyster-dredging, seamanship, and wild-duck catching; the women make large quantities of woollen jackets. The chief places are Keitum (850 inhabitants), Westerland, which is annually visited by about 1500 sea-bathers, and Morsum. Some very interesting pagan tombs have been found on the island.[1]

SYLVESTER. See SILVESTER.

SYMBOL. See CREEDS.

SYME, JAMES (1799-1870), surgeon, was born at Edinburgh on 7th November, 1799. His father was a writer to the signet and a landowner in Fife and Kinross, who lost most of his fortune in attempting to develop the mineral resources of his property. James was sent to the High School at the age of nine, and remained there until he was fifteen, when he entered the university. For two years he frequented the arts classes (including botany), and in 1817 began the medical curriculum, devoting himself with particular keenness to chemistry. His chemical experiments led him to the discovery that "a valuable substance is obtainable from coal tar which has the property of dissolving india-rubber," and could be used for waterproofing silks and other textile fabrics,—an idea which was patented a few months afterwards by Macintosh of Glasgow. In the session of 1818-19 Syme became assistant and demonstrator in the dissecting room of Liston, who had started as an extra-mural teacher of anatomy in competition with his old master Barclay; in those years he held also resident appointments in the infirmary and the fever hospital, and spent some time in Paris practicing dissection and operative surgery. In 1823 Liston handed over to him the whole charge of his anatomy classes, retaining his interest in the school as a pecuniary venture; the arrangement did not work smoothly, and a feud with Liston arose, which did not terminate until twenty years later, when the latter was settled in London. Syme's next venture was the Brown Square school of medicine, which he started in 1824-25 in conjunction with Dr. Macintosh, Dr. Fletcher, and others; the partnership was again inharmonious, and soon came to an end. Announcing his intention to practice surgery only, Syme started a surgical hospital of his own, Minto House hospital, which he carried on from May, 1829, to September, 1833, with great success as a surgical charity and school of clinical instruction. It was here that he first put into practice his method of clinical teaching, which consisted in having the patients to be operated or prelected upon brought from the ward into a lecture-room or theatre where the students were seated conveniently for seeing and taking notes. His private practice had become very considerable, his position having been assured ever since his amputation at the hip joint in 1823, the first of the kind in Scotland. In 1833 he succeeded Russell as professor of clinical surgery in the university. Syme's accession to the clinical chair was marked by two important changes in the conditions of it: the first was that the professor should have the care of surgical patients in the infirmary in right of his professorship, and the second, that attendance on his course should be obligatory on all candidates for the medical degree. When Liston removed to London in 1835 Syme became the leading consulting surgeon in Scotland. On Liston's death in 1847 Syme was offered his vacant chair of clinical surgery at University College, London, and accepted it. He began practice in London in February, 1848; but early in May the same year difficulties with two of his colleagues at Gower Street and a desire to "escape from animosity and contention" led him to throw up his appointment. He returned to Edinburgh in July, and was re-instated in his old chair, which the crown authority had meanwhile found a difficulty in appointing to. The judgment of his friends was that "he was always right in the matter, but often wrong in the manner, of his quarrels." In 1849 he broached the subject of medical reform in a letter to the lord advocate; in 1854 and 1857 he addressed open letters on the same subject to Lord Palmerston; and in 1858 a Medical Act was passed which largely followed the lines laid down by himself. As a member of the General Medical Council called into existence by the Act, he made considerable stir in 1868 by an uncompromising statement of doctrines on medical education, which were thought by many to be reactionary; they were, however, merely an attempt to recommend the methods that had been characteristic of Edinburgh teaching since Cullen's time,—namely, a constant reference of facts to principles, the subordination (but not the sacrifice) of technical details to generalities, and the preference of large professorial classes and the "magnetism of numbers" to the tutorial system, which he identified with "cramming." In April, 1869, he had a paralytic seizure, and at once resigned his chair; he never recovered his powers, and died on 26th June, 1870.

Syme's surgical writings are numerous, although the terseness of his style and directness of his method save them from being bulky. In 1831 he published *A Treatise on the Excision of Diseased Joints* (the celebrated ankle-joint amputation is known by his name). His *Principles of Surgery* (often reprinted) came out a few months later; *Diseases of the Rectum* in 1838; *Stricture of the Urethra and Fistula in Perineo* in 1849; and *Excision of the Scapula* in 1864. In 1848 he collected into a volume, under the title of *Contributions to the Pathology and Practice of Surgery*, thirty-one original memoirs published in periodicals from time to time; and in 1861 he issued another volume of *Observations in Clinical Surgery*. Syme's character is not inaptly summed up in the dedication to him by his old pupil, Dr. John Brown, of the series of essays *Locke and Sydenham*: "Verax, capax, perspicax, sagax, efficax, tenax."

See *Memorials of the Life of James Syme*, by R. Paterson, M.D., with portraits, Edinburgh, 1874.

SYMEON OF DURHAM was the author of two works of great importance in English history, especially in that of northern England, viz., the *Historia Dunelmensis Ecclesiæ* and the *Historia Regum*. Very little is known of his life. There is no record of the date of his birth or death. He was at Jarrow about 1080, before the monastic community moved thence to Durham (1083). He probably did not become a professed monk till some time after that event. In 1104 he was present at the opening of the coffin and the examination of the remains of St. Cuthbert. Between 1104 and 1108 he composed his *History of the Church of Durham*, bringing it down to the death of William of St. Carilef (1096). Many years later he compiled his *Historia Regum*, which is a chronicle of Northumbrian affairs from the date at which Bede stops (731). He was also probably the author of a letter *De Archiepiscopis Eboraci*, but not of the treatise *De Miraculis et Translationibus* sometimes attributed to him. Selden in his introduction to Twysden's *Decem Scriptores*, attributes the *Historia Dunelmensis Ecclesiæ* to Turgot, prior of that church; but Mr. Arnold, in the preface to his edition of Symeon's works, successfully disproves Selden's assertions. This work is original and of great value; the *Historia Regum*, on the other hand, is a compilation from various sources, brought down by Symeon to 1121 or 1129. Both works were continued by other hands.

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[1] [This island was the *traditional* starting place of Hengist and Horsa in the Saxon invasion of Britain.—AM. ED.]

See Twysden, *Decem Scriptores*, and prefaces to Symeon's works, by Mr. Hodgson Hinde (Surtees Society edition, 1868) and by Mr. T. Arnold (Rolls Series edition, 1882–85).

SYMEON, surnamed **Metaphrastes**, Byzantine hagiographer, according to Leo Allatius (*De Symeonum Scriptis*, Paris, 1664), lived during the first half of the 10th century under Leo the Philosopher and his successor at Constantinople, where he successively held the positions of secretary, grand logothete, and master of the palace. This view, subsequently adopted by Cave, Fabricius, and others, was afterwards disputed, but not convincingly, by Oudin (*Comm. de Scriptt. Eccles. Antiq.*, vol. ii., 1722), who identified Metaphrastes with another Symeon who also held the offices of logothete and master of the palace under John Comnenus, and published a still extant *Epitome Canonum* in 1160. Symeon's *Metaphrases*, as his legends are called (whence his name Metaphrastes), occur in MS. in many European libraries; many of them are also to be found in the *Acta Sanctorum* and similar collections; but others remain unprinted. Allatius and Cave recognize only 122 of the hundreds of lives assigned to him as genuine. The titles of other writings of Symeon, with references to further authorities, will be found in the article "Metaphrastes," by Gass, in Herzog-Plitt's *Encykl.*, vol. ix.

SYMMACHUS, pope from 498 to 514, had Anastasius II. for his predecessor and was himself followed by Hormisdas. He was a native of Sardinia, apparently a convert from paganism, and was in deacon's orders at the time of his election. The choice was not unanimous, another candidate, Laurentius, having the support of a strong Byzantine party; and both competitors were consecrated by their friends, the one in the Lateran church and the other in that of St. Mary, on 22d November, 498. A decision was not long afterwards obtained in favor of Symmachus from Theodoric, to whom the dispute had been referred; but peace was not established until 505 or 506, when the Gothic king ordered the Laurentian party to surrender the churches of which they had taken possession. An important incident in the protracted controversy was the decision of the "palmary synod" (see vol. xix. p. 507). The remainder of the pontificate of Symmachus was uneventful; history speaks of various churches in Rome as having been built or beautified by him.

SYMMACHUS, Quintus Aurelius, consul in 391, and one of the most brilliant representatives in public life and in literature of the old pagan party at Rome, was educated in Gaul, and, having discharged the functions of prætor and quæstor, rose to higher offices, and in 373 was proconsul of Africa. His public dignities, which included that of pontiff, his great wealth and high character, added to his reputation for eloquence, marked him out as the champion of the pagan senate against the measures which the Christian emperors directed against the old state religion of Rome. In 382 he was banished from Rome by Gratian for his protest against the removal of the statue and altar of Victory from the senate-house, and in 384, when he was prefect of the city, he addressed to Valentinian a letter praying for the restoration of these symbols. This is the most interesting of his literary remains, and called forth two replies from St. Ambrose, as well as a poetical refutation from Prudentius. After this Symmachus was involved in the rebellion of Maximus, but obtained his pardon from Theodosius, and appears to have continued in public life up to his death.

Of the writings of Symmachus we possess (1) ten books of *Epistles*, published after his death by his son. The model followed by the writer is Pliny the Younger, and from a reference in the *Saturnalia* of Macrobius (bk. v., i. § 7), in which Symmachus is introduced as one of the interlocutors, it appears that his contemporaries deemed him second to none of the ancients in the "rich and florid" style. The first edition of the *Epistles* by Bart. Cynischus (*s. l. et. a.*, but published under Pope Julius II.) is very incomplete, and the collection was only gradually completed by subsequent editors. (2) Fragments of nine *Complimentary Orations* from a palimpsest, of which part is at Milan and part in the Vatican, were discovered by Mai, who published the Milan fragments in 1815, the Roman ones in his *Scriptorum Veterum Nova Collectio*, vol. i. (1825), and the whole in 1846. The work was not well done, and many corrections are given in a new collation by O. Seeck (*Commentationes in Honorem Th. Mommseni*, Berlin, 1877, p. 595 *sq.*), which has been followed by an edition of the works of Symmachus in the *Monumenta Germaniæ Historica*, Berlin, 1883.

SYMPHONY. See Music, vol. xvii. p. 102.

SYNAGOGUE (*συναγωγή*), literally "assemblage," is the term employed to denote either a congregation of Jews, *i.e.*, a local circle accustomed to meet together for worship and religious instruction, or the building in which the congregation met. In the first sense the word is a translation of כנסה, *keneseth*, in the second of בית הכנסת, *bêth hakkeneseth*. The germ of the synagogue, that is, of religious assemblages dissociated from the ancient ritual of the altar, may be found in the circle of the prophets and their disciples (see especially Isa. viii. 16 *sq.*); but the synagogue as an institution characteristic of Judaism arose after the work of Ezra, and is closely connected with the development of that legal Judaism to which his reformation gave definite shape. From the time of Ezra downwards it was the business of every Jew to know the law; the school (*bêth hammidrāsh*) trained scholars, but the synagogue, where the law was read every Sabbath (Acts xv. 21), was the means of popular instruction. Such synagogues existed in all parts of Judæa in the time of Psalm lxxiv. 8 (probably a psalm of the Persian period); in Acts xv. 21 it appears that they had existed for many generations "in every city." This held good not only for Palestine but for the Dispersion; in post-Talmudic times the rule was that a synagogue must be built wherever there were ten Jews. And, though the name "synagogue" varies with *προσευχή* ("place of prayer"), it appears that everywhere the assemblage was primarily one for instruction in the law: the synagogue, as Philo puts it, was a *διδασκαλεῖον*. A formed institution of this sort required some organization: the general order of the service was directed by one or more "rulers of the synagogue" (*ἀρχισυνάγωγοι*, Luke xiii. 14; Acts xiii. 15), who called on fit persons to read, pray, and preach; alms were collected by two or more "collectors" (*gabbâê ṣedākā*); and a "minister" (*ḥazzân*, *ὑπηρέτης*, Luke iv. 20) had charge of the sacred books (preserved in an "ark") and of other ministerial functions, including the teaching of children to read. The discipline of the congregation was enforced by excommunication (*ḥèrem*) or temporary exclusion (*niddûy*), and also by the minor punishment of scourging (Matt. x. 17), inflicted by the *ḥazzân*. The disciplinary power was in the hands of a senate of elders (*πρεσβύτεροι*, *γερουσία*), the chief members of which were ἀρχοντες. The principal service of the synagogue was held on Sabbath morning, and included, according to the Mishnah, the recitation of the *shema'* (Deut. vi. 4-9, xi. 13-21; Numb. xv. 37-41), prayer, lessons from the law and prophets with Aramaic translation, a sermon (*derāshah*) based on the lesson (Acts xiii. 15), and finally a blessing pronounced by the priest or invoked by a layman. On Sabbath afternoon and on Monday and Thursday there was a service without a lesson from the prophets; there were also services for all feast-days. Synagogues were built by preference beside water for the convenience of the ceremonial ablutions (comp. Acts xvi. 13); and remains of very ancient buildings of this class exist in several parts of Galilee; they generally lie north and south, and seem to have had three doors to the south, and sometimes to have been divided by columns into a nave and two aisles.

Jewish tradition has a great deal to say about a body called "the great synagogue," which is supposed to have been the supreme religious authority from the cessation of prophecy to the time of the high priest Simeon the Just, and is even said (by modern writers since Elias Levita) to have fixed the Old Testament canon (cp. vol. v. p. 5 *sq.*). But Kuenen in his essay "Over de Mannen der Groote Synagoge" (*Verslagen* of the Amsterdam Academy, 1876) has shown that these traditions are fiction, and that the name *keneseth haggādôla* originally denoted, not a standing authority, but the great convocation of Neh. viii.-x.

Compare in general Schürer, *Geschichte des jüdischen Volkes*, § 27, where the older literature is catalogued. For the usages of the synagogue in more recent times, see Buxtorf, *Synagoge Judaica*, Basel, 1641.

SYNEDRIUM (συνέδριον), a Greek word which means "assembly" and is especially used of judicial or representative assemblies, is the name by which (or by its Hebrew transcription, סנהדרין, *sanhedrin*, *sanhedrim*) that Jewish body is known which in its origin was the municipal council of Jerusalem, but acquired extended functions and no small authority and influence over the Jews at large (see vol. xiii. p. 434 *sq.*). In the Mishnah it is called "the sanhedrin," "the great sanhedrin," "the sanhedrin of seventy-one [members]," and "the great court of justice" (*bêth dîn haggādôl*). The oldest testimony to the existence and constitution of the synedrium of Jerusalem is probably to be found in 2 Chron. xix. 8; for the priests, Levites, and hereditary heads of houses there spoken of as sitting at Jerusalem as a court of appeal from the local judicatories does not correspond with anything mentioned in the old history, and it is the practice of the Chronicler to refer the institutions of his own time to an origin in ancient Israel. And just such an aristocratic council is what seems to be meant by the gerusia or senate of "elders" repeatedly mentioned in the history of the Jews, both under the Greeks from the time of Antiochus the Great (Jos., *Ant.*, xii. 3, 3) and under the Hasmonean high priests and princes. The high priest as the head of the state was doubtless also the head of the senate, which, according to Eastern usage, exercised both judicial and administrative or political functions (comp. 1 Mac. xii. 6, xiv. 20). The exact measure of its authority must have varied from time to time, at first with the measure of autonomy left to the nation by its foreign lords and afterwards with the more or less autocratic power claimed by the native sovereigns.

As has been shown in vol. xiii. p. 434 *sq.*, the original aristocratic constitution of the senate began to be modified under the later Hasmoneans by the inevitable introduction of representatives of the rising party of the Pharisees, and this new element gained strength under Herod the Great, the bitter enemy of the priestly aristocracy.[1] Finally under the Roman procurators the synedrium was left under the presidency of the chief priest as the highest native tribunal, though without the power of life and death (John xviii. 31). The aristocratic element now again preponderated, as appears from Josephus and from the New Testament, in which "chief priests" and "rulers" are synonymous expressions. But with these there sat also "scribes" or trained legal doctors of the Pharisees and other notables, who are simply called "elders" (Mark xv. 1). The Jewish tradition which regards the synedrium as entirely composed of rabbins sitting under the presidency and vice-presidency of a pair of chief doctors, the *nāsî* and *āb bêth dîn*,[2] is quite false as regards the true synedrium. It was after the fall of the state that a merely rabbinical *bêth dîn* sat at Jabneh and afterwards at Tiberias, and gave legal responses to those who chose to admit a judicature not recognized by the civil power. Gradually this illegal court usurped such authority that it even ventured to pronounce capital sentences,—acting, however, with so much secrecy as to allow the Roman authorities to close their eyes to its proceedings (Origen, *Ep. ad Afr.*, § 14). That this was possible will appear less surprising if we remember that in like manner the synedrium of Jerusalem was able to extend an authority not sanctioned by Roman law over Jews beyond Judæa, *e.g.*, in Damascus (Acts ix. 2; xxii. 5).

The council-chamber (βουλή) where the synedrium usually sat was between the Xystus and the temple, probably on the temple-hill, but hardly, as the Mishnah states, within the inner court. The meeting in the palace of the high priest which condemned our Lord was exceptional. The proceedings also on this occasion were highly irregular, if measured by the rules of procedure which, according to Jewish tradition, were laid down to secure order and a fair trial for the accused.

Of the older literature of the subject it is enough to cite Selden, *De Synedriis*. The most important critical discussion is that of Kuenen in the *Verslagen*, etc., of the Amsterdam Academy, 1866, p. 131 *sq.* A good summary is given by Schürer, *Geschichte des jüdischen Volkes*, 2d ed., § 23, iii.

SYNESIUS, bishop of Ptolemais in the Libyan Pentapolis from 410 to *c.* 414, was born of wealthy parents, who claimed descent from Spartan kings, at Cyrene about 375. While still a youth (393) he went with his brother Euoptius to Alexandria, where he became an enthusiastic Neoplatonist and disciple of HYPATIA (*q.v.*). Returning to his native place some time before 397, he was in that year chosen to head an embassy from the cities of the Pentapolis to the imperial court to ask for remission of taxation and other relief. His stay in Constantinople, which lasted three years, was wearisome and otherwise disagreeable; the leisure it forced upon him he devoted in part to literary composition (see his *De Providentia*). The oration he delivered when at last admitted to the presence of Arcadius is also extant (*De Regno*). Returning abruptly to Cyrene in 400, he spent the next ten years partly in that city, when unavoidable business called him there, but chiefly on an estate in the interior of the province, where he was able to enjoy the literary leisure that was most congenial to him, varying his studies with gardening and hunting and the quiet pleasures of domestic life. His marriage took place at Alexandria in 403; in the previous year he had visited Athens. In 409 or 410 Synesius, whose Christianity had until then been by no means very pronounced, was popularly chosen to be bishop of Ptolemais, and, after long hesitation on personal and doctrinal grounds, he ultimately accepted the office thus thrust upon him, being consecrated by Theophilus at Alexandria. One personal difficulty at least was obviated by his being allowed to retain his wife, to whom he was much attached; but as regarded orthodoxy he expressly stipulated for personal freedom to dissent on the questions of the soul's creation, a literal resurrection, and the final destruction of the world, while at the same time he agreed to make some concession to popular views in his public teaching (τὰ μὲν οἴκοι φιλοσοφῶν, τὰ δ' ἔξω φιλομυθῶν). His tenure of the bishopric, which was comparatively brief, was troubled not only by domestic bereavements but also by barbaric invasions of the country, and by conflicts with the prefect Andronicus, whom he excommunicated for interfering with the church's right of asylum. The date of his death is unknown, but he died probably not later than 414.

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[1] The name *synedrium* first appears under Hyrcanus II. (Jos., *Ant.*, xiv. 9, 4).

[2] The former word properly means the sovereign and the latter the president of the tribunal. The false traditional application is post-Mishnic.

His extant works are—(1) a speech before Arcadius, *De Regno*; (2) *Dio, sive de suo ipsius Instituto*, in which he signifies his purpose to devote himself to true philosophy; (3) *Encomium Calvitii*, a literary *jeu d'esprit*, suggested by Dio Chrysostom's *Praise of Hair;* (4) *De Providentia*, in two books; (5) *De Insomniis;* (6) 157 *Epistolæ;* (7) 12 *Hymni;* and several homilies and occasional speeches. The *editio princeps* is that of Turnebus (Paris, 1553); it was followed by that of Morell, with Latin translation by Tetavius (1612, greatly enlarged and improved 1633; reprinted by Migne, 1859). The *Epistolæ*, which for the modern reader greatly exceed his other works in interest, have been edited by Demetriades (Vienna, 1792) and by Glukus (Venice, 1812), the *Calvitii Encommium* by Krabinger (Stuttgart, 1834), the *De Providentia* by Krabinger (Sulzbach, 1835), the *De Regno* by Krabinger (Munich, 1825), and the *Hymns* by Flach (Tübingen, 1875).

See Clausen, *De Synesio Philosopho* (Copenhagen, 1831); Volkmann, *Synesius von Cyrene* (Berlin, 1869); and Miss Alice Gardner's monograph in "The Fathers for English Readers" (London, 1886).

SYNOD. See COUNCIL and PRESBYTERIANISM.

SYPHILIS. See PATHOLOGY, vol. xviii. pp. 414–415, and SURGERY, p. 721 above.

SYRA, or SYROS, a Greek island in the middle of the Cyclades, which in the 19th century has become the commercial centre of the Archipelago, and is also the residence of the nomarch of the Cyclades and the seat of the central law courts. In ancient times this island was remarkably fertile, as is to be gathered not only from the Homeric description (*Od.* xv. 403), which might be of doubtful application, but also from the remains of olive presses and peculiarities in the local nomenclature. The destruction of its forests has led to the loss of all its alluvial soil, and now it is for the most part a brown and barren rock, covered at best with scanty aromatic scrub, pastured by sheep and goats. The length of the island is about 10 miles, the breadth 5, and the area is estimated at 42½ square miles. The population is now estimated to number about 33,700, of whom about 20,500 are in the chief town. Commerce is the main occupation of the islanders, though they also build ships, have extensive tanneries, large steam flour-mills, a steam weaving and rope factory, and a handkerchief factory, and grow vegetables for export.

Hermopolis, as the chief town is called, is built round the harbor on the east side of the island. It is governed by an active municipality, whose revenue and expenditure have rapidly increased. Among the public buildings are a spacious town-hall in the central square, a club-house, an opera-house, and a Greek theatre. Old Syra, on a conical hill behind the port town, is an interesting place, with its old Roman Catholic church of St. George's still crowning the summit. This was built by the Capuchins, who in the Middle Ages chose Syra as the headquarters of a mission in the East. Louis XIII., hearing of the dangers to which the Syra priests were exposed, took the island under his especial protection, and since that time the Roman Catholic bishops of Syra have been elected by the pope. About the beginning of the 19th century the inhabitants of Syra numbered only about 1000; whenever a Turkish vessel appeared they made off to the interior and hid themselves. On the outbreak of the war of Greek independence refugees from Chios, after being scattered throughout Tenos, Spezia, Hydra, etc., and rejected by the people of Ceos, took up their residence at Syra under the protection of the French flag. Altogether about 40,000 had sought this asylum before the freedom of Greece was achieved. The chief city was called Hermopolis after the name of the ship which brought the earlier settlers. Most of the immigrants elected to stay, and, though they were long kept in alarm by pirates, they have continued steadily to prosper. In 1875 1568 sailing ships and 698 steamers (with a total of 740,731 tons) entered and 1588 sailing ships and 700 steamers (with a total of 756,807 tons) cleared this port; in 1883 3379 sailing and 1126 steam vessels (with a total of 1,056,201 tons) entered and 3276 sailing and 1120 steam vessels (with a total of 960,229 tons) cleared. Most of the sailing vessels were Greek and Turkish, and most of the steamers were Austrian, French, and Turkish.

Topography.

SYRACUSE (Συράκοσαι, Συράκουσαι, Συρήκουσαι; Lat. *Syracusæ;* Italian *Siracusa*), the chief Greek city of ancient Sicily and one of the earliest Greek settlements in the island (see SICILY, p. 21 above). The foundation legend takes several shapes (Thuc., vi. 3; Strabo, vi. 4, p. 269); but there is no reason to doubt that Syracuse was founded by Archias of Corinth as part of a joint enterprise together with Corcyra, and the received date 735 B.C. may pass as approximate.[1] The first settlement was on a small island, parted from the coast by a very narrow channel (for map, see pl. II.). It points southward, in front of a deep bay, which, with the opposite headland (Plemmyrium), it helps to shelter from the sea. This formed the Great Harbor; the Lesser Harbor of Laccius lay to the north of the island, between it and a peninsula of the mainland, with the open sea to the east and north. The peninsula consists of part of a hill which almost everywhere leaves some space between itself and the sea. To the west of the Great Harbor a marshy plain lies on each side of the river Anapus. On the south side of the river is a smaller hill. The coast of the island and of the peninsula is rocky. That of the harbor is for the most part flat, except part of the west and south sides and the headland opposite the island. From the island the city spread over the whole peninsula, while a detached suburb (Polichne) arose on the outlying hill beyond Anapus. The marshy ground between the two was not fit for building. All these additions have been gradually forsaken, and the modern town is confined to the island.

Island of Ortygia.

The island was called Ortygia, a name connected with the Delian legend of Artemis (see Holm, *Gesch. Sic.*, i. 886), but often simply the Island (Liv., xxv. 24, 30). Though the lowest part of the city, its position and strength made it the citadel, and it is therefore often spoken of by Diodorus and Plutarch as if it had been a real acropolis. It is famous for the fountain of Arethusa, connected in Greek legend with the river Alpheus in Peloponnesus.[2] The sweet water perished when an earthquake brought in the sea in 1170.[3] At the time of the first settlement the island was held by Sicels; some have thought that a Phœnician element lingered on under both Sicels and Greeks. It is certain (Herod., vii. 166) that Syracuse and Carthage stood in relations to one another which were not usual between Greek and barbarian cities. It has also been thought from some legendary hints that Polichne was the original Syracuse, and that the plural form (Συράκουσαι) arose from the union of Ortygia and Polichne. But the plural form is common enough in other cases. The chief evidence for the belief is that the great temple of Olympian Zeus stood in Polichne and that (Plut., *Nic.*, 14) the register of Syracusan citizens was kept there.

Earliest historical period.

Till the beginning of the 5th century B.C. our notices of Syracusan history are quite fragmentary. Almost the only question is whether, as some stray notices (Athen., i. 56; see Müller's *Dorians*, i. 161, Eng. tr.) might suggest, the primitive kingship was retained or renewed at Syracuse, as it certainly was in some other Greek colonies. A king Pollis is spoken of; but nothing is known of his actions. It is far more certain that Syracuse went through the usual revolutions of a Greek city. The descendants of the original settlers kept the land in their own hands, and they gradually brought the Sicel inhabitants to a state not unlike villainage. Presently other settlers, perhaps not always Greek, gathered round the original Syracusan people; they formed a distinct body, δῆμος or *plebs*, personally free, but with an inferior political franchise or none at all. The old citizens thus gradually grew into an exclusive or aristocratic body, called γάμοροι or landowners. We hear incidentally of disputes, seditions, and changes, among others the banishment of a whole *gens* (Thuc., v. 5; Arist., *Pol.*, v. 3, 5, 4, 1); but we have no dates or details till we have entered the 5th century B.C. In its external development Syracuse differed somewhat from other Sicilian cities. Although it lagged in early times behind both Gela and Acragas (Agrigentum), it very soon began to aim at a combination of land and sea power. Between 663 and 598 it founded the settlements of Acræ, Casmenæ, and Camarina, of which the first was unusually far inland. The three together secured for Syracuse a continuous dominion to the southeast coast. They were not strictly colonies but outposts; Camarina indeed was destroyed after a revolt against the ruling city (Thuc., v. 1). That the inland Sicel town of Henna was ever a Syracusan settlement there is no reason to believe. Of this early time some architectural monuments still remain, as the two temples in Ortygia, one of which is now the metropolitan church, and the small remains of the Olympieum or temple of Zeus in Polichne,—all of course in the ancient Doric style.

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[1] See Plut., *Amat. Narr.*, 2.

[2] See Pind., *Nem.*, i. 1, and the scientific discussions in Strabo, vi. 2, p. 270; also Pausanias, v. 7, 2–4.

[3] Hugo Falc., ed. Murat, vii. 862; Lumia, *Sicilia sotto Guglielmo il Buono*, 117.

Gelon.

The second period of Syracusan history, which roughly begins with the 5th century, is far better ascertained. It is a period of change in every way. The aristocratic commonwealth becomes in turn a tyranny and a democracy; and Syracuse becomes the greatest Greek city in Sicily, the mistress of other cities, the head of a great dominion,—for a moment, of the greatest dominion in Hellas. Strange to say, all this growth begins in subjection to the ruler of another city. Hippocrates, tyrant of Gela, held the chief power in eastern Sicily at the beginning of the 5th century B.C. (498–491). He threatened Syracuse as well as other cities, and it was delivered only by the joint intervention of Corinth and Corcyra, and by the cession of the vacant territory of Camarina. In 485 the Syracusan δῆμος or *plebs* joined with the Sicel serf population to drive out the *gamoroi*, the ruling oligarchs. These last craved help of Gelon, the successor of Hippocrates, who took possession of Syracuse without opposition, and made it the seat of his power. Syracuse now grew by the depopulation of other cities conquered by Gelon. He gave citizenship both to mercenaries (Diod., xi. 73) and to settlers from old Greece (Paus., v. 27, 16, 17; Pind., *Olymp.*, vi.), so that Syracuse became a city of mingled race, in which the new citizens had the advantage. The town spread to the mainland: the new town of Achradina, with separate fortifications, arose on the eastern part of the adjoining peninsula (Diod., xi. 73), while Ortygia became the inner city, the stronghold of the ruler. Indeed in the form of unwalled suburbs the city seems to have spread even beyond Achradina (Diod., xi. 61, 68, 72). Gelon's general rule was mild, and he won fame as the champion of Hellas by his great victory over the Carthaginians at Himera. He is said to have been greeted as king; but he does not seem to have taken the title in any formal way.

Gelon's successors.

Gelon's brother and successor Hiero (478–467) kept up the power of the city; he won himself a name by his encouragement of poets and philosophers; and his Pythian and Olympian victories made him the special subject of the songs of Pindar. He appeared also as a Hellenic champion in the defence of Cumæ, and he attempted to found a Syracusan colony on the island of Ænaria, now Ischia. But his internal government, unlike that of Gelon, was suspicious, greedy, and cruel. After some family disputes the power passed to his brother Thrasybulus, who was driven out next year by a general rising (see SICILY, p. 21). In this revolution Thrasybulus and his mercenaries held the fortified quarters of Ortygia and Achradina; the revolted people held the unwalled suburbs, already, it is plain, thickly inhabited. Thrasybulus yielded to the common action of Siceliots and Sicels. Syracuse again became a free commonwealth, and, as the effect of the tyranny had been to break down old distinctions, it was now a democratic commonwealth. Renewed freedom was celebrated by a colossal statue of Zeus Eleutherius and by a yearly feast in his honor. But when the mercenaries and other new settlers were shut out from office[1] new struggles arose. The mercenaries again held Ortygia and Achradina. The people now walled in the suburb of Tyche to the west of Achradina (Diod., xi. 73). The mercenaries were at last got rid of in 461. Although we hear of attempts to seize the tyranny and of an institution called *petalism*, like the Athenian ostracism, designed to guard against such dangers, popular government was not seriously threatened for more than fifty years. The part of Syracuse in general Sicilian affairs has been traced in the article SICILY (*q.v.*); but one striking scene is wholly local, when the defeated Ducetius took refuge in the hostile city (451), and the common voice of the people bade "spare the suppliant." We have but one solitary notice of the great military and naval strength of Syracuse in 439 (Diod., xii. 30). Yet all that we read of Syracusan military and naval action during the former part of the Athenian siege shows how Syracuse had lagged behind the cities of old Greece, constantly practiced as they were in warfare both by land and sea.

Athenian siege.

The Athenian siege (415–413) is of the deepest importance for the topography of Syracuse, and it throws some light on the internal politics. Hermocrates, the best of counsellors for external affairs, is suspected, and seemingly with reason, of disloyalty to the democratic constitution. Yet he is, like Nicias and Phocion, the official man, head of a board of fifteen generals, which he persuades the people to cut down to three. Athenagoras, the demagogue or opposition speaker, has the best possible exposition of democratic principles put into his mouth by Thucydides (vi. 36–40). Through the whole siege[2] there was a treasonable party within the city, which—for what motive we are not told—kept up a correspondence with the besiegers.

The speech of Athenagoras is that of a very clever demagogue; it sums up very forcibly all that can be said against oligarchy, and it may have been perfectly sincere. But his views were overruled, and preparation was made in earnest for the city's defence. When the Athenian fleet under Nicias and Lamachus was at Rhegium in Italy, the question for the commanders was whether they should seek to strengthen themselves by fresh alliances on the spot or strike the blow at once. Lamachus was for immediate action, and there can hardly be a doubt that Syracuse must have fallen before a sudden attack by so formidable an armament in the summer of 415. The Syracusans were neither at unity among themselves nor by any means adequately prepared for effectual defence. Throughout the whole struggle it is perfectly clear that they owed their final deliverance to the most extraordinary good fortune. Athens had the prize within her grasp, and she lost it wholly through the persistent dilatoriness and blundering of her general, the desponding, vacillating Nicias. It was at his advice that the summer and autumn of 415 were frittered away and the siege not begun till the spring of 414. By that time the Syracusans were both in better spirits and better prepared: their troops were better organized, and they had built a wall from the Great Harbor to Panagia so as to screen them from attack on the side of Epipolæ on the northwest. The effect of this was to bar the enemy's approach and push back his blockading lines, which had to be carried over an inconveniently large extent of ground. The Syracusans had been at first thoroughly cowed; but they were cowed no longer, and they even plucked up courage to sally out and fight the enemy on the high ground of Epipolæ. They were beaten and driven back; but at the suggestion of Hermocrates they carried a counter-work up the slope of Epipolæ, which, if completed, would cut in two the Athenian lines and frustrate the blockade. At this point Nicias showed considerable military skill. The Syracusans' work was destroyed by a prompt and well-executed attack; and a second counter-work carried across marshy ground some distance to the south of Epipolæ and near to the Great Harbor was also demolished after a sharp action, in which Lamachus fell. However, the blockade on the land side was now almost complete, and the Athenian fleet had at the same time entered the Great Harbor. The citizens began to think of surrender, and Nicias was so confident that he neglected to push his advantages. He left a gap in his lines at the point where Epipolæ slopes down to the sea, and he omitted to occupy an important position on its northwestern ridge, known as Euryalus, a pass which commanded on this side the approach to the city from the interior.

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[1] Diod., xi. 72; cf. Arist., *Pol.*, v. 3, 10, and Grote's note, v. 319.

[2] The chief authorities for the siege are Thucydides (bks. vi. and vii.), Diodorus (bk. xiii.), and Plutarch, *Life of Nicias*.

The second act of the drama may be said to open with the irretrievable blunder of Nicias in letting the Spartan Gylippus first land in Sicily, and then march at the head of a small army, partly levied on the spot, across the island, and enter Syracuse by way of Epipolæ, through the Euryalus pass. Gylippus was felt to be the representative of Sparta, and of the Peloponnesian Greeks generally, and his arrival inspired the Syracusans with the fullest confidence. Just before his arrival a few ships from Corinth had made their way into the harbor with the news that a great fleet was already on its way to the relief of the city. The tables were now completely turned, and we hear of nothing but defeat and disaster for the besiegers till their final overthrow. The military skill of Gylippus enabled the Syracusan militia to meet the Athenian troops on equal terms, to wrest from them their fortified position on Plemmyrium, and to reduce them to such a plight that, as Nicias said in his despatch to Athens towards the close of 414, they were themselves besieged rather than besieging. In the spring of the following year Syracuse once again gave herself up for lost, when seventy-three warships from Athens, under Demosthenes, entered the harbor with a large force of heavy infantry and light troops. Demosthenes decided at once to make a grand attack on Epipolæ, with a view to recovering the Athenian blockading lines and driving the Syracusans back within the city walls. The assault was made by night, by the uncertain light of the moon, and this circumstance turned what was very nearly a successful surprise into a ruinous defeat. The affair seems to have been well planned up to a certain point, and well executed; but the Athenian van, flushed with a first success, their ranks broken and disordered by a pursuit of the enemy over rough ground, were repulsed with great loss by a body of heavy armed Bœotians, and driven back in disorder. The confusion spread to the troops behind them, and the action ended in a wild flight through the narrow roads and passes of Epipolæ. The army was now thoroughly out of heart, and Demosthenes was for at once breaking up the camp, embarking the troops, and sailing back to Athens. But Nicias could not bring himself to face the Athenian people at home, nor could he be prevailed on to retire promptly to some position on the coast, such as Catana or Thapsus, where the army would be at least able to maintain itself for a time. He dallied till the end of August, many weeks after the defeat, and on the 27th of that month was an eclipse of the moon, on the strength of which he insisted on a delay of almost another month. His fleet too lingered uselessly in the harbor, till, after a frantic effort to break out and a desperate conflict, it was utterly defeated and half destroyed. The broken and demoralized army, its ranks thinned by fever and sickness, at last began its hopeless retreat in the face of the numerous Syracusan cavalry, and, after a few days of dreadful suffering, was forced to lay down its arms. The Syracusans sullied the glory of their triumph by huddling their prisoners into their stone-quarries,—a living death, dragged out, for some of them at least, to the space of seventy days.

Diocles and Hermocrates.

Her great deliverance and victory naturally stirred up the energies of Syracuse at home and abroad. Syracusan ships under Hermocrates now play a not unimportant part in the warfare between Sparta and Athens on the coast of Asia. Under the influence of Diocles the constitution became a still more confirmed democracy, some at least of the magistracies being filled by lot, as at Athens (Diod., xiii. 31, 35; Arist., *Pol.*, v. 3-6). Diocles appears also as the author of a code of laws of great strictness, which was held in such esteem that later lawgivers were deemed only its expounders. There seems no reason to suppose, with Holm, an earlier lawgiver Diocles distinct from the demagogue; but the story of his death by his own hand to punish a breach of his own law is, we may suspect, a repetition of the story of Charondas (Diod., xiii. 33; cf. xii. 19). Under these influences Hermocrates was banished in 409; he submitted to the sentence, notwithstanding the wishes of his army. He went back to Sicily, warred with Carthage on his own account, and brought back the bones of the unburied Syracusans from Himera, but was still so dreaded that the people banished Diocles without restoring him. In 407 he was slain in an attempt to enter the city, and with him was wounded one who was presently to outstrip both rivals.

Dionysius the Elder.

This was Dionsysius, son of another Hermocrates, and an adherent of the aristocratic party, but soon afterwards a demagogue, though supported by some men of rank, among them the historian Philistus (Diod., xiii. 91, 92). By accusing the generals engaged at Gela in the war against Carthage, by obtaining the restoration of exiles, by a variety of tricks played at Gela itself, he secured his own election, first as one of the generals, then as sole general (or with a nominal colleague) with special powers. He next, by another trick, procured from a military assembly at Leontini a vote of a bodyguard; he hired mercenaries and in 406-5 came back to Syracuse as tyrant of the city (Diod., xiii. 91-96). Dionysius kept his power till his death thirty-eight years later (367). But it was wellnigh overthrown before he had fully grasped it. His defeat before Gela (see SICILY, p. 23) was of course turned against him. His enemies in the army, chiefly the horsemen, reached Syracuse before him, plundered his house—he had not yet a fortress—and horribly maltreated his wife; but they took no political or military steps against himself. He came and took his vengeance, slaying and driving out his enemies, who established themselves at Ætna (Diod., xiii. 113). This revolution and the peace with the Carthaginians confirmed Dionysius in the possession of Syracuse, but of no great territory beyond, as Leontini was again a separate city. It left Syracuse the one great Hellenic city of Sicily, which, however enslaved at home, was at least independent of the barbarian. Dionysius was able, like Gelon, though with less success and less honor, to take up the part of the champion of Hellas.

Quarters of the city.

During the long tyranny of Dionysius the city grew greatly in size, population, and grandeur. Plato says (*Epist.*, vii.) that he gathered all Sicily into it. In fact the free Greek cities and communities, in both Sicily and southern Italy, were sacrificed to Syracuse; there the greatness and glory of the Greek world in the West were concentrated. The mass of the population of Gela and Camarina in the disastrous year 405 had, at the prompting of Dionysius, taken refuge at Syracuse. Gela had in the previous year received the fugitive inhabitants of Acragas (Agrigentum), which had been sacked by the Carthaginians. Syracuse thus absorbed three of the chief Greek cities of Sicily. It received large accessions from some of the Greek cities of southern Italy, from Hipponium on its west and Caulonia on its east coast, both of which Dionysius captured in 389 B.C. There had also been an influx of free citizens from Rhegium. At the time of the Athenian siege Syracuse consisted of two quarters—the Island and the "outer city" of Thucydides, generally known as Achradina, and bounded by the sea on the north and east, with the adjoining suburb of Apollo Temenites farther inland at the foot of the southern slopes of Epipolæ. With the vast increase in its population, it now grew into a city of four quarters. The suburb Temenites was expanded into Neapolis (New Town), spreading over the adjoining slopes. A district stretching down to the sea, to the northwest of Achradina, was taken in, and subsequently enlarged into a separate fortified town. Tyche (Τύχη) was the name given to this quarter, according to Cicero (*In Verr.*, iv. 52, 53) from an old temple of Fortune somewhere within its limits,—a fact which seems to indicate that the spot must have been inhabited in very early times. But of this Thucydides says nothing, and his silence on a point which would have naturally entered into his description of the Athenian blockading operations is somewhat perplexing. This quarter was in Cicero's time the most populous part of the entire city; it was practically secured by the new city walls, which were drawn inland in a triangular form so as to inclose the hill of Epipolæ, the apex of the triangle being the fortress of Euryalus, the remains of which are said to be the most perfect existing specimen of ancient fortification. Syracuse was now secure on the land side. The Island (Ortygia) had been provided with its own defences, converted in fact into a separate stronghold, with a fort to serve specially as a magazine of corn, and with a citadel or acropolis which stood apart, and might be held as a last refuge. Dionysius, to make himself perfectly safe, drove out a number of the old inhabitants and turned the place into barracks for his soldiers, he himself living in the citadel. For any unpopularity he may have thus incurred he seems to have made up by his great works for the defence of the city; these were executed under the direction of the most skilful engineers, and are said to have found employment for 60,000 men. The new lines covered an extent of 3½ miles, and were constructed of huge well-cut blocks of stone from the neighboring quarries. Each quarter of the city had its own distinct defences, and Syracuse was now the most splendid and the best fortified of all Greek cities. Its naval power, too, was vastly increased; the docks were enlarged; and 200 new warships were built. Besides the triremes, or vessels with three banks of oars, we hear of quadriremes and quinqueremes with four and five banks of oars,—larger and taller and more massive ships than had yet been used in Greek sea warfare. The fleet of Dionysius was the most powerful in the Mediterranean. It was doubtless fear and hatred of Carthage, from which city the Greeks of Sicily had suffered so much, that urged the Syracusans to acquiesce in the enormous expenditure which they must have incurred under the rule of Dionysius. Much too was done for the beauty of the city as well as for its strength and defence. Several new temples were built, and gymnasia erected outside the walls near the banks of the Anapus (Diod., xv. 13).

Dionysius the Younger.

Dion.

"Fastened by chains of adamant" was the boastful phrase in which Dionysius described his empire; but under his son, the younger Dionysius, an easy, good-natured, unpractical man, a sort of cleverish dilettante, a reaction set in amongst the restless citizens of Syracuse, which, with its vast and mixed population, must have been full of elements of turbulence and faction. But the burdensome expenditure of the late reign would be enough to account for a good deal of discontent. A remarkable man now comes to the front,—Dion, the friend and disciple of Plato, and for a time the trusted political adviser of Dionysius, whom he endeavored to impress with a conviction of the infinite superiority of free and popular government to any form of tyranny or despotism. Dion's idea seems to have been to make Dionysius something like a constitutional sovereign, and, with this view he brought him into contact with Plato. All went well for a time; but Dionysius had those about him who were opposed to any kind of liberal reform, and the result was the banishment of Dion from Syracuse as a dangerous innovator. Ten years afterwards, in 357, the exile entered Achradina a victor, welcomed by the citizens as a deliverer both of themselves and of the Greeks of Sicily generally. As yet, however, this was the only part of the city gained. A siege and blockade, with confused fighting and alternate victory and defeat, and all the horrors of fire and slaughter, followed, till Dion made himself master of the mainland city. Ortygia, however, was still held by Dionysius; but, provisions failing, it also was soon surrendered. Dion's rule lasted only three years, for he perished in 354 by the hand of a Syracusan assassin. It was, in fact, after all his professions, little better than a military despotism. The tyrant's stronghold in the island was left standing, and Dion actually opposed a proposal for its destruction. The man who won immense popularity by the proposal was murdered, and Dion seems to have been an accomplice in the crime.

Of what took place in Syracuse during the next ten years we know but little. The younger Dionysius came back and from his island fortress again oppressed the citizens; the plight of the city, torn by faction and conflicts and plundered by foreign troops, was so utterly wretched that all Greek life seemed on the verge of extinction (Plato, *Epist.*, viii.). Sicily, too, was again menaced by Carthage. Syracuse, in its extremity, asked help from the mother-city, Corinth; and now appears on the scene one of the noblest figures in Greek history, TIMOLEON (*q.v.*).

Timoleon.

To him Syracuse owed her deliverance from the younger Dionysius and from the rule of despots, and to him both Syracuse and the Sicilian Greeks owed a decisive triumph over Carthage and the safe possession of Sicily west of the river Halycus, the largest portion of the island. From 343 to 337 he was supreme at Syracuse, with the hearty goodwill of the citizens. The younger Dionysius had been allowed to retire to Corinth; his island fortress was destroyed and replaced by a court of justice. Syracuse rose again out of her desolation —grass, it is said, grew in her streets—and, with an influx of a multitude of new colonists from Greece and from towns of Sicily and Italy, once more became a prosperous city. Timoleon, having accomplished his work, accepted the position of a private citizen, though, practically, to the end of his life he was the ruler of the Syracusan people. After his death (337) a splendid monument, with porticoes and gymnasia surrounding it, known as the Timoleonteum, was raised at the public cost to his honor.

Agathocles.

In the interval of twenty years between the death of Timoleon and the rise of Agathocles to power another revolution at Syracuse transferred the government to an oligarchy of 600 leading citizens. All we know is the bare fact. It was shortly after this revolution, in 317, that Agathocles, with a body of mercenaries from Campania and a host of exiles from the Greek cities, backed up by the Carthaginian Hamilcar, who was in friendly relations with the Syracusan oligarchy, became tyrant or despot of the city, assuming subsequently, on the strength of his successes against Carthage, the title of king. Syracuse passed through another reign of terror; the new despot proclaimed himself the champion of popular government, and had the senate and the heads of the oligarchical party massacred wholesale. This man of blood seems to have had popular manners, and to have known how to flatter and cajole, for a unanimous vote of the people gave him absolute control over the fortunes of Syracuse. His wars in Sicily and Africa left him time to do something for the relief of the poorer citizens at the expense of the rich, as well as to erect new fortifications and public buildings; and under his strong government Syracuse seems to have been at least quiet and orderly. After his death in 289 comes another miserable and obscure period of revolution and despotism, in which Greek life was dying out; and but for the brief intervention of Pyrrhus in 278 Syracuse, and indeed all Sicily, would have fallen a prey to the Carthaginians.

Hiero II.

A better time began under Hiero II., who had fought under Pyrrhus and who rose from the rank of general of the Syracusan army to be tyrant—king, as he came to be soon styled—about 270. During his reign of over fifty years, ending probably in 216, Syracuse enjoyed tranquillity, and seems to have grown greatly in wealth and population. Hiero's rule was kindly and enlightened, combining good order with a fair share of liberty and self-government. His financial legislation was careful and considerate; his laws[1] as to the customs and the corn tithes were accepted and maintained under the Roman government, and one of the many bad acts of the notorious Verres, according to Cicero, was to set them aside (Cic., *In Verr.*, ii. 13; iii. 8). It was a time too for great public works,—works for defence at the entrance of the Lesser Harbor between the Island and Achradina, and temples and gymnasia. Hiero through his long reign was the stanch friend and ally of Rome in her struggles with Carthage; but his paternal despotism, under which Greek life and civilization at Syracuse had greatly flourished, was unfortunately succeeded by the rule of a man who wholly reversed his policy.

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[1] The laws of Hiero are often mentioned with approval in Cicero's speeches against Verres.

Hieronymus.

Siege by Marcellus.

Hieronymus, the grandson of Hiero, thought fit to allay himself with Carthage; he did not live, however, to see the mischief he had done, for he fell in a conspiracy which he had wantonly provoked by his arrogance and cruelty. There was a fierce popular outbreak and more bloodshed: the conspirators were put to death and Hiero's family was murdered; whilst the Carthaginian faction, under the pretence of delivering the city from its tyrants, got the upper hand and drew the citizens into open defiance of Rome. Marcellus was then in command of the Roman army in Sicily, and he threatened the Syracusans with attack unless they would get rid of Epicydes and Hippocrates, the heads of the anti-Roman faction. Epicydes did his best to stir up the citizens of Leontini against Rome and the Roman party at Syracuse. Marcellus therefore struck his first blow at Leontini, which was quickly stormed; and the tale of the horrors of the sack was at once carried to Syracuse and roused the anger of its population, who could not but sympathize with their near neighbors, Greeks like themselves. The general feeling was now against any negotiations with the Roman general, and, putting themselves under Epicydes and Hippocrates, they closed their gates on him. Marcellus, after an unsuccessful attempt to negotiate, began the siege in regular form (214 B.C.) by both land and sea, establishing a camp on Polichne, where stood the old temple of Olympian Zeus; but he made his chief assault on the northern side and on the defences of Tyche, particularly at the Hexapylum, the entrance facing Megara and Leontini. His assault seawards was made mainly on Achradina, but the city was defended by a numerous soldiery and by what seems to have been still more formidable, the ingenious contrivances of Archimedes, whose engines dealt havoc among the Roman ships, and frustrated the attack on the fortifications on the northern slopes of Epipolæ (Liv., xxiv. 34). Marcellus had recourse to a blockade, but Carthaginian vessels from time to time contrived to throw in supplies. At length treachery began to work within. Information was given him in the spring of 212 (two years from the commencement of the siege) that the Syracusans were celebrating a great festival to Artemis; making use of this opportunity, he forced the Hexapylum entrance by night and established himself in Tyche and on the heights of Epipolæ. The strong fortress of Euryalus held out for a time, but, being now isolated, it soon had to surrender. The "outer" and the "inner city" of Thucydides still held out, whilst a Carthaginian fleet was moored off Achradina and Carthaginian troops were encamped on the spot. But a pestilence broke out in the autumn of 212, which swept them clean away, and thinned the Roman ranks. The ships sailed away to Carthage; on their way back to Syracuse with supplies they could not get beyond Cape Pachynus owing to adverse winds, and they were confronted by a Roman fleet. All hope for the city being now at an end, the Syracusans threw themselves on the mercy of Marcellus; but Achradina and the Island still held out for a brief space under the Syracusan mercenaries, till one of their officers, a Spaniard, betrayed the latter position to the enemy, and at the same time Achradina was carried and taken. Marcellus gave the city up to plunder (Liv., xxv. 31), and the art treasures[1] in which it was so rich—many of the choicest of them no doubt—were conveyed to Rome. From this time art seems to have become quite fashionable in certain Roman circles. Archimedes perished in the confusion of the sack, while he was calmly pursuing his studies (Liv., xxv. 31).

Under Rome.

Syracuse was now simply one of the provincial cities of Rome's empire, and its history is henceforward merged in that of Sicily. It retained much of its Greek character and many of its finest public buildings, even after the havoc wrought by Marcellus. Its importance and historic associations naturally marked it out as the residence of the Roman prætor or governor of Sicily. Cicero often speaks of it as a particularly splendid and beautiful city, as still in his own day the seat of art and culture[2] (*Tusc.*, v. 66; *De Deor. Nat.*, iii. 81; *De Rep.*, i. 21), and in his speeches against Verres (iv. 52, 53) he gives an elaborate description of its four quarters (Achradina, Neapolis, Tyche, the Island), or rather the four cities which composed it. It seems to have suffered in the civil wars at the hands of Sextus Pompeius, the son of the triumvir, who for a short time was master of Sicily; to repair the mischief, new settlers were sent by Augustus in 21 B.C., and established in the Island and in the immediately adjoining part of Achradina (Strabo, vi. 270, ed. Kramer). It is in these districts that the remains of Roman works —of amphitheatres and other public buildings—are mainly to be traced. We hear nothing of any importance about Syracuse during the period of the empire. It had its own senate and its own magistrates.[3] Caius Caligula restored its decayed walls and some of its famous temples (Suetonius, *Caius*, 21). Tacitus, in a passing mention of it (*Ann.*, xiii. 49), says that permission was granted to the Syracusans under Nero to exceed the prescribed number of gladiators in their shows. Hence the city by that time must have been provided with an amphitheatre. In the 4th century it is named by the poet Ausonius in his *Ordo Nobilium Urbium*, chiefly, perhaps, on the strength of its historic memories.

Modern town.

Modern Syracuse is confined to the island of Ortygia, and is only about 2½ miles in circumference. The island is irregularly oval in shape, and extends from north to south on the east side of the fine natural harbor, the Porto Grande (*Magnus Portus*). On the north it is connected with the mainland by a dyke or narrow isthmus, and between the southern extremity and the opposite peninsula of Massolivieri, the ancient Plemmyrium, there is a stretch of 1300 yards, forming the entrance to the harbor. The approach to the town from the mainland is defended by a dilapidated citadel of the time of Charles V., and the southern extremity is occupied by a castle named after George Maniaces, the last Byzantine general by whom it was held in the 11th century before it fell into the hands of the Saracens. The town is further defended by walls with bastions. The streets are in general narrow, and their chief feature consists in their numerous convents with wooden-latticed windows. One tolerably wide and handsome street crosses the island from east to west. Besides the fortifications, the principal objects of interest are the cathedral of Santa Maria delle Colonne (the ancient temple of Minerva), adjoining which is the archiepiscopal residence; the archæological museum, the finest works preserved in which are a statue of Venus in Parian marble and a colossal head of Zeus; and the fountain of Arethusa, which still bubbles up as clear and abundant as ever on the west side of the island. Its waters, however, are no longer drinkable, an earthquake in 1170 having allowed the sea water to become mingled with them. From the neighborhood of this fountain a favorite promenade extends northwards along the shore of the Porto Grande.

Syracuse has been a place of little importance since the year 878, when it was destroyed by the Saracens under Ibrahim ibn Ahmed. Since that date the mainland portion of the city has never been rebuilt. Syracuse is the seat of an archbishop, and since 1865 has been the capital of a province, which takes its name from the town. The inhabitants manufacture drugs and other chemical articles, earthenware, etc., and carry on a considerable trade, principally in wine. In 1885 785 vessels of 21,818 tons entered the port and 778 vessels of 21,480 tons cleared. At Syracuse Admiral de Ruyter died in 1676 after his defeat by the French at Agosta. The population in 1881 was 21,157.

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[1] Statues and pictures are particularized by Livy, xxv. 40.

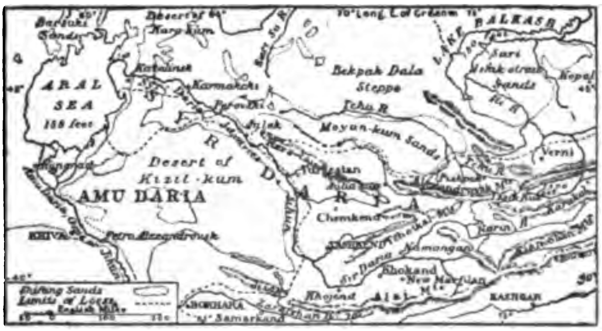
[2] The poets Theocritus and Moschus were Syracusans.

[3] Local self-government, in fact, like most of the Greek cities.

See Hare, *Cities of Southern Italy and Sicily* (London, 1883).

SYRACUSE, a city of the United States, the county seat of Onondaga county, New York, 148 miles west of Albany, midway between that city and Buffalo. Syracuse is situated near the southern end of Onondaga Lake (5 miles long by 1 broad), whose waters flow northwards through Seneca and Oswego rivers into Lake Ontario at Oswego. The Erie Canal, flowing east and west, joins the Oswego Canal within the city. Syracuse contains several handsome public buildings,—the county court-house, the United States Government building, the city-hall, the State asylum for idiots, the Onondaga penitentiary, the county orphan asylum, the asylum of St. Vincent de Paul, the high school (containing the Central Library of 15,000 volumes), a State armory, etc. It is the seat of the Syracuse (Methodist) university, founded in 1870 and consisting of a college of the liberal arts, a college of the fine arts, and a college of physicians and surgeons. The salt industry, to which Syracuse owed much of its early prosperity, is still the staple; the springs situated near the southern end of Lake Onondaga, which appears to be the remains of a once very extensive basin, have been under State control since 1797. Previous to the opening of the Michigan springs they were the largest in the United States, and they still yield on an average from 7,000,000 to 8,000,000 bushels of salt per annum. Rolling-mills, furnaces, steel-works, glass-works, breweries, and manufactories of barrels, agricultural machinery, and clothing are among the secondary industrial establishments. At the completion of the Erie Canal in 1825 Syracuse had only 300 inhabitants; by 1855 they were 25,107, and in 1860, 1870, and 1880 respectively they numbered 28,119, 43,051, and 51,792; in 1886 the number had risen to 81,000, including some adjacent villages recently annexed.

By some investigators it is believed that Lake Onondaga was De Soto's "silver-bottomed" lake. The great tribal fortress of the Onondagas on the east side of the lake near the spot now occupied by Liverpool was attacked without success by Champlain in 1615. The first house on the site of Syracuse was built in 1805. The village, to which the name of Syracuse had been given in 1824, was incorporated in 1825, and the city in 1847.



Map[1] of Syr-Daria.

SYR-DARIA (Gr. and Lat. *Juxartes*; Arab. *Shash* or *Sihun*), a river flowing into the Sea of Aral, and having a length of 1500 miles and a drainage area of about 320,000 square miles. Incertitude as to its source prevailed until the recent occupation of Turkestan by the Russians. It has now been traced to the Naryn, which has its sources in the heart of the Tian-Shan complex, some 30 miles south of Lake Issik-kul, in the elevated valleys or *syrts* (12,000 feet) on the southern slope of the Terskei Ala-tau. Here under the name of Jaak-tash the river takes its rise amid mountain scenery of the wildest description, partly from the marshy mountain plateaus by which the "Warm Lake" is also fed, and partly from the immense glaciers of the dark and barren Ak-shiriyak Mountains (Petroff and Sir-tash glaciers). After its union with another mountain stream, the Barskaun, it is called the Taragai, and flows west-southwest at from 11,000 to 10,000 feet above the sea, in a barren longitudinal valley between the Terskei Ala-taû and the foothills of the lofty Kokshal-tau. On entering a wild, narrow gorge driven from west to east through the southwest continuation of the Terskei Mountains (Samatyn-tau) it receives the name of Naryn. Through this gorge it descends by a series of rapids from the heights of the mountain *massif* to a deep valley of the alpine region, its level at its issue from the gorge being reduced by fully 4000 feet: Fort Narynsk, 20 miles below the junction of the Great and the Little Naryn, is only 6800 feet above the sea. Here the river enters a broad valley—formerly the bottom of an alpine lake—and flows past the ruins of Fort Kurtka, for 90 miles westward, as a stream some 50 yards wide and from 3 to 11 feet deep. Its waters are utilized for irrigating Kirghiz cornfields, which contrast strangely with the barren aspect of the lofty treeless mountains. The Atpasha—a large mountain stream—joins the Naryn at the head of this valley and the Alabuga at its lower end, both from the left. Before reaching the lowlands, the Naryn crosses three ridges separating the valley of Kurtka from that of Ferghana, by a series of wild gorges and broad valleys (170 miles), representing the bottoms of old lakes; the Togus-torgau, 2000 feet lower than Kurtka, and the Ketmen-tube are both covered with Kirghiz cornfields. Taking a wide sweep towards the north, the river enters Ferghana—also the bottom of an immense lake—where, after joining the Kara-Daria (Black river) near Namangan, it receives the name of Syr-Daria.[2] The Kara-Daria is a mighty stream rising in the northeastern spurs of the Alai Mountains. As it deflects the Naryn towards the west again, the natives consider it the chief branch of the Syr-Daria, but its volume is much smaller. At the confluence the Syr is 1440 feet above sea-level.

The waters of the Syr-Daria and its tributaries are in this part of its course largely absorbed by numberless canals for irrigation. It is to the Syr that Ferghana is indebted for its high, if somewhat exaggerated, repute in Central Asia as a rich garden and granary; cities like Khokand, Marghilan, and Namangan, and more than 800,000 inhabitants of the former khanate of Khokand, live by its waters. Notwithstanding this drain upon it, the Syr could be easily navigated, were it not for the Bigovat rapids at Irdjar, at the lower end of the valley, where the river finds its way to the Aral-Caspian deserts by piercing a depression of the Mogol-tau.

On issuing from this gorge the Syr enters the Aral depression, and flows for 850 miles in a northwesterly and northerly direction before reaching the sea of Aral. On this section it is navigated by steamers. Between the Irdjar rapids and Baïdyr-turgai (where it bends north) the Syr flows along the base of the mountain ridges which girdle the Tchotkal Mountains (see below) on the northwest, and receives from the longitudinal valleys of these alpine tracts a series of tributaries (the Angren, the Tchirtchik, the Keles), which in their lower courses fertilize the wide plains of loess extending from the right bank of the Syr. These plains and their rich supply of water have been the cause of an oasis of Moslem civilization developing between the barren sands of the Aral depression and the mountain tracts of the Tian-Shan. The Angren rises beneath the highest parts of the Tchotkal range, and its valley is the granary of the region. The Tchirtchik has its origin in the Borolday Mountains at the junction of the Tchotkal and the Pskem rivers, and at the point where it issues from the mountains it sends off the famous canal Zakharyk; it flows past Tashkend along a valley 20 miles wide, and joins the Syr a few miles below its confluence with the Angren. The Keles comes from the Jity-su Mountains and also brings a large volume of water for irrigation. But owing to wars and continued insecurity cities formerly important have now been abandoned; and near Tchinaz, at the mouth of the Tchirtchik, are the ruins of a large town formerly fortified with high walls, and of *aryks* with manifold ramifications.

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[1] Reduced from Mushketoff's "Geological Map of the Turkestan Basin," in his *Turkestan* (Russian), 1886, vol. i.

[2] *Syr* and *daria* both signify "river," in two different dialects.

Some 50 miles below Tchinaz (770 feet above sea-level) the Syr bends northwards, but resumes its northwesterly course 150 miles farther down, following with remarkable persistency the borders of the loess which fringes the mountains. Its low banks, covered with rushes and rendered uninhabitable in summer by clouds of mosquitoes, are inundated for 20 miles on both sides when the snows begin to melt. These inundations prevent the moving sands of the Kizil-kum desert from approaching the Syr; below Perovsk, however, the steppe gains the upper hand. Down to Perovsk the river rolls its muddy yellow waters, at the rate of 3 to 5 miles an hour, in a channel 300 to 600 yards wide and 3 to 5 fathoms deep; at Perovsk its vertical section is 8220 square feet, and 312,500 cubic feet of water are discharged per second. The Arys and the Buguñ are the only tributaries worthy of notice on this part of its course; the other streams which descend from the Kara-tau fail to reach the river. The Kungrad Kirghiz rear numerous herds of cattle and sheep in the valley of the Arys, while lower down, as far as Julek, the Igintchis carry on agriculture. All this applies, of course, only to the right bank; on the left the moistness is absorbed by the hot winds which cross the Kizil-kum sands towards the river. The dryness of the atmosphere makes its influence markedly felt on the Syr when it enters, below Julek, a region where the Kara-kum sands extend on its right. Ten miles below Perovsk the river traverses a marshy depression—the bottom of a lake not yet fully dried up—where it divides into two branches,—the Jamandaria and the Kara-uzyak. The latter spreads out in marshes and ponds, from which it again issues to join the former at Karmaktchi, after a course of 80 miles. The main branch also, owing to its shallowness and sinuosity, is very difficult to navigate, and this is increased by the rapidity of the current and the want of fuel. Between Kazalinsk and the Sea of Aral (158 feet) the navigation becomes somewhat easier, except for the last ten miles, where the river divides into three shallow branches before entering the "Blue Sea." All three have at their mouths sandy bars with only 3 feet of water, which are often forded by the Kirghiz.

Two former right-hand tributaries of the Syr—the Tchu and the Sary-su—which now disappear in the sands some 60 miles before reaching it, must be mentioned. The Tchu, which is 600 miles in length, rises in the Tian-Shan to the southwest of Lake Issik-kul, and is made up of many streams, of which the Kyz-art, the Juvan-aryk, and the Koshkar are the more important. On their union these form the Koshkar, which flows towards Lake Issik-kul, but a few miles before reaching that lake turns suddenly to the northwest, enters under the name of Tchu the narrow gorge of Buam, and, piercing the snow-clad Kunghei Ala-tau, emerges on its northern slope, having descended from 5500 feet to less than 2000 in a course of not more than 50 miles. In this part of its course it receives from the right the Kebin, whose high valley equals in size that of the upper Rhone. It then flows northwestwards through the valley of Pishpek, and, avoiding the Muyun-kum sands, describes a wide curve to the north before finally taking a western direction. Numberless streams flow towards it from the snow-clad Alexandrovsk Mountains, but they are for the most part lost in the sands before reaching it. The Talas, 170 miles long, formerly an affluent of the Tchu, which rises in the highest parts of that range, pierces the Tcha-archa Mountains, and, flowing past Aulie-ata on the south border of the Muyum-kum, enters the salt lake Kara-kul 60 miles from the Tchu. The Tchu reaches the Saumal-kul group of lakes, 60 miles from the Syr, in the form of marshes with undefined channels. Another elongated group of lakes—the Uzun-kul—near the above and 50 miles from Perovsk, receives the Sary-su, which has a length of nearly 570 miles, and flows rapidly in a narrow channel along the west borders of the northern Famine Steppe (Bekpak-dala).

The delta of the Syr at present begins at Perovsk, whence it sends a branch to the southwest, the Yany-daria (Jany-daria or New river), which formerly reached the southeastern corner of the Sea of Aral, very near the mouth of the Amu-daria. The Kirghiz affirm that a canal dug for irrigation by the Karakalpaks gave origin to this river. It had, however, but a temporary existence. A dam erected by the Khokandese at Ak-metchet (Perovsk) caused its disappearance, and the Russians found but a dry bed in 1820. When the dam was removed the Yany-daria again reappeared, but it failed to reach the Sea of Aral; in 1853 it lost itself in Lake Kutchka-denghiz, after a course of 250 miles; all traces of its bed were then lost in the sand. The Kirghiz legend can only be accepted, however, with very great caution; the present writer is inclined to think that the canal of the Karakalpaks was merely intended to redirect the waters of the Syr into a channel which existed of old, but had been dried up.[1] Certain it is that five centuries ago, in the time of Timur, the Yany-daria brought the waters of the Syr to the Dau-kara Lakes, close by the present mouth of the Amu. The series of old beds in the Kizil-kum, which are still seen above Perovsk, shows that the Syr had a constant tendency to seek a channel to the southwest and that its present delta is but a vestige of what it was in past times. At a still more remote period this delta probably comprised all the space between the Kara-tau and the Nura-tau; and in the series of elongated lakes at the base of the Nura-tau—the Tuz-kane and Bogdan-ata Lakes—we see an old branch of the delta of the Syr which probably joined the Zerafshan before reaching the Amu. The causes of this immense change are to be sought for simply in the rapid desiccation of the whole northern and central parts of Asia, due to the fact that we are now living in the later phase of the Lacustrine period, which has followed the Glacial period. The extremely rapid desiccation of the Sea of Aral is proved even by surveys a few decades old, and this process is but a trifle in comparison with the changes which have taken place during the last five centuries: the extension of the Caspian Sea as far as the Sarakamysh lakes during the Post-Pliocene period and the extension of the Sea of Aral at least 100 miles to the east of its present banks are both proved by the presence of Post-Pliocene marine deposits. (P. A. K.)

SYR-DARIA, or **Syr-Dariinsk**, a province of Russian Turkestan, in Asia, comprising wide tracts of land on both sides of the Syr-Daria river, from its entrance into the Sea of Aral up to Khojend, where it issues from the mountain region of the Tian-Shan. It is bounded on the N. by the Russian provinces of Turgai and Akmolinsk, on the E. by Semiryetchensk and Ferghana (ex-khanate of Khokand), on the S. by the district of Zerafshan, Bokhara, and the Russian province of Amu-daria, and on the W. by the Sea of Aral. Its area (166,000 square miles), its population (more than one million inhabitants), and its cities (Tashkend, Khojend, Jizak, etc.) make it the most important province of Russian Turkestan; and from its position between the mountain region of Central Asia and the great lake of the west Asian depression it is a region of deep interest for the geographer and geologist.

The southeastern border of the province runs along the lofty Tchotkal Mountains. This chain, which separates the river Tchotkal from the Naryn, and runs for more than 200 miles from southwest to northeast, joining Alexandrovsk Mountains on the east, raises its snow-clad peaks to an altitude of 14,000 feet. It diminishes in height towards the south, not exceeding 7000 feet in the barren Mogol-tau Mountains, but seems to be continued to the southwest by the Baisun-tau. A series of shorter chains—the Talas Ala-tau, the Bishelik, the Badam Mountains, the Kazyk-urt, and the Alym-tau—fringe the above on the northwest, and occupy the southeast corner of Syr-Dariinsk. The snow-clad summits of the Talas Ala-tau range from 14,000 to 15,000 feet, and immense glaciers occur about Manas Mountain. So far as our maps show, the range seems to run from west-southwest to east-northeast. The other chains just mentioned have a decidedly southwesterly direction, and are much lower, the outlying ranges having rather the character of broad plateaus, above 2000 feet in height, where the Kirghiz find excellent pasture grounds. Some of them, such as the Kazyk-urt, rise as isolated mountains from the steppe, and have therefore been called Ararats. The Kara-tau is quite separate from the preceding and runs at right angles to them—that is, from northwest to southeast. It belongs therefore to another series of upheavals which prevails in western Asia and to which Richthofen has given the name of the "Kara-tau series." Its length is about 270 miles, and its average height about 5000 feet, rising at some points to 6000 and 7000 feet. It separates the Syr-Daria from the Tchu, and its gentle southwestern slope contains the sources of a multitude of streams, which water the oasis around the town of Turkestan. Another range, having the same direction, from northwest to southeast, touches the southern border of Syr-Daria, namely, the Nura-tau (or Nuratyn-tau), also called Turkestan Mountains, which lifts its icy peaks (15,000 to 16,000 feet in height) abruptly from the steppe. It separates Syr-Daria from Zerafshan, and the passes by which it is crossed reach an altitude of from 10,000 to 13,000 feet. Finally, a few islands of metamorphic or granitic rock, called Ararats by the natives, stand isolated in the steppes.

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[1] For the old beds of the Syr and the Amu, see Kaulbars's "Lower Parts of the Amu," in *Mem. Russ. Geogr. Soc.*, Phys. Geogr., ix. (1881).

The mountainous tracts occupy, however, only a small part of Syr-Daria; the rest of its wide surface is steppe. Three different areas must be distinguished,—the Kizil-kum, the Muyun-kum or Ak-kum, and the Kara-kum ("black sands," so called more from their desert character than from their color). The Kizil-kum (red sands) is the most interesting.[1] These sands occupy the wide stretch between the Amu and the Syr, and have a gradual ascent from 160 feet at the Sea of Aral to 1500 and 2000 feet in the southeast. They are covered with numerous folds or elongated dunes (*barkhans*), partly shifting partly stationary, 30 to 60 feet high, and mostly parallel to each other, amidst which are immense spaces covered with clay, and saline clays appear here and there on the surface. The Kizil-kum varies much in its characteristics. Close by the Sea of Aral it is covered with shifting sands, the result of the disintegration of cretaceous sandstones; and every storm raises clouds of hot sand which render communication exceedingly difficult. But even there a rich verdure covers the undulations in spring. Farther east the sands lose their shifting character, and the barkhans are covered with a kind of *Carex*, which serves as excellent food for sheep. The *Holoxylon Anemodendron* grows extensively on the elevated ridges and yields fuel and charcoal, which last is exported to Bokhara. In the west the surface is covered with remains of Aral-Caspian deposits. As the Tian-Shan is approached the steppe takes another character: a thick covering of loess girdles the foothills and forms the fertile soil to which Turkestan is indebted for its rich fields and gardens.

The Kara-kum sands, situated to the northeast of the Sea of Aral, are manifestly a former bottom of the lake. They are covered with débris of *Cardium edule*, *Mytilus*, *Dreissena polymorpha*, *Neritina litturata*, *Adacna vitrea*, *Hydrobia stagnalis*, with remains of marine *Algæ* (*Zostera*), and with fragments of *Scirpus* and *Phragmites*. The Kizil-kum is characterized by the presence of *Lithoglyphus caspius*, *H. stagnalis*, *Anodonta podervsa*, and the sponge *Metchnikowia tuberculata*. The evil reputation of the Kara-kum has been exaggerated to some extent; the harsh things said of it apply only to the neighborhood of the Sea of Aral. In the east the steppe has some vegetation and is readily visited by the Kirghiz. The barkhans do not shift, being covered with *Calligonum*, *Tamarix*, *Holoxylon Anemodendron*, and some rushes; shifting dunes 40 to 50 feet high occur, especially towards the Sea of Aral. The Muyun-kum or Ak-kum Steppe, between the Kara-tau Mountains and the Tchu, is quite uninhabited, except in the loess region at the northern base of the mountains.

Granites, granilites, syenites, porphyries, and various metamorphic slates constitute the bulk of the western Tian-Shan Mountains. They appear also in the Kara-tau and Nura-tau, and sometimes in the form of isolated islands in the steppe. Silver and lead ores, as well as malachite and copper ore, are found in them, especially in the Mogol-tau, and turquoises about Khojend. The crystalline rocks, much metamorphosed, especially in the west, are overlain by thick Devonian and Carbouiferous deposits. Jurassic rocks (Rhætic) cover small areas on the slopes of the mountains. These last are all of fresh-water origin; hence it would seem that throughout the Jurassic and Triassic periods Turkestan was a continent intersected only by lagoons of the Jurassic sea. The Jurassic deposits are most important on account of their coal-beds, which occur in the basins of the Badam and Sairam and in Ferghana. Chalk and Tertiary marine deposits are superimposed upon the above to the thickness of 2000 to 5000 feet, and are widely spread, although they have suffered greatly from denudation. The former belong to the Upper (Ferghana deposits, much resembling Senonian) and Middle Chalk, and contain phosphorite, gypsum, and naphtha (in the Amu-Daria basin). The Tertiary deposits, which contain gypsum and lignite, are represented by nummulitic sands around the sea of Aral, and by Oligocene and Miocene (Sarmatic) deposits. In the Tian-Shan the red Tertiary conglomerates (Pliocene?) attain a great development. Throughout the Chalk and earlier Tertiary periods the lowlands of Syr-Daria were under the sea. The character of the region during the Post-Pliocene period remains unsettled. To what extent the mountains of the western Tian-Shan were under ice during the Glacial period remains a subject of controversy among geologists; many deposits, however, have been described, even in the outer parts of mountain tracts, which have a decidedly Glacial character. A girdle of loess, varying in width from 30 to 50 miles, encircles all the mountain tracts, increasing in extent in Bokhara and at the lower end of the valley of Ferghana. It seems certain that during the Lacustrine period the Caspian was connected by a narrow gulf with the Aral basin, which was then much larger, while another inland sea of great dimensions covered the present Balkash basin, and at an earlier period may have been connected with the Aral basin. Recent traces of these basins are found in the steppes.

The chief river of the province is the SYR-DARIA (see above), with its tributaries. The frontier touches the eastern shore of the sea of Aral, and numerous small lakes, mostly salt, are scattered over the sandy plains. A few lakes of alpine character occur in the valleys of the hilly tracts.

The climate of Syr-Daria varies greatly in its different parts. It is most severe in the high treeless *syrts* of the mountain region; and in the lowlands it is very hot and dry. As a whole, the western parts of the Tian-Shan receive but little precipitation, and are therefore very poor in forests. In the lowlands the heat of the dry summer is almost insupportable, the thermometer rising to 111° Fahr. in the shade; the winter is severe in the lower parts of the province, where the Syr remains frozen for three months. The average yearly temperature at Tashkend and Kazalinsk respectively is 54° and 44° (January, 28° and 8°; July, 80° and 76°).

The flora and fauna belong to two distinct regions,—to Turkestan and to the Aral-Caspian depression (see TURKESTAN). The terraces of loess mentioned above are alone available for culture, and accordingly less than 1 per cent. (0.8) of the total area of the province is under crops, the remainder being either quite barren (57 per cent. of the surface) or pasture land (42 per cent.). Although cultivation is possible only in a few oases, it is there carried to great perfection owing to a highly developed system of irrigation,—two crops being gathered every year. Wheat and barley come first, then pease, millet, and lentils, which are grown in the autumn. Rye and oats are grown only about Kazalinsk. Cotton is cultivated in the districts of Khojend, Kurama, and Turkestan. Gardening is greatly developed. Sericulture is also an important source of income, nearly 85 tons of silk being produced every year. Cattle-breeding is largely pursued, not only by the nomads but also by the settled population, and in 1881 it was estimated that Syr-Daria had 242,000 camels, 396,000 horses, 294,000 horned cattle, and 3,200,000 sheep. Fishing is pursued to some extent on the lower Syr. Timber and firewood are exceedingly dear; timber is floated down from the mountains, but in small quantities; trees raised in gardens, dung, and some coal (the last in very limited quantity) are used for fuel.

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[1] Comp. J. Mushketoff's *Turkestan*, vol. I.

The population of the province amounted to 1,109,500 in 1881, of whom 146,300 lived in towns, 326,600 were settled, and 621,600 were nomadic. It is comparatively dense in certain parts, reaching 15 to 31 inhabitants per square mile in Kurama and Khojend, and still more in the valley of the Tchirtchik. Its ethnographical composition is very mixed. The Russians barely number 8500, if the military be left out of account; they live principally in towns and about Kazalinsk. Kirghiz (709,400 with the Kara-Kirghiz) and Sarts (211,000) are the main elements of the population; 50,000 Tadjiks, 26,000 Uzbegs, 4500 Tatars, about 77,000 Kuramints (settled Kirghiz mixed with other elements), and a few Jews, Persians, and Hindus must be added. The chief occupations of the Sarts, Uzbegs, Tadjiks, and Kuramints are agriculture and gardening, while the Kirghiz chiefly lead a nomadic pastoral life. Manufactures are represented by a few distilleries; but a great variety of petty industries are practiced in the towns and villages. Trade is carried on very largely.

Syr-Daria is divided into eight districts, the chief towns of which, with their population in 1881, were: TASHKEND (*q.v.*) (100,000), Aulie-ata (4450), Jizak (8700), Kazalinsk (2950), Khojend (28,000), Perovsk (3400), Tchemkent (8050), and Tchinaz (300). Turkestan or Agret (6700) and Ura-tube (11,000) also deserve mention. (P. A. K.)

SYRIA. Etymologically "Syria" is merely an abbreviation of "Assyria," a name which covered the subject-lands of the Assyrian empire, the subject-peoples being also called "Syrians." Afterwards, in the Græco-Roman period, the shorter word came to be restricted to the territory west of the Euphrates,—the designation "Syrians," however, being given to the great mass of the Semitic populations dwelling between the Tigris and the Mediterranean, who are more accurately called Aramæans (Gen. x. 22; comp. SEMITIC LANGUAGES, vol. xxi. p. 681 *sq.*). The present article deals with Syria only in its geographical significance. For a map, see vol. xvi. pl. VIII.

Boundaries and extent.

Syria is the designation of the country which extends for about 380 miles (between 36° 5′ and 31° N. lat.) along the eastern shore of the Mediterranean; its eastern limit, properly speaking, is formed by the middle portion of the course of the Euphrates, but in point of fact it insensibly merges into the steppe country which naturally belongs more or less to Arabia. It is only the oases lying nearest the western border of the steppe (*e.g.*, Aleppo, Palmyra) that can be reckoned as belonging to Syria.[1] From time immemorial the land between Egypt and the Euphrates has been the battlefield for the empires of western Asia on the one hand and those of Egypt and Africa on the other. It has also been the territory which the trading caravans of these empires have had to traverse; and by its position on the Mediterranean it has been the medium for transmitting the civilizing influences of the East to the West and again of the West to the East. Hence it is easy to understand how the peoples of Syria should only in exceptional cases have played an independent part either in politics or in art and science; none the less on that account is their place in history one of the highest interest and importance.

Orography.

The surface configuration of the country is a uniform one; the mountains for the most part stretch from north to south in parallel ridges, connecting the Cilician Taurus with the Red Sea range. The continuity is broken for short intervals at one or two points. Immediately connected with the Cilician Taurus in the north, and forming part of it, is the Alma Dagh (ancient Amanus). At its highest it does not rise much above 6000 feet, but it has an abrupt descent towards the sea, and terminates at its southern extremity in a bold headland, the Rás el-Khanzír. Here the Orontes reaches the sea through a depression in the chain, and the same outlet forms an important pass into the interior of the country. Frequently in ancient times it was only the territory to the south of the lower Orontes valley that was reckoned as constituting Syria. Farther South is the isolated Jebel Aḳra', about 6000 feet high (the Mons Casius of the ancients), which was held sacred by the Phœnicians; still farther to the south are the low Anṣairi Hills, which derive their name from the people inhabiting them. Beyond those the 'Nahr el-Kebír (Eleutherus) falls into the sea, and here north Syria may be held to terminate. To the south of this begins the Lebanon district (see LEBANON, vol. xiv. p. 392); an imaginary line drawn eastwards from a point a little to the south of Tyre will represent the southern boundary of what may be designated as middle Syria. Occasionally Syria is spoken of in a narrow sense, as distinguished from Palestine; but there is no scientific ground for such a practice, for the mountains of PALESTINE (*q.v.*), the southern third of Syria, can be described as a southward continuation of the mountain masses already referred to, and cis-Jordanic as well as trans-Jordanic Palestine is simply a portion of Syria. Indeed, the district as far as Sinai can be spoken of as a fourth division of the same country. A glance at a geological map reveals this very clearly. Cretaceous limestone constitutes the bulk of the hills and plateaus of Syria, and extends towards Sinai, where the zone of primitive rocks is reached. In the south of Palestine, nummulitic limestone and Nubian sandstone make their appearance from Sinai and northern Arabia. In addition to these, alluvial soils are principally met with. In middle Syria especially, eastwards from the upper course of the Jordan, great basaltic masses occur; in the Ḥauran (comp. BASHAN, vol. iii. p. 354) there are basalt peaks nearly 6000 feet in height. The basalt mountains are often much broken up so as to be quite inaccessible (Ḥarra); but the basalt when decomposed forms the best of arable soils. It is only in isolated cases that the igneous formation extends into western Syria. The tableland to the east of the principal mountain chains consists partly of good clay soil; the steppe (*bádiyet esh-sham*, also called *ḥamád*), which has an average elevation of about 1800 feet, extends towards the Euphrates with a gradual slope.

Rivers.

The direction of the principal valleys is determined by that of the mountains. The chief river of Syria in the narrower sense is the Orontes (Arabic *El-'Aṣi*), which rises in the Beḳá', the mountain valley between Libanus and Antilibanus, and follows a northerly course. At Antioch, where it is augmented by the stream which flows from the great lake of Ak Deniz, it turns westwards, falling into the sea near the ancient Seleucia. Not far from the source of the Orontes is that of the Líṭáni (formerly Líta), which runs southwards through the Beḳá', and afterwards westwards through a deep gorge of its own excavation, having its mouth a little to the north of Tyre; in its lower course it bears the name of El-Ḳásimíye. The principal river of south Syria is the JORDAN (*q.v.*). Like it, most of the other streams of Syria rising on the eastern side of the water-shed terminate in inland lakes. Of these may be named the El-A'waj and the Barada (Pharpar and Abana) of Damascus, which lose themselves in the lakes and marshes to the east of the city. In like manner the river of Aleppo falls into the lake El-Maṭḥ. The 'Afrína (Ufrenus of the ancients) falls into the Ak Deniz lake, and so into the Orontes; the Sádjúr is a tributary of the Euphrates. Other lakes are the great salt lake to the southeast of Aleppo, and the remarkable lake near Homs, in the neighborhood of which the ruins of the old Hittite city of Kadesh have recently been discovered. The coastal streams have been enumerated under LEBANON and PALESTINE (*q.v.*).

Vegetation.

Two distinct floral regions meet in Syria (Comp. LEBANON). That of the coast is Mediterranean, and is characterized by a number of evergreen shrubs, with small leathery leaves, and of quickly-flowering spring plants. On the coast of Phœnicia (comp. vol. xviii. p. 815) and southwards towards Egypt more southern forms of the same vegetation occur, as, for example, *Ficus Sycomorus*, and especially date-palms. This region is separated from the easterly one, that of the steppe flora, by the ridge of Lebanon and the mountains of Palestine. It is distinguished by the variety of its species, by the dry and thorny character of its shrubs, and by its marked poverty in trees. The Jordan valley has, on account of its low level, a sub-tropical character. As regards cultivated species, Syria is the home of the olive tree, which, like the vine, is found in all parts; but the white mulberry for silk is limited to a small district. Syria is, throughout, far from unfertile; the district of the Ḥauran is one magnificent cornfield, while the orchard land about Damascus is renowned far and wide. In former times, however, cultivation was carried on with much greater zeal, and the arrangements for irrigation—a necessity everywhere, especially on the side bordering on the steppe—were much more considerable, and more carefully seen to. The numerous ruins on the lands at present under cultivation and still more on those to the east of them, indicate that the limits of agriculture were once more extensive and the population much denser than at present. During the Roman period, frontier fortresses on the edge of the steppe served to check the rapacity and barbarizing influence of the Bedouin hordes.

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[1] In the cuneiform inscriptions Syria is called *Mát Khatti*, "the land of the Cheta," a designation transferred from the North Syrian people of that name (see below) to the region as a whole; *Mát Akharri*, the "hinder," or "western" land, denotes more properly the southern portion, but is also used for the whole. By the Arabs it is called *Esh-Shám* (more properly *Esh-Sha'm*), "the land on the left hand," as distinguished from *Yemen*, "the land on the right," but the designation originally implied a wider region than the Syria defined above, including as it did a portion of Arabia.

Climate.

Syria presents great diversities of climate. The mountains, though sometimes not absolutely very high, arrest the west winds blowing from the Mediterranean, so that the atmospheric precipitation is much greater on the western than on the eastern slopes. Hence the springs on the eastern versant are fewer, and cultivation is therefore confined to isolated areas resembling oases. The rainfall drains off with great rapidity, the beds of the streams soon drying up again. Within historic times the climate, and with it the productivity of the country, cannot have greatly changed; at most the precipitation may have been greater, the area under wood having been more extensive. Except for Jerusalem, we have hardly any accurate meteorological observations; there the mean annual temperature is about 63° Fahr.; in Beyrout it is about 68°. The rainfall in Jerusalem is 36.22 inches, in Beyrout 21.66. The heat at Damascus and Aleppo is great, the cooling winds being kept off by the mountains. Frost and snow are occasionally experienced among the mountains and on the inland plateaus, but never along the coast. Even the steppe exhibits great contrasts of temperature; there the rainfall is slight and the air exceedingly exhilarating and healthy. The sky is continuously cloudless from the beginning of May till about the end of October; during the summer months the nights as a rule are dewy, except in the desert. Rain is brought by the west wind; the northwest wind, which blows often, moderates the heat. On the other hand, an ozoneless east wind (sirocco) is occasionally experienced—especially during the second half of May and before the beginning of the rainy season—which parches up everything and has a prejudicial influence on both animal and vegetable life. On the whole the climate of Syria—if the Jordan valley and the moister districts are excepted—is not unhealthy, though intermittent fevers are not uncommon in some places.

Ancient Syrians.

Of the political relations of Syria in ancient times we know but little. Each town with its surrounding district seems to have constituted a small separate state; the conduct of affairs naturally devolved upon the noble families. At a very early period—as early probably as the 15th century B.C.—Syria became the meeting place of Egyptian and Babylonian elements, resulting in a type of western Asiatic culture peculiar to itself, which through the commerce of the Phœnicians was carried to the western lands of the Mediterranean basin. Industry especially attained a high state of development; rich garments were embroidered and glass and the like were manufactured. The extant inventories of spoil carried off by the ancient conquerors include a variety of utensils and stuffs. The influence exercised at all times on Syrian art by the powerful neighboring states is abundantly confirmed by all the recent finds. The Syrians were more original in what related to religion: every place, every tribe, had its "lord" (Ba'al) and its "lady" (Ba'alat); the latter is generally called 'Ashtar or 'Ashtaret. Besides the local Baal there were "the god of heaven" (El) and other deities; human sacrifices as a means of propitiating the divine wrath were not uncommon. But in the Syrian mythology foreign influences frequently betray themselves. Over against its want of originality must be set the fact, not merely that Syrian culture spread extensively towards the west, but that the Syrians (as is shown by recently discovered inscriptions) long before the Christian era exercised over the northern Arabs a perceptible influence, which afterwards, about the beginning of the 1st century, became much stronger through the kingdom of the Nabatæans. The art of writing was derived by the Arabs from the Syrians.

Relations with ancient Egypt.

Something about the ancient political and geographical relations of Syria can be gleaned from Egyptian sources, especially in connection with the campaigns of Thothmes III. in western Asia. The Egytians designated their Eastern neighbors collectively as 'Amu. Syria up to and beyond the Euphrates is called more precisely Sahi (or Zahi), and is regarded as consisting of the following parts: (1) Rutenu, practically the same as Palestine (occasionally Palestine with Cœlesyria is called Upper Rutenu, as distinguished from Lower Rutenu extending to the Euphrates); (2) the land of the Cheta (sometimes reckoned as belonging to Rutenu), with Kadesh on the Orontes as its capital; (3) Naharina, the land on both sides of the Euphrates (extending, strictly speaking, beyond the Syrian limits); (4) Kaftu, the coast land of the Phœnicians (Fenchu), along with Cyprus. The Canaanites in general are called Charu. From these lands the Egyptian kings often derived rich booty, so that in those days Syria must have been civilized and prosperous. Moreover, we possess enumerations of towns in the geographical lists of the temple of Karnak and in a hieratic papyrus dating about 200 years after Thothmes III. Some of these names can be readily identified, such as Aleppo, Kadesh, Sidon, and the like, as well as many in Palestine. These materials, however, do not enable us to form even a moderately clear conception of the condition of the country at that time. It is certain that most of the cities are of very great antiquity.

Cheta.

It appears that the Cheta very probably were a non-Semitic people and that their power for a time extended far beyond the Syrian limits. Their inscriptions have not yet been deciphered with certainty. Within Syria their kingdom extended westwards from the middle course of the Euphrates to the neighborhood of Ḥamath; their capital appears to have been Carchemish. The most prevalent opinion identifies Carchemish with Jerábîs on the Euphrates, an identification which is favored by the recent discovery of important "Hittite" monuments at the place. Before then the so-called "Ḥamath stones" were the most important inscriptions of the Cheta we possessed, but numerous others, as well as various other remains, are now at our command, and show that the influence of the powerful Cheta kingdom extended far into Asia Minor (compare HITTITES). The kingdom disappeared at an early date, but some of the minor Cheta states continued to subsist down to the 12th century B.C.

Aramæans.

Next to the Cheta the Aramæans were the people who held the most important towns of Syria, gradually advancing until at last they occupied the whole country. Of the Aramæan stocks named in Gen. x. 23, xxii. 21 *sq.*, very little is known, but it is certain that Aramæans at an early period had their abode close on the northern border of Palestine (in Maachah). A great part was played in the history of Israel by the state of Aram Dammesek, *i.e.*, the territory of the ancient city of Damascus (see vol. vi. p. 697); it was brought into subjection for a short time under David. The main object of the century-long dispute between the two kingdoms was the possession of the land to the east of the Jordan (Ḥauran and especially Gilead). Another Aramæan state often mentioned in the Bible is that of Aram Zobah. That Zobah was situated within Syria is certain, though how far to the west or north of Damascus is not known; in any case it was not far from Ḥamath. Ḥamath in the valley of the Orontes, at the mouth of the Beḳá' valley, was from an early period one of the most important places in Syria; according to the Bible, its original inhabitants were Canaanites. The district belonging to it, including amongst other places Riblah (of importance on account of its situation), was not very extensive. In 733 B.C. Tiglath-Pileser II. compassed the overthrow of the kingdom of Damascus; he also took Arpád (Tell Arfád), an important place three hours to the north of Aleppo. Ḥamath was taken by Sargon in 720. Henceforward the petty states of Syria were at all times subject to one or other of the great world-empires, even if in some cases a certain degree of independence was preserved.

Greek period.

The foundation of numerous Greek cities shortly after Alexander's time was of great importance for Syria; ANTIOCH (*q.v.*) founded about 300 B.C. by Seleucus, became the capital of the Syrian kingdom of the Seleucidæ. Among other influential Greek towns were Apamea on the Orontes and Laodicea. The Seleucidæ had severe struggles with the Ptolemies for the possession of the southern part of Syria (comp. ISRAEL, vol. xiii. p. 430).

After having been reckoned for a short time (from 83 to 69 B.C.) among the dominions of Tigranes, king of Armenia, the country was conquered for the Romans by Pompey (64-63

Under Roman sway.

B.C.). It is impossible here to follow in detail the numerous changes in the distribution of the territory and the gradual disappearance of particular dynasties which maintained a footing for some time longer in Chalcis, Abila, Emesa, and Palestine; but it is of special interest to note that the kingdom of the Arab Nabatæans (comp. vol. xvii. p. 166) was able to subsist for a considerable period towards the north as far as Damascus. In the year 40 B.C. Syria had to endure a sudden but brief invasion by the Parthians. The country soon became one of the most important provinces of the Roman empire; its proconsulship was from the first regarded as the most desirable, and this eminence became still more marked afterwards. Antioch, adorned with many sumptuous buildings, as the chief town of the provinces of Asia, became in point of size the third city of the empire; its port was Seleucia, surnamed Pieria. The high degree of civilization then prevailing in the country is proved by its architectural remains dating from the early Christian centuries; the investigations of De Vogüé have shown that from the 1st to the 7th century there prevailed in north Syria and the Hauran a special style of architecture,—partly no doubt following Græco-Roman models, but also showing a great deal of originality in details.

Roman divisions.

The administrative divisions of Syria during the Roman period varied greatly at different times; subjoined is an enumeration of them as they existed at the beginning of the 5th century. (1) Syria Euphratensis, which had for its capital Hierapolis (Syr. *Mabbóg;* Arab. *Mambidj;* Gr. Βαμβύκη). The kingdom of Commagene, beyond the limits of Syria, belonged to Syria Euphratensis; its capital was Samosata, at the point where the Euphrates leaves the mountains, and it had other important towns on that river, such as Europus (the modern Barbalissus). (2) Syria I., or Cœlesyria, having Antioch as its capital. The name Cœlesyria (ἡ κοιλὴ Συρία) originally, no doubt, was applied to the valley between Libanus and Antilibanus, but was afterwards extended to the district stretching eastwards from the latter range. (3) Syria II., or Syria Salutaris, with Apamea (Arab. *Fámiya,* the modern Ḳal'at el-Mudíḳ) on the Orontes as capital. (4) Phœnice Maritima; capital, Tyre. (5) Phœnice ad Libanum; capital, Emesa (Ḥims). To this division Damascus and Palmyra belonged; occasionally they were reckoned to Cœlesyria, the middle strip of coast being designated Syrophœnicia. (6, 7, 8) Palestina I., II., and III. For these, which from the time of Vespasian had governors of their own, see vol. xviii. p. 181. (9) Arabia (capital, Bostra), which embraced all the region from the Ḥauran to the Arnon, and skirted the Jordan valley, stretching southwards to Petra. Through the kingdom of the Nabatæans Roman influence penetrated from Syria far into northern Arabia.

Under Mohammedan rule.

In 616 Syria was subjugated for a brief period by the Persian Chosroes II.; from 622 till 628 it was again Byzantine; 636 and the immediately following years saw its conquest by the Mohammedans (see MOHAMMEDANISM, vol. xvi. p. 585). Mo'áwiya, the first Ommayad caliph, chose Damascus for his residence; but in 750 the capital of the empire was removed by the 'Abbásids to Baghdád. Under the early caliphs the Arabs divided Syria into the following military districts (*gonds*): (1) Filistin (Palestine), consisting of Judæa, Samaria, and a portion of the territory east of Jordan; its capital was Ramleh, Jerusalem ranking next. (2) Urdun (Jordan), of which the capital was Tabaríye (Tiberias); roughly speaking it consisted of the rest of Palestine as far as Tyre. (3) Damascus, a district which included Baalbec, Tripoli, and Beyrout, and also the Ḥauran. (4) Ḥims, including Ḥamath. (5) Ḳinnasrín, corresponding to northern Syria; the capital at first was Ḳinnasrín to the south of Ḥaleb (Aleppo), by which it was afterwards superseded. (6) The sixth district was the military frontier (*'awásim*) bordering upon the Byzantine dominions in Asia Minor. The struggles of the Mohammedan dynasties for the possession of Syria cannot be gone into here; suffice it to say that throughout their course the country still enjoyed a considerable degree of prosperity.

Turkish supremacy.

In the crusading period the kingdom of Jerusalem, whose rulers were never able to establish a foothold to the east of the Jordan, extended northwards to Beyrout; next it was the countship of Tripoli on the coast; and beyond that in north Syria was the principality of Antioch. Syria suffered severely from the Mongol invasions (1260), and it never recovered its former prosperity. In 1516 the Ottomans took it from the Egyptian Mamelukes. Under the Turks its administrative divisions again varied at different times; out of the five pashalics of Aleppo, Tripoli, Damascus, Sidon (later 'Akka), and Jerusalem two vilayets were subsequently formed, having their capitals at Aleppo and Damascus. Quite recently south Palestine has been made a separate vilayet from that of Damascus.

Languages.

Rude stone monuments (circles and dolmens) and other prehistoric remains show that Syria must have been inhabited from a very early period. Within historic times a great number of different nationalities have fought and settled within its borders, the majority belonging to the Semitic stock. This last circumstance has rendered possible a considerable degree of fidelity in the tradition of the oldest local names. After the Aramæans had absorbed what remained of the earlier population, they themselves were very powerfully influenced by Græco-Roman civilization, but as a people they still retained their Aramæan speech. At present an Aramaic dialect largely mixed with Arabic is spoken in three villages on the eastern slope of Antilibanus (in Ma'lúla, Bakh'a, and Jub'adín), but this small survival is on the point of disappearing. Throughout the whole country elsewhere the language spoken is Arabic, but with Aramaic elements, especially in the language of the peasants. Ethnographically the Aramaic element of the population admits of being distinguished from the Arabic type; it is specially strong in the mountain districts. The majority of the Christians dwelling in Syria may be regarded as representatives of the Aramæan race. No traces of the earlier races, such as the Canaanites or Phœnicians, can any longer be distinguished; and every trace of the presence of Greeks, Romans, and Franks has completely disappeared.

Arab elements of population.

In the Arab immigration, two principal types are to be distinguished,—the pure Arab type of the nomad tribes (Bedouins) and the type of the sedentary town Arabs and peasants, which shows an intermixture of foreign and older elements. The two confront each other in sharp contrasts. Bedouin tribes are scattered throughout the whole country; despising agriculture and the settled life, they are found with their camels, sheep, and goats on the borders of the territories appropriated by the peasants. Being more or less independent of the Government, especially in the district bordering on the steppe, they are able to exact blackmail from their sedentary brethren. Taxed thus on both hands, the life of the peasant is economically far from an easy one; hence it should be the duty of Government to restrain the influence of the nomads and to force them as far as possible to form fixed settlements. In this respect the policy of the Turks during the 19th century to insure the safety of the peasants and of travellers has been on the whole successful. In the districts bordering on the coast there are no large nomadic tribes, and on the higher plateaus of the cultivated land the power of the Bedouins is much reduced; but south of Palestine and everywhere on the edge of the steppe they continue much as before. The most powerful tribe of the Syrian desert is that of the 'Aneze, falling into numerous subdivisions, of which the Ruwala, Wuld 'Alí, Hesene, and Bischer may be mentioned. The tribe, estimated to number 300,000 in all, extends far into Arabia and reaches the Euphrates. The other Bedouin tribes of Syria have for the most part tolerably definite and circumscribed territories. East of the Jordan the best known are the 'Adwín on the Balḳa and the Bani Sakhr in Moab. The Bedouins to the south of the Dead Sea are called Ahl el-Ḳibli ("the people of the south") in contradistinction to those of the north (Ahl esh-Shemál). Finally, there occur sporadically in central and northern Syria nomadic Turkish tribes. Gypsy hordes are also met with in considerable numbers.

Religions.

The religious as well as the ethnographical types are strongly divergent. The bulk of the population are Mohammedan; the Bedouins have not much religion of any kind, but they profess Islam. Besides orthodox Moslems there are also Shí'ite sects, such as that of the Metáwile (especially in northern Palestine), as well as a number of religious communities whose doctrines, combining philosophical and Christian with Mohammedan elements, is the outcome of the process of fermentation that characterized the first centuries of Islam. To this last class belong the Ishmaelites, Nosairians, and especially the DRUSES (*q.v*). In many cases it is obvious that the political antipathy of natives against the Arabs has found expression in the formation of such sects. The Nosairians, for instance, and no doubt the Druses also, were originally survivals of the Syrian population. The Jews are found exclusively in the larger centres of population; in every case they have immigrated back from Europe.[1] The Christians are an important element, constituting probably as much as a fifth of the whole population; the majority of them belong to the Orthodox Greek Church, which has two patriarchs in Syria, at Antioch and Jerusalem. Catholics—United Greeks, United Syrians and Maronites—are numerous. The mission of the American Presbyterian Church, which has had its centre in Beyrout for the last sixty years has done much for Syria, especially in the spread of popular education; numerous publications issue from its press, and its medical school has been extremely beneficial. The Catholic mission has done very good work in what relates to schools, institutes, and the diffusion of literature. The Christians constitute the educated portion of the Syrian people; but the spirit of rivalry is producing stimulative effects on the Mohammedans who have greatly fallen away from that zeal for knowledge which characterized the earlier centuries of their faith.

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[1] [Except in Damascus; see Victor Ryssel, article "Syrien," in *Herzog's Real-Encyklopädie,* 2d ed., vol. xv. p. 173.—AM. ED.]

Area and population.

Accurate statistics of any kind for Syria cannot be had; even the area of the land under cultivation is unknown. The returns of population, are, according to the Turkish official documents, only approximations. The total population may safely be put at less than 2,000,000; an official estimate in 1872–73 gave 1,365,680, of whom 976,322 were Mohammedans. Probably, however, this was an under-estimate. Reclus (*Nouv. Géogr. Univ.*, Paris, 1884) gives the area of Syria as 183,000 square kilomètres (70,638 square miles) and the population as 1,450,000.

Commerce and industry.

From the Egyptian and Assyrio-Babylonian monuments we learn that in ancient times one of the principal exports of Syria was timber; this has now entirely ceased. But it continues to export wheat, and with good roads the amount could be very largely increased. Other articles of export are silk cocoons, wool, hides, sponges, and fruits (almonds, raisins, and the like); the amounts of cotton, tobacco, and wine sent out of the country are small. The only good harbors are those of Beyrout and Alexandretta (Scanderoon). The caravan trade with the East has almost entirely ceased, and the great trade routes from Damascus northwards to Aleppo and eastwards through the wilderness are quite abandoned. The traffic with Arabia has ceased to be important, being limited to the time of the going and returning of the great pilgrim caravan to Mecca, which continues to have its mustering-place at Damascus. The native industries in silk, cotton, and wool have been almost entirely destroyed by the import trade from Europe. The land is poor in minerals, including coal; water-power also is deficient, so that the introduction of European industries is attended with difficulties even apart from the insecurity of affairs which forbids such experiments as the improvement of agriculture by means of European capital. As regards the cultivation of the soil Syria remains stable; but the soil is becoming relatively poorer, the value of the imports constantly gaining upon that of the exports.

Literature.—Ritter, *Erdkunde von Asien*, vol. xvii., parts 1 and 2, Berlin, 1854–55; Burckhardt, *Travels in Syria and the Holy Land*, London, 1822; Lortet, *La Syrie d'aujourd' hui*, Paris, 1884; Baedeker, *Palestine and Syria*; Murray's *Syria and Palestine*; Porter, *Five Years in Damascus*, 2 vols., London, 1855; Burton and Drake, *Unexplored Syria*, 2 vols., London, 1872; A. v. Kremer, *Mittelsyrien u. Damascus*, Vienna, 1853. For the art history of Syria De Vogüé's *Syrie Centrale: architecture civile et religieuse du 1er au 7me siècle* (Paris, 1865–77) may be consulted, and on its trade Zwiedineck v. Südenhorst, *Syrien u. seine Bedeutung für den Welthandel*, Vienna, 1873.

(A. SO.)

SYRIAC LITERATURE.

The literature of Syria, as known to us at the present day, is, with the exception of translations from the Greek and some other languages, a Christian literature. The writings of the Syrian heathens, such as the so-called Sābians (see **Ṣabians**) of Ḥarrān, which were extant, at least in part, even in the 13th century,[1] seem to have now wholly disappeared. The beginnings of this literature are lost in the darkness of the earliest ages of Christianity. It was at its best from the 4th to the 8th century, and then gradually died away, though it kept up a flickering existence till the 14th century or even later. We must own—and it is well to make the confession at the outset—that the literature of Syria is, on the whole, not an attractive one. As Renan said long ago,[2] the characteristic of the Syrians is a certain mediocrity. They shone neither in war, nor in the arts, nor in science. They altogether lacked the poetic fire of the older—we purposely emphasize the word—the older Hebrews and of the Arabs. But they were apt enough as pupils of the Greeks; they assimilated and reproduced, adding little or nothing of their own. There was no Al-Fārābī, no Ibn Sīnā, no Ibn Rushd, in the cloisters of Edessa, Ḳen-neshrē, or Nisībis. Yet to the Syrians belongs the merit of having passed on the lore of ancient Greece to the Arabs, and therefore, as a matter of history, their literature must always possess a certain amount of interest in the eyes of the modern student. The Syrian Church never produced men who rose to the level of a Eusebius, a Gregory Nazianzen, a Basil, and a Chrysostom; but we may still be thankful to the plodding diligence which has preserved for us in fairly good translations many valuable works of Greek fathers which would otherwise have been lost. And even Syria's humble chroniclers, such as John of Ephesus, Dionysius of Tell-Maḥrē, and Bar-Hebræus, deserved their meed of praise, seeing that, without their guidance, we should have known far less than we now know about the history of two important branches of the Eastern Church, besides losing much interesting information as to the political events of the periods with which their annals are occupied.

As Syriac literature commences with the Bible, we first briefly enumerate the different versions of Holy Scripture.

Pĕshīṭṭā.

The most important of these is the so-called Pĕshīṭṭā (*mappaḳtā pĕshīṭtā*), "the simple" or "plain version," the Syriac vulgate. This name is in use as early as the 9th or 10th century.[3] As to the Old Testament, neither the exact time nor place of its translation is known; indeed, from certain differences of style and manner in its several parts, we may rather suppose it to be the work of different hands, extending over a considerable period of time. It would seem, however, as a whole, to have been a product of the 2d century, and not improbably a monument of the learning and zeal of the Christians of Edessa. Possibly Jewish converts, or even Jews, took a part in it, for some books (such as the Pentateuch and Job) are very literally rendered, whereas the coincidences with the LXX. (which are particularly numerous in the prophetical books) show the hand of Christian translators or revisers. That Jews should have had at any rate a consultative share in this work need not surprise us, when we remember that Syrian fathers, such as Aphraates, in the middle of the 4th century, and Jacob of Edessa, in the latter half of the 7th, had frequent recourse, like Jerome, to the scholars of the synagogue. To what extent subsequent revision may have been carried it is not easy to say; but it seems tolerably certain that alterations were made from time to time with a view to harmonizing the Syriac text with that of the LXX. Such an opportunity may, for instance, have been afforded on a considerable scale by the adoption of Lucian's text of the LXX. at Antioch in the beginning of the 4th century (see **Septuagint**, vol. xxi. p. 699). On all these points, however, we know nothing for certain, and may well repeat the words of Theodore of Mopsuestia in his commentary on Zephaniah i. 6[4]: *ἡρμήνευται δὲ ταῦτα εἰς μὲν τὴν Σύρων παρ' ὅτου δή ποτε· οὐδὲ γὰρ ἔγνωσται μέχρι τῆς τήμερον ὅστις ποτὲ οὗτος ἐστίν.*

Canonical books of Old Testament.

The canonical books of the Old Testament according to the Pĕshīṭṭā are substantially those of the Hebrew Bible. In the Massoretic MSS. (see below), whether Nestorian or Jacobite, the books of Chronicles, Ezra, and Nehemiah are passed over, and in the Nestorian the book of Esther also. But, on the other hand, it must be noticed that all these books are cited by Aphraates, and that they all appear in the *Codex Ambrosianus*. Of the Chronicles there is a MS. of the 6th century in the British Museum, Add. 17104. Esther appears in a volume of equal age (Add. 14652) as one of the constituent parts of the "Book of Women," the others being Ruth, Susanna, Judith, and the history of Thecla, the disciple of St. Paul, which last is excluded from Biblical MSS. The oldest dated MS. of any portion of the Old Testament at present known to us is Add. 14425 in the British Museum (Gen., Exod., Num., Deut.), transcribed at Āmid by a deacon named John in 464. The deutero-canonical books or apocrypha, translated by different hands from the Greek,[1] are nearly the same as in the LXX.[2] The *Codex Ambrosianus*,[3] for example, contains Wisdom, the Epistle of Jeremiah, and two Epistles of Baruch; the Song of the Three Children, Bel and the Dragon, and Susanna; Judith, Siracides or Ecclesiasticus; the Apocalypse of Baruch; the fourth book of Esdras; and five books of the Maccabees, the fourth being the history of Samona and her sons, and the fifth *Josephi de Bello Judaico lib. vi.*[4] To these must be added from other MSS. the first or third book of Esdras, the book of Tobit, and the prayer of Manasses. Of the first book of the Maccabees two recensions are extant, as far as chap. xiv. 24. The book of Tobit presents the text of the LXX. as far as chap. vii. 11.[5]

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[1] Bar-Hebræus, *Chron. Syr.*, ed. Bruns and Kirsch, p. 176; Chwolsohn, *Ssabier und Ssabismus*, i. 177.

[2] *De Philosophia Peripatetica apud Syros*, 1852, p. 3.

[3] See the passage of Moses bar Kēphā, who died in 903, cited by the Abbé Martin in his *Introduction à la Critique Textuelle du Nouveau Testament*, p. 101, note.

[4] Mai, *Patrum Nova Bibliotheca*, vol. vii. 252.

Apocrypha.

Canonical books of New Testament.

The canonical books of the New Testament are the four Gospels, the Acts of the Apostles (to which are annexed the three catholic epistles, viz., James, 1 Peter, and 1 John), and the fourteen epistles of St. Paul. The shorter apostolic epistles, viz., 2 and 3 John, 2 Peter, and Jude, and the Apocalypse of St. John, were rejected by the early Syrian Church.[6]

Tatian's *Dia-ṭessarōn* and the Curetonian Gospels.

As to the Pĕshīttā version of the Gospels (P), a variety of critical questions arise when we consider it in connection with two other works, the *Dia-ṭessarōn* of Tatian (T) and the *Curetonian Gospels* (Sc).[7] Tatian, the friend of Justin Martyr, afterwards counted a heretic, composed out of the four Gospels a work which received the title of Τὸ διὰ τεσσάρων εὐαγγέλιον, in Syriac more briefly *Dia-ṭessarōn*, or *Evangelion da-Mĕḥallĕṭē*, "the Gospel of the Mixed." It is a subject of controversy whether Tatian wrote this work in Greek or in Syriac, and whether he compiled it from the Greek Gospels or from a previous Syriac version. According to Zahn[8] and Baethgen,[9] the author's language was Syriac, his sources Greek. They hold that this was the only Gospel in use in the Syrian Church for nearly a century, but that about the year 250, under the influence of Western MSS. of the Greek text (see Westcott and Hort, *The New Testament in the Original Greek*, Introd., §§ 118, 214), a version of "the Separate Gospels," *Evangelion da-Mĕpharrĕshē*, was introduced.[10] The translator, according to Baethgen,[11] made use of T as far as he could; and of this text Sc is, in the opinion of these scholars, the solitary survival in our days. The evidence for this view does not, however, appear to be conclusive. It seems that a Syriac version of the four Gospels, as well as of the other parts of the New Testament, must have existed in the 2d century, perhaps even before the version of the Old Testament. From this Tatian may have compiled his *Dia-ṭessarōn*, or he may have written that work in Greek and others may have done it in Syriac. Be that as it may, T certainly gained great popularity in the early Syrian Church, and almost superseded the Separate Gospels. Aphraates quoted it;[12] Ephraim wrote a commentary upon it;[13] the *Doctrine of Addai* or Addæus (in its present shape a work of the latter half of the 4th century) transfers it to the apostolic times;[14] Rabbūlā, bishop of Edessa (411–435), promulgated an order that "the priests and deacons should take care that in every church there should be a copy of the Separate Gospels (*Evangelion da-Mĕpharrĕshē*), and that it should be read;"[15] and Theodoret, bishop of Cyrrhus (423–457), swept up more than two hundred copies of it in the churches of his diocese, and introduced the Four Gospels in their place: τὰ τῶν τεττάρων εὐαγγελιστῶν ἀντεισήγαγεν εὐαγγέλια.[16] The result of these and similar well-meant efforts is that not a single copy of T has come down to our times.[17] Both Aphraates and Ephraim, however, made use of the Separate Gospels. The former seems to have employed a text which Baethgen calls a slightly revised form of Sc (*op. cit.*, p. 95); we would rather speak of it as a revised form of the old Syriac Gospels of the 2d century. The latter made use of a more thorough Edessene revision, closely approaching in form to, if not identical with, P (Baethgen, p. 95; Zahn, p. 63). Our oldest MSS. of P are, however, more than a hundred years later than Ephraim's time. We cannot, therefore, expect very important textual results from the collation of even such MSS. as Add. 14470, 14453, 14459, ff. 1–66, and 17117, in the British Museum, all of which may be safely ascribed to the latter part of the 5th or the beginning of the 6th century. Early in the 5th century Rabbūlā, bishop of Edessa, the friend and correspondent of Cyril of Alexandria, occupied himself with "translating the New Testament out of the Greek into the Syriac, because of its variations, exactly as it was."[18] This probably means, as has been suggested by Nestle, that Rabbūlā undertook a revision of the Syriac text according to a Greek MS. or MSS. in his possession, that is to say, still further assimilated P of that day to a Greek (possibly, from his connection with Cyril, Alexandrian) text. We do not as yet know, however, whether this revision was merely a private effort, or what influence, if any, it exercised on the history of P; more likely it was a first step in the direction of the Philoxenian version (see below). The result of these successive revisions as regards Sc has been that it survives in but one mutilated codex, and that written at comparatively so late a date as 450–470,[19]—a phenomenon which has its parallel in the case of the Itala codex *c* of the Gospels, copied in the 11th century. The greater part of this volume is in the British Museum (Add. 14451);[20] but there are three leaves of it in the royal library at Berlin, forming the fly-leaves of the MS. marked Orient. Quart. 528.[21] Crowfoot's attempt to retranslate Sc into Greek is a failure (*Fragmenta Evangelica*, 1870–72); Baethgen's work

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[1] Some scholars, such as P. de Lagarde and Bickell, think that Ecclesiasticus was translated from the lost Hebrew text.

[2] See Ceriani, *Monumenta Sacra et Profana*, vol. i. fascc. 1, 2; vol. v. fascc. 1 2; P. de Lagarde, *Libri Vet. Test. Apocryphi Syriace*.

[3] Splendidly reproduced at Milan by the process of photo-lithography under the direction of the Rev. Dr. A. M. Ceriani, 5 parts, 1876 foll.

[4] See *Das 6te Buch d. Bellum Judaicum übersetzt u. kritisch bearbeitet*, by Dr. H. Kottek, Berlin, 1886; only capp. 1 and 2.

[5] See the Syriac note on p. xii. of De Lagarde's edition.

[6] The principal editions of the Pĕshīṭtā are contained in the Paris polyglott of Le Jay and the London polyglott of Walton, to which latter is attached the immortal *Lexicon Heptaglotton* of Edmund Castle. The Old Testament (without the Apocrypha) was edited by S. Lee in 1823 for the Bible Society, and is frequently bound up with the New Testament of 1826. The first edition of the New Testament was that of J. A. Widmanstadt, with the help of Moses of Mārdīn (Vienna, 1555). Those of Tremellius (1569), Trost (1621), Gutbir (1664), and Leusden and Schaaf (1708, 1717) are well known. To the last named belongs Schaaf's admirable *Lexicon Syriacum Concordantiale*. The American missionaries at Urūmiyah have published both the Old and New Testaments in ancient and modern Syriac, the former in 1852, the latter in 1846.

[7] *Remains of a very Ancient Recension of the Four Gospels in Syriac, hitherto unknown in Europe, discovered, edited, and translated by W. Cureton, D.D., F.R.S.*, 1858.

[8] *Forschungen zur Geschichte des neutestamentlichen Kanons*, etc., 1 *Theil: Tatian's Diatessaron*, pp. 98, 99.

[9] *Evangelienfragmente. Der griechische Text des Cureton'schen Syrers wiederhergestellt*, 1885.

[10] Zahn, *op. cit.*, pp. 104–106.

[11] *Op. cit.*, pp. 59, 60, 72 *sq.*

[12] Wright's edition, p. [illegible], l. 10, "as it is written at the head of the Gospel of our Lifegiver, In the beginning was the Word."

[13] Now extant only in the old Armenian version, translated by the Mechitarist Aucher, and revised by G. Mösinger under the title of *Evangelii Concordantis Expositio facta a S. Ephraemo*, Venice, 1876.

[14] Phillips's edition, p. [illegible], l. 17.

[15] *S. Ephraemi Syri Rabulæ epi Edesseni Balæi aliorumque opera selecta*, ed. J. J. Overbeck, Oxford, 1865, p. 220, 3.

[16] Αἱρετικῆς κακομυθίας ἐπιτομή, i. 20.

[17] Martin's article "Le Διὰ τεσσάρων de Tatien" (from *Revue des Questions Historiques*, April, 1883) contains much curious literary information, particularly regarding similar compilations of later date. See also Ciasca's article "De Tatiani Diatessaron Arabica Versione," in Cardinal Pitra's *Analecta Sacra Spicilegio Solesmensi parata*, iv. 465. This Arabic *Diatessaron* begins with Mark i. 1, John i. 1–5, Luke i. 5–80, Matthew i. 1–25a, Luke ii. 1–39. Ciasca's copy is now (1887) in the hands of De Lagarde, who has published a few pages of it in *Nachrichten von der königl. Gesellschaft der Wissenschaften*, 1886, No. 4, pp. 150–158. According to De Lagarde, the text is that of the ordinary Pĕshīṭtā.

[18] Overbeck, *op. cit.*, p. 172, 18–20.

[19] The whole of the Abbé Martin's elaborate argumentation (*Introd. à la Critique Textuelle du N. T.*, pp. 163–236) is of no avail against this palæographic fact. No one who is conversant with Syriac MSS. can for a moment doubt that our codex of Sc was written within a few years of the time indicated above. The handwritings of Jacob of Edessa's time (the latter half of the 7th century) are altogether different. Possessors of the abbé's work should cancel pp. 234–236. The "Postscriptum," as the author himself has explained, is only an elaborate *joke*. There is no MS. Add. 70125 in the British Museum, no catalogue of the Greek MSS. in twenty-five volumes, and of course no such photograph exists as he has described. As for the "special telegram" from "Révérend Crowfoot" through the "agence Fri-Frou-Fro and Co.," dated 25th December, 1882, it is enough to say that Mr. Crowfoot died on 18th March, 1875.

[20] See Wright's *Catalogue*, p. 73, No. cxix.

[21] See Rödiger in the *Monatsberichte* of the Berlin Academy for July, 1872, p. 557; Wright, *Fragments of the Curetonian Gospels* (privately printed).

(*Evangelienfragmente*, etc.) will perhaps be found more satisfactory.

Monophysite versions.

Philoxenus.

Paul of Tellā.

Thomas of Harkel.

Jacob of Edessa.

The scholars of the Monophysite branch of the Syrian Church were, however, by no means satisfied even with the revised text of P, and demanded a yet more accurate reproduction of the Greek text in use among them. Accordingly Aksĕnāyā or Philoxenus, bishop of Mabbōgh (485–519), undertook to satisfy this want, and with the assistance of his chorepiscopus, Polycarp, produced a literal translation of the whole Bible in the year 508.[1] This seems at first to have met with considerable approval; Moses of Aggēl, for example, who flourished from 550 to 570,[2] refers to the version of the New Testament and of the Psalms evidently as the standard work of the day.[3] But it was in its turn superseded by two later revisions, and MSS. of it are now very rare. Portions of Isaiah survive in the British Museum, Add. 17106, ff. 74–87,[4] and the text of the Gospels in the codex A. 2, 18 of the Biblioteca Angelica at Rome, of the 11th or 12th century,[5] and perhaps also in the Beirūt (Beyrout) MS.[*] described by Prof. Isaac H. Hall.[6] At the beginning of the 7th century the work of retranslation and revision was again taken in hand by the Monophysites, the scene of their labors being the different convents in the neighborhood of Alexandria. There, in the years 616–617,[7] Paul, bishop of Tellā dhĕ-Mauzĕlath or Constantina, undertook a version of the hexaplar text of the LXX. at the request of the patriarch Athanasius I.[8] Of parts of this many MSS. are extant in the British Museum and the Bibliothèque Nationale at Paris, and the Biblioteca Ambrosiana at Milan possesses the second volume of a codex of the entire work, which has been reproduced by photolithography under the direction of Ceriani.[9] This version not only exhibits the asterisks and obeli of Origen's text of the LXX., but the marginal notes contain many readings of the other Greek translators, which have been largely utilized by Field in his noble work *Origenis Hexaplorum quæ supersunt* (2 vols., Oxford, 1875). At the same time and place the New Testament of Philoxenus was thoroughly revised by Thomas of Ḥarḳel or Heraclea,[10] bishop of Mabbōgh,[11] who, being driven from his diocese, betook himself to Alexandria and worked there in the convent of St. Antony at the Enaton (or Nine-mile-village).[12] This version comprises not only all the books contained in the Pĕshīṭtā but also the four shorter epistles.[13] The lapse of another century brings us to the last attempt at a revision of the Old Testament in the Monophysite Church. Jacob, bishop of Edessa, undertook, when living in retirement in the convent of Tell-‘Addā or Teleda,[14] in 704–705, to revise the text of the Pĕshiṭtā with the help of the Greek versions at his disposal,[15] thus producing a curious eclectic or patchwork text. Of this work there are but five volumes extant in Europe, four of which came from the Nitrian Desert and form parts of a set which was written in the years 719–720. It would seem, therefore, never to have attained popularity.[16]

Malkite version.

One other version remains to be noticed, namely, that used by the Christian population of the Malkite (Greek) Church in Palestine, written in an Aramaic dialect more akin to the language of the Jewish Targūms than to that of the Pĕshīṭtā.[17] A lectionary containing large portions of the Gospels in this dialect was described by Assemani in the catalogue of the Vatican library,[18] studied by Adler,[19] and edited by Count Fr. Miniscalchi Erizzo under the title of *Evangeliarium Hierosolymitanum* (2 vols., Verona, 1861–64). It was written in a convent at a place called Ābūd,[20] not very far from Jerusalem, in the year 1030, and the scribe claims to have copied sundry other service-books for the use of his church (see Assemani, *op. cit.*, p. 102). Fragments of other evangeliaria have been published by Land, from MSS. at London and St. Petersburg, in his *Anecd. Syr.*, iv. pp., 114–162, 213–222; of the Acts of the Apostles, p. 168; and of the Old Testament (translated from the Greek), pp. 103–110, 165–167, 222–223. According to the same authority (p. 231), the calendar in the Vatican MS. must have been drawn up about the middle of the 9th century. Few, if any, of the extant fragments appear to be of older date. Nöldeke places the origin of the version in the 4th or 5th century, certainly not later than 600 (*loc. cit.*, p. 525).[21]

Mār-abhā I.

All the above revisions of the text of the Syriac Bible according to the Greek are, as we have seen, the work of Monophysites, with the single exception of the last, which proceeded from the Malkites. The Nestorian community obstinately adhered to the old Pĕshīṭtā, and the solitary attempt made to introduce a revised text among them seems to have been an utter failure. Mār-abhā I.,[22] a convert from Zoroastrianism, who was catholicus from 536 to 552, went to Edessa, studied Greek there under a teacher named Thomas,[23] and with his help translated the whole of the Old Testament into Syriac, and perhaps also the New. This statement rests on the authority of the author of the *Kitāb al-Majdal* (Mārī ibn Sulaimān,[24] about the middle of the 12th century, supplemented and abridged by ‘Amr ibn Mattā of Ṭīrhān, who lived towards the middle of the 14th century),[25] of ‘Abhd-īshō‘, bishop of Nisībis (died 1318), and of Bar-Hebræus (died 1286); and there appears to be no reason to doubt their word.[26]

Massoretic MSS.

Before quitting the subject of the versions of Holy Scripture we must devote a few words to the Massoretic MSS. of the Nestorians and Jacobites.[27] In the year 1721 Assemani made mention in the *Bibliotheca Orientalis* (ii. 283), on the authority of Bar-Hebræus in the *Auṣar Rāzē*, of a "versio *Karkaphensis*, hoc est *Montana*, qua videlicet incolæ montium utuntur."[28] About the meaning of these words scholars disputed, and some searched for MSS. of the alleged version, but in vain. At last, N. Wiseman (afterwards cardinal), guided by the light of another passage in the *Bibliotheca Orientalis* (ii. 499, 500, No. xxii.), recognized in Cod. Vat. cliii. a copy of what he believed to be the Karkaphensian version.[1] Later researches, more especially those of the Abbé Martin, have corrected these errors. The MSS. of the Karkaphensian tradition, of which there are ten in our European libraries, are now known to contain a philological and grammatical tradition of the pronunciation and punctuation of Holy Writ and sometimes of other writings.[2] Syria was rich in schools and colleges; most of its towns possessed institutions where instruction was given, more especially to students of theology, in the reading and exposition of the Greek and Syriac Scriptures and their commentators. Such were the great "Persian school" of Edessa, which was destroyed, on account of its Nestorian tendencies, in 489; the school of Nisībis; of Māḥōzē near Seleucia; of the monastery of Dōr-Ḳōnī or Dair-Ḳunnā; of the monastery of Ḳen-neshrē or the Eagles' Nest, on the left bank of the Euphrates, opposite Jerābis; of the Dairā 'Ellāitā, or monastery of St. Gabriel and St Abraham, at Mosul; and many others.[3] Every such school or college had its teacher of reading and elocution, *mahgĕyānē* and *maḳrĕyānē* (or *maḳeryānē*), who taught their pupils to pronounce, add the vowel-points, and interpunctuate correctly.[4] before they were passed on to the higher classes of the *eskōlāyē' bādhōkē* or *mallĕphānē*. that is, the professors of exegesis and doctors of theology.[5] The more difficult words and phrases of Scripture were gradually collected and written down so as to form "collectanea," *lukkāṭē dha-shĕmāhē*, or "fasciculi," *kurrāsē dha-shĕmāhē*, and the union of these composed a *kĕthābhā dha-ḳĕrāyāthā*, or "book of readings," in which it was shown by means of vowel-points and other signs how each word was to be pronounced and accentuated.[6] One such volume in the British Museum (Add. 12138, dated 899) represents the work of a Nestorian student in the convent of Mār Gabriel at Ḥarrān[7]; but the other MSS. extant in the different libraries of Europe[8] are of Jacobite origin and have a common source, the scholastic tradition of the convent of Ḳarḳaphĕthā, or "the Skull," at the village of Maghdal or Mijdal near Rēsh-'ainā or Rās-'ain.[9] Such are, for example, Cod. Vat., No. clii., now cliii., described by Assemani (*Catal.* iii., 287) and Wiseman (*Horæ Syr.*, p. 151); Cod. Paris, Ancien fonds 142, described by Zotenberg (*Catal.*, p. 30, No. 64) and Martin (*Tradition Karkaphienne*, p. 36); Cod. Brit. Mus. Add. 7183, described by Rosen (*Catal.*, p. 64, No. xlii.), and 12178, described by Wright (*Catal.*, p. 108). From these and similar MSS., as well as from the words of Bar-Hebræus,[10] it appears that the Ḳarḳĕphāyē were the monks of the convent of Ḳarḳaphĕthā; that they were Westerns or Occidentals, therefore Jacobites; and that one of their chief authorities, if not the actual originator of the compilation, was Jacob, bishop of Edessa. Accordingly, the marginal notes indicate various readings from Syriac MSS., from the LXX., and from the Ḥarḳlensian version, as well as from different fathers and teachers.[11] To the collection of words and phrases from the Pĕshīttā version is added in several of these MSS. a similar, though shorter, collection from the Ḥarḳlensian version and from the principal works of the Greek fathers which were read in translations in the schools,[12] followed by tracts on different points of orthography, grammar and punctuation.[13]

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[1] Assemani, *Bibliotheca Orientalis*, ii. 23.

[2] *B. O.*, ii. 82.

[3] *Ibid.*, ii. 83; Guidi, *Rendiconti della R. Accademia dei Lincei*, May and June, 1886, p. 404.

[4] Edited by Ceriani in *Monumenta Sacra et Profana*, vol. v. fasc. 1, pp. 1–40.

[5] See Bernstein, *Das heilige Evangelium des Johannes*, Leipsic, 1853, *krit. Anmerkungen*, pp. 3, 29; Martin, *Introd. à la Crit. Text. du N. T.*, pp. 160–161.

[6] *Syriac Manuscripts, Gospels of a pre-Harklensian Version, Acts and Epistles of the Peshitto Version, written (probably) between 700 and 900 A.D.*, January, 1884.

[7] See Ceriani, *Monumenta*, vol. i. fasc. 1: *Prolegomena in Edit. Vers. Syr. ex Textu LXX.*, p. iii.; Martin, *Introd.*, p. 139, note.

[8] *B.O.*, ii. 333–334.

[9] *Monumenta*, vol. vii.: *Codex Syro-hexaplaris Ambrosianus*, 1874. The first volume of this codex was in the possession of Andreas Masius, but has disappeared since his death in 1578. It contained part of Deuteronomy, Joshua, Judges, (four books of) Kings, Chronicles, Ezra (and Nehemiah), Judith, and Tobit (complete?). See Middeldorpf, *Codex Syriaco-hexaplaris*, Berlin, 1835, who enumerates in his preface the labors of previous editors. Since his time the books of Judges and Ruth have been published by T. Skat Rördam (*Libri Judicum et Ruth secundum Vers. Syriaco-hexaplarem*, Copenhagen, 1859–61), and Exodus, Numbers, Joshua, 1 and 2 Kings, by P. de Lagarde (*Vet. Test. ab Origene recensiti Fragmenta apud Syros servata quinque*, Göttingen, 1880, printed with Hebrew letters). Ceriani has commenced a critical edition in the *Monumenta*, vol. i. fasc. 1; vol. ii. fascc. 1–4; vol. v. fasc. 1, 2.

[10] See *B.O.*, ii. 90, 334; Bernstein, *De Hharklensi N. T. Translatione Syriaca Commentatio*, p. 4.

[11] Or Manbij; according to others, of Germanicia or Mar‘ash. He must not be confounded with an older Thomas of Germanicia, a Monophysite of the earlier part of the 6th century; see *B.O.*, ii. 92, 326; Kleyn, *Jacobus Baradaeüs*, p. 43, note 1.

[12] See Wright, *Catal.*, p. 34, note.

[13] It has been edited by White at Oxford—the Gospels in 1778, the Acts and Apostolic epistles in 1799, the Pauline epistles in 1803 (the epistle to the Hebrews is defective, ending in the middle of chap. xi. 27). The text of the shorter epistles, 2 Peter, 2 and 3 John, and Jude, has been recently reproduced by phototype from a manuscript dated 1471—*Williams Manuscript. The Syrian Antilegomena Epistles . . . edited by Isaac H. Hall*, 1886. Consult also *Transactions of the Royal Irish Academy*, vol. xxvii. No. viii., "On a Syrian MS. belonging to the Collection of Archbishop Ussher," by the Rev. J. Gwynn, D.D. There is a fine MS. of this version, dated 1170, in the university library, Cambridge, Add. MS. 1700. Its peculiar feature is that it has the two epistles of Clement inserted between the catholic epistles and those of St. Paul.

[14] Probably the modern Tell‘ādī or Tell‘āde; see Socin, *Paläst. u. Syrien*, p. 480; Sachau, *Reise in Syrien u. Mesopotamien*, p. 459.

[15] Wright, *Catal.*, p. 38, col. 1.

[16] See Ceriani, *Le Edizioni e i Manoscritti delle Versioni Siriache del Vecchio Test.*, 1869, p. 27, and *Monumenta*, vol. ii. fasc. 1, pp. xi., xii., vol. v. fasc. 1, pp. 1–40; Martin, *Introd.*, pp. 230–232, 296 *sq.*

[17] See Nöldeke, in *Z.D.M.G.*, xxii. (1868), p. 443 *sq.*

[18] *MSS. Codd. Bibl. Apost. Vatic. Catalogus*, ii. No. xix. p. 70 *sq.*

[19] *N. Tes. Verss. Syriacæ Simplex, Philoxeniana, et Hierosolymitana*, Copenhagen, 1789; see also Martin, *Introd.*, p, 287 *sq.*

[20] See Nöldeke, *loc. cit.*, pp. 521, 527; Land, *Anecd. Syr.*, iv. pp. 227–229.

[21] The remaining literature in this dialect (all of it published by Land) consists of a few hymns (pp. 111–113), lives of saints (pp. 169, 170), and theological fragments (pp. 171–210). One fragment (p. 177) contains the title of a homily of John Chrysostom.

[22] Properly Mār(i)-abhā.

[23] *B. O.*, iii. 1, 86; compare ii. 411.

[24] See p. 896, note 10.

[25] See Hoffmann, *Auszüge aus syrischen Akten persischer Märtyrer*, pp. 6, 7.

[26] See *B. O.*, ii. 411–412, iii. 1, 75; Bar-Hebræus, *Chron. Eccles.*, ed. Abbeloos and Lamy, ii. 89; Martin, *Introd.*, pp. 292–294.

[27] See Martin, *Tradition Karkaphienne ou la Massore chez les Syriens*, Paris, 1870 (from *Journ. Asiat.*), and *Introd.*, pp. 276–291.

[28] In the Vatican *Catalogue* (vol. iii. 287, No. cliii.) he translates the words *akh mashlĕmānūthā ḳarkĕphāitā* by "juxta traditionem verticalem (!): hoc est, Montanorum in Phœnice et Mesopotamia degentium."

[*] [Prof. Hall claims that the Beirūt MS. certainly preserves the Philoxenian text. See his article in *Jour. Soc. Bibl. Exegesis and Lit.*, 1886, pp. 1–26.—AM. ED.]

Apocryphal works.

We have spoken above (p. 863) of the deutero-canonical books of the Old Testament. Other apocrypha may now be noticed more briefly; *e.g.*, Ps. cli. (in the hexaplar version of Paul of Tellā); the *Parva Genesis*, or *Liber Jubilæorum*, a fragment of which has been edited by Ceriani (*Monumenta*, vol. ii. fasc. 1, p. ix.); the testament of Adam[14]; the History of Joseph and Āsyath (Asenath), translated by Moses of Aggēl[15]; the History of Sanḥērīb, his Vizīr Aḥīkār or Ḥīkār, and his Disciple Nādhān.[16] Many similar books exist in Arabic, some of them probably translated from lost Syriac originals. The names of Daniel and Ezra "the scribe" are prefixed to late apocalyptic works,[17] and even to almanacs containing prognostications of the weather, etc.[18] The list of apocrypha of the New Testament is also tolerably extensive. We may mention the *Protevangelium Jacobi;* the Gospel of Thomas the Israelite, or of the Infancy of our Lord; the Letters of Abgar and our Lord; the Letters of Herod and Pilate; prayers ascribed to St. John the Baptist; the *Transitus*, *Assumptio*, or Κοίμησις *Beatæ Virginis*, extant in four or five redactions[19]; Acts of the Apostles, such as St. John, St. Philip, St. Matthew and St. Andrew, St. Paul and Thecla, and St. Thomas[20]; the Doctrine of St. Peter;[21] and the Apocalypse of St. Paul.[22] Others of these apocrypha are extant in Arabic, but the Syriac originals have not yet been recovered. To these may be added such works as the *Didascalia Apostolorum*, edited (anonymously) by P. de Lagarde in 1854; extracts from the *Constitutiones Apostolorum*, ascribed to Clement, in the same editor's *Reliquiæ Juris Eccles. Antiq.*, pp. 2–32, 44–60; and the *Doctrina Apostolorum*, in Cureton's *Ancient Syriac Documents*, pp. 24–35, and in *Reliquæ Juris Eccles. Antiq.* (under the title of *Doctrina Addæi*), pp. 32–44.

Service-books.

Into a description of the service-books of the Syrian Church in its different sects—Nestorians, Jacobites, Maronites, and Malkites—we cannot here enter.[23] The bare enumeration of the various psalters, lectionaries, missals, etc., would far exceed our present limits. The oldest Syriac psalter in our European collections is not earlier than 600 (Brit. Mus. Add. 17110), and the series of lectionaries commences with the 9th century. Of anaphoræ or liturgies it would be easy to specify some sixty.[24] The oldest of all is a fragment of the anaphora of Diodorus of Tarsus (in the British Museum, Add. 14699, ff. 20, 21), of the 6th century, which has been edited and translated by Bickell.[25]

Besides the versions of Holy Writ and other works enumerated above, the literature of Syria comprises a vast amount of matter, interesting not merely to the Orientalist but also to the classical scholar, the theologian, and the historian. Some portions of this literature we must now endeavor to pass under review.

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[1] See his *Horæ Syriacæ*, Rome, 1828, p. 78: II. *Symbolæ Philologicæ ad Hist. Versionum Syriac. vet. fœderis. Particula prima; de versionibus generatim, deinde de Peschito*, p. 147; III. *Particula secunda; recensionem Karkaphensem nunc primum describens.* We need not here indicate Wiseman's mistakes, but it is a pity to see them all reproduced even in the third edition of Scrivener's *Plain Introduction*, 1883.

[2] See Hoffmann, *Opuscula Nestoriana*, 1880, p. v. *sq.*

[3] See, for example, *B. O.*, iii. 1, 341, col. 2 at the foot, and iii. 2, cmxxiv. *sq.*

[4] Hoffmann, *Opusc. Nestor.*, p. vii.; Martin, *Introd.*, p. 289.

[5] Hoffmann, *op. cit.*, pp. xx., xxi. What the whole curriculum of such a student should be, according to the mind of Bar-Hebræus in the 13th century, may be seen from the *B. O.*, iii. 2, 937–938 (*Nomocanon*, translated by J. A. Assemani, in Mai, *Scriptt. Vett. Nova Coll.*, x. cap. vii. § 9, pp. 54–56).

[6] Hoffmann, *op. cit.*, pp. vi., vii.

[7] See Wright,[a] *Catal.*, p. 101.

[8] Martin, *Introd.*, p. 291.

[9] Hoffmann, in *Z.D.M.G.*, xxxii. (1878), p. 745; and in Stade's *Zeitschrift für d. Alttest. Wissenschaft*, 1881, p. 159.

[10] Martin, *op. cit.*, pp. 122, 129.

[11] See Wiseman, *op. cit.*, p. 178; Martin, *op. cit.*, pp. 76, 77, 133; Rosen, *Catal.*, pp. 65, 66; Wright, *Catal.*, p. 109. Among these occur ܛܘ and ܣܒܐ. The investigations of Hoffmann (in Stade's *Zeitschrift*, 1881, p. 159) and Duval (*Journ. Asiat.*, 1884, p. 560) have made it certain that ܛܘ designates not the Pĕshīṭtā, nor Jacob of Edessa, but one Ṭūbhānā (perhaps surnamed "the Beardless"), an eminent teacher at Rēsh-'ainā. His colleague Sābhā was probably the famous scribe Sābhā, who wrote Brit. Mus. Add. 14428, 14430 (724), and 12135, ff. 1–43 (726).

[12] Namely, (Pseudo-)Dionysius Areopagita, Gregory Nazianzen (2 vols.), the works of Basil, the epistles of Gregory and Basil, John Philoponus (the Διαιτητής) and Severus of Antioch (*Homiliæ Cathedrales* and certain synodical letters relating to the council of Antioch). A fuller list is given by Assemani, *B. O.*, iii., 2, cmxxxvii. *sq.*

[13] See Phillips, *A Letter of Mār Jacob, Bishop of Edessa, on Syriac Orthography*, etc., 1869 (Appendix iii. pp. 85–96, issued separately in 1870); Martin, *Jacobi epi Edesseni Epistola ad Georgium epum Sarugensem de Orthographia Syriaca*, etc., 1869.

[14] Wright, *Catal.*, p. 1242; see Renan, in the *Journ. Asiat.*, November and December, 1853, p. 427, and Wright, *Contributions to the Apocryphal Literature of the New Testament*, 1865, p. 61.

[15] Wright, *Catal.*, p. 1047; Land, *Anecd. Syr.*, iii. 15–46.

[16] Wright, *Catal.*, p. 1207, col. 1; Hoffmann, *Auszüge aus syrischen Akten persischer Märtyrer*, 1880, p. 182; see for the Syriac text Brit. Mus. Orient. 2313, and a MS. in the collection of the S. P. C. K. (now presented by the Society to the university of Cambridge).

[17] Wright, *Catal.*, pp. 9, 1065.

[18] Wright, *Catal.*, p. 852, col, 2; Brit. Mus. Orient. 2084, f. 1, *Kĕthābhā dhĕ-Shūdhā'ē dhĕ-sabhnē dhĕ-Dhānī'ēl nĕbhīyā.*

[19] Most of these are published in Wright's *Contributions*: see also the *Journal of Sacred Literature*, 1865, vol. vi. 417, vol. vii. 129; and B. H. Cowper, *The Apocryphal Gospels*, etc., 1867.

[20] See Wright, *Apocryphal Acts of the Apostles*, 2 vols., 1871.

[21] Cureton, *Ancient Syriac Documents*, pp. 35–41.

[22] Translated by Zingerle in Heidenheim's *Vierteljahrsschrift*, iv. p. 139 *sq.*, and by Perkins, *Journal of the American Oriental Society*, viii, p. 182 *sq;* reprinted in the *Journal of Sacred Literature*, January, 1865, p. 372 *sq.*

[23] The reader is referred to the following works: J. A. Assemani, *Codex Liturg. Ecclesiæ Universæ*, 15 vols., Rome, 1749–66; Renaudot, *Liturgiarum Orient. Collectio*, 2 vols., Paris, 1716; Etheridge, *The Syrian Churches, their Early History, Liturgies, and Literature*, London, 1846; Badger, *The Nestorians and their Rituals*, 2 vols., London, 1852; Howard, *The Christians of St. Thomas and their Liturgies*, Oxford, 1864; Danzinger, *Ritus Orientalium, Coptorum, Syrorum, et Armenorum in administrandis sacramentis*, 2 vols., Würzburg, 1863–64; J. Morinus, *Comment. de Sacris Eccles. Ordinationibus*, etc., Paris, 1655, Antwerp, 1695; Bickell, *Conspectus Rei Syrorum Literariæ*, chaps. vii.–x.

[24] See a complete list in Bickell's *Conspectus*, pp. 65–68; comp. also Neale and Littledale's *Liturgies of SS. Mark, James*, etc., 2d ed., 1869, p. 146, and Appendix i.

[25] See his *Conspectus*, pp. 68, 71–72. The Syriac text is given in *Z.D.M.G.*, xxvii. (1873), pp. 608–613.

[a] [William (1838–89), born in Bengal, professor of Arabic in Univ. Col., London, in Dublin, and (1870) in Cambridge, where he died; keeper of MSS. in British Museum, author of Oriental translations and text-books. See CURETON, Vol. VI. p. 627.—AM. ED.]

Bardesânes. The long series of Syrian writers is headed by the name of Bar-Daiṣân or Bardesânes, "the last of the Gnostics."[1] He was born at Edessa on 11th July, 154,[2] and seems to have been the son of heathen parents of rank. Of the manner of his conversion to Christianity, and how he came to deviate from orthodoxy, we are uninformed. Part of his life he spent at the court of Edessa; then he betook himself as a missionary to the rude mountaineers of Armenia, and finally settled down in the fortress of Anium, where he probably remained till his death in 222.[3] He wrote, we are told, a *History of Armenia*, which Moses of Chorene used in a Greek translation; *Hypomnemata Indica*, compiled from the oral information which he obtained from an Indian embassy passing through Edessa on its way to the Roman court, and polemical treatises against the polytheism of the heathens and the dualism of Marcion. He and his son Harmonius were poets, and their hymns were greatly admired and imitated. Even Ephraim could not help admitting their merits, whilst he reviled them.[4] Of these works, however, only a few fragments have been preserved by later writers.[5] The famous dialogue Περὶ εἱμαρμένης or *De Fato*, which the voice of antiquity has unanimously ascribed to Bardesânes, was in reality composed by his disciple Philip, and doubtless presents us with an accurate account of his master's teaching. The Syriac title is *Kĕthâbhâ dhĕ-Nâmôsê dh'Athrawâthâ* (The Book of the Laws of the Countries).[6]

Simeon bar Ṣabbâ'ê and Millês. Of Simeon bar Ṣabbâ'ê ("the Dyers' Son"), bishop of Seleucia and Ctesiphon, and Millês, bishop of Susa, we know little beyond the fact of their martyrdom in the great persecution of the Christians by Shâbhôr or Sapor II., which began in 339–340.[7] Simeon is said by 'Abhd-îshô'[8] to have written "epistles,"[9] which seem to be no longer extant. To him are also ascribed sundry hymns,[10] and a work entitled *Kĕthâbhâ dh'Abhâhâthâ* (The Book of the Fathers), which, according to Sachau, treats of the heavenly and earthly hierarchy.[11] The writings of Millês are stated by 'Abhd-îshô' (*loc. cit.*) to have been "epistles and discourses (*mêmrê*) on various subjects"; but of these time has also robbed us.

Jacob of Nisibis. The name of Jacob (or St. James) of Nisîbis[12] is far more widely known. As bishop of that city he was present at the council of Nicæa. He lived to witness the outbreak of war between the Romans and the Persians, and is said to have delivered the city by his prayers from the latter power. He died in the same year (338).[13] To him has been ascribed, on the authority of Gennadius of Marseilles[14] and of the ancient Armenian version,[15] a collection of homilies, the Syriac text of which has only been recovered and published within the last few years. George, bishop of the Arab tribes, writing to a friend in the year 714, is aware that the author was a certain "Persian sage," *ḥakkîmâ Phârsâyâ*, and discusses his date and position in the church,[16] but does not think of identifying him with Jacob of Nisîbis.

Aphraates. Later writers are better informed. Bar-Hebræus knows the name of Pharhâdh as the author;[17] 'Abhd-îshô' gives the older form of Aphrahaṭ or Ἀφραάτης[18]; and he also cited by name by Elias of Nisîbis (11th century) in his *Chronicle*.[19] The real author of the twenty-two alphabetical *Homilies* and the separate homily "On the Cluster" is now, therefore, known to have been Aphraates, a Persian Christian, who took the name of Jacob, and was subsequently famous as "the Persian sage." He was probably bishop of the convent of Mâr Matthew near Mosul, and composed his works, as he himself tells us, in the years 337, 344, and 345, during the great persecution under Sapor II.[20]

Ephraim Syrus. A junior contemporary of Aphraates was Ephraim,[21] commonly called Ephraem Syrus, "the prophet of the Syrians," the most celebrated father of the Syrian Church and certainly one of its most voluminous and widely read writers. He was born of heathen parents at Nisîbis, but became the pupil of the bishop Jacob, and finished his education at Edessa. The incidents of his career are too well known to need recapitulation here.[22] His death took place in June, 373.[23] His works have been largely translated into Greek,[24] Armenian, Coptic, Arabic, and Ethiopic.[25] They consist of commentaries on the Scriptures, expository sermons, and a vast mass of metrical homilies and hymns on every variety of theological subject.[26] Many of these last are composed in his favorite seven-syllable metre, in stanzas of different length; but he frequently used other metres and mixed strophic arrangements.[27] Of Ephraim's commentaries on the Old Testament but little has reached us in the original Syriac.[28] Most of what has been published in *Ephraemi Opera Syr.*, vols. i. and ii., is derived from a large *Catena Patrum*, compiled by one Severus, a monk of Edessa, in 861.[29] Of his commentary on the *Dia-ṭessarôn*, preserved only in an early Armenian translation, we have spoken above (p. 864). In the same language there is extant a translation of his commentary on the Pauline epistles.[30] Vol. ii. of the Roman edition contains some exegetical discourses (pp. 316–395), the number of which has been largely increased by Overbeck (*S. Ephraemi Syri*, etc., *Opera Selecta* pp. 74–104). In the same work will be found two of the discourses against early heresies addressed to Hypatius and Domnus (pp. 21–73; comp. Wright, *Catal.*, p. 766, col. 2), two tracts on the love of the Most High (pp. 103–112), and the epistle to the monks who dwelt in the mountains (pp. 113–131). Of metrical writings the same book contains (pp. 339–354) the hymns against Julian the Apostate (pp. 1–20), and the conclusion of the hymns on Paradise (wanting in the Roman ed., vol. iii. 598).[31] Other metrical homilies were published by Zingerle;[32] but far more important, as having a real historical interest, are the *Carmina Nisibena*, or "Hymns relating to the City of Nisībis," edited by Bickell in 1866. These poems, which deal in great part with the history of Nisībis and its bishops and of adjacent cities (such as Anzīṭ or Hanzīṭ, Edessa, and Ḥarrān), were composed, according to Bickell (Introd., p. 6 *sq.*), between the years 350 and 370 or thereabouts.[1] A large quantity of hitherto unpublished matter is also contained in Lamy, *S. Ephraemi Syri Hymni et Sermones*, vol. i., 1882, and vol. ii., 1886,—*e.g.*, fifteen hymns on the Epiphany, a discourse on our Lord, several metrical homilies (in particular for Passion week, the Resurrection, and New or Low Sunday), hymns on the Passover or unleavened bread (*De Azymis*) and on the Crucifixion, acts of Ephraim from the Paris MS. Ancien fonds, 144, commentaries on portions of the Old Testament, other metrical homilies, and hymns on the nativity, the Blessed Virgin Mary, Lent, etc. The so-called *Testament* of Ephraim[2] has been printed in the *Opera Græca*, ii. pp. 395–410 (with various readings at p. 433), and again by Overbeck (*op. cit.*, pp. 137–156).[3]

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[1] See Merx, *Bardesanes von Edessa*, 1868; Hilgenfeld, *Bardesanes, der letzte Gnostiker*, 1864; Hahn, *Bardesanes Gnosticus Syrorum primus Hymnologus*, 1819.

[2] So the *Chronicon Edessenum*, in Assemani, *B.O.*, i. 389, and Bar-Hebræus, *Chron. Eccles.*, i. 47; but Elias of Nisîbis, as cited by Abbeloos in his notes on Bar-Hebræus, *loc. cit.* places his birth in 134.

[3] Bar-Hebræus, *Chron. Eccles.*, i. 47.

[4] E.g., *Opera Syr.*, ii. 439 D, 553 F, last line.

[5] Compare the hymn in the Syriac Acts of St. Thomas (Wright, *Apocryphal Acts*, p. 274); Lipsius, *Die Apocryphen-Apostelgeschichten und-Apostellegenden*, i. 292 *sq.*

[6] It was first edited by Cureton, with an English translation, in his *Spicilegium Syriacum*; see also T. & T. Clark's *Ante-Nicene Christian Library*, vol. xxii. p. 85 *sq.*, and Merx, *op. cit.*, p. 25 *sq.*

[7] See S. E. Assemani, *Acta Sanctorum Martyrum*, i. 10 *sq.*, 66 *sq.*

[8] Or 'Ebêdh-yêshû', bishop of Nisîbis, whose bibliographical *Catalogue* has been edited by Abraham Ecchellensis, Rome, 1653, and by J. S. Assemani in his *B.O.*, iii. 1. There is an English translation of it by Badger, *The Nestorians*, ii. 361–379.

[9] *B.O.*, iii. 1, 51.

[10] Assemani, *Acta Sanctorum Martyrum*, i. 5; Rosen, *Catalogue*, p. 14, col. 2, aa; Overbeck, *S. Ephraemi*, etc., *Opera Selecta*, p. 424.

[11] *Kurzes Verzeichniss der Sachau'schen Sammlung syrischer Handschriften*, Berlin, 1885, p. x. and No. 108, 3.

[12] Καὶ Συρίης πέδον εἶδα καὶ ἄστεα πάντα, Νίσιβιν, Εὐφράτην διαβάς; Lightfoot, *S. Ignatius*, i. 480.

[13] This date is given by the *Chronic. Edess.* (*B.O.*, i. 395), by Dionysius of Tell-Maḥrê (*ibid.*, p. 17), by the so-called *Liber Chalipharum* (in Land, *Anecd. Syr.*, i. 4), by Elias of Nisîbis (see Abbeloos's note in Bar-Hebræus, *Chron. Eccles.*, ii. 31), and inferentially by Ephraim (Bickell, *S. Ephraemi Syri Carmina Nisibena*, p. 20).

[14] In his *De Viris Illustribus*, written before 496.

[15] Published by N. Antonelli (Rome, 1756) with a Latin translation, and reprinted in Gallandius, *Bibl. Vet. Patrum*, vol. v. The mistake has passed (no doubt through the Arabic) to the Ethiopic translation of the fifth homily; see Zotenberg, *Catal. des MSS. Ethiopiens de la Bibl. Nat.*, p. 248, col. 2, No. 17.

[16] See De Lagarde, *Anal. Syr.*, p. 108: *The Homilies of Aphraates*, ed. Wright, p. 19; Ryssel, *Ein Brief Georgs, Bischofs der Araber*, 1883.

[17] *Chron. Eccles.*, ii. 34.

[18] *B.O.*, iii. 1, 85.

[19] See Wright, *Aphraates*, p. 38.

[20] Wright, *Aphraates*, pp. 440 and 507; comp. Sasse, *Prolegomena in Aphr. Sap. Pers. Sermones Homileticos*, 1878; J. Forget, *De Vita et Scriptis Aphr., Sap. Persæ*, 1882; Bickell in Thalhofer, *Bibliothek der Kirchenväter*, 102 and 103, where eight of the homilies are translated.

[21] More correctly Aphrêm.

[22] See the *Acta S. Ephraemi* in the Roman ed. of his works by Peter Mobârak (Petrus Benedictus) and the Assemanis, pp. xxiii.-lxiii.; and comp. Bickell, *Conspectus*, p. 26, note 11.

[23] See the various authorities cited by Assemani, *B.O.*, i. 54, note; Bickell, *Carmina Nisibena*, p. 9, note; Gabriel Cardâḥî, *Liber Thesauri de Arte Poetica Syrorum*, 1875, pp. 9–18.

[24] Even Photius speaks with respect of the rhetorical talent of Ephraim, so far as he could judge of it from these imperfect translations (ed. Bekker, p. 160).

[25] See *B.O.*, i. 149 *sq.*

[26] *Ibid.*, i. 63–149; iii. 1, 61.

[27] Compare, for instance, Bickell, *Carm. Nisib.*, Introd., p. 31. The Syrian line consists of a certain fixed number of syllables, four, five, six, seven, eight, twelve, etc. In the older writers there is no intentional rime, which first appears, we believe, among the Westerns, in Antonius Rhetor (9th century). Real metres, like those of the Greeks and Arabs, coupled in the latter case with rime, were wholly unknown to the Syrians. Hebrew poetry barely rises, as regards outward form, beyond the level of Arabic rimed prose; the Syrians, whilst destitute of rime, at least imposed upon themselves the restraint of a limited but fixed number of syllables.

[28] Genesis and Exodus in Cod. Vat. cx., and five leaves of Genesis in Cod. Vat. cxx. (see Assemani, *Catal.*, iii. p. 125).

[29] Cod. Vat. ciii., Brit. Mus. Add. 12144. Severus used for Genesis a commentary different from that in Cod. Vat. cx.; see Bickell, *Conspectus*, p. 19; comp. Pohlmann, *S. Ephraemi Syri Commentariorum in s. scripturam textus in codd. vatt. manuscriptus et in edit. Rom. impressus*, 2 parts, 1862–64.

[30] See Bickell, *Conspectus*, p. 20.

[31] The last hymn (p. 351) is genuine, as the very fact of its being an acrostic shows (see Bickell, *Conspectus*, p. 19); whereas the metrical homily on the baptism of Constantine (pp. 355–361) is certainly spurious (Bickell, *loc. cit.*).

[32] *S. P. Ephraemi Syri Sermones duo*, Brixen, 1869 (see *B.O.*, i. 149, col. 1, No. 31); *Monumenta Syriaca ex Romanis Codd. collecta*, i. 4

Ephraim's pupils.

Notwithstanding his vast fecundity and great popularity as a theological writer, Ephraim seems not to have had any pupils worthy to take his place. In the *Testament* we find mentioned with high commendation the names of Abhā, Abraham, Simeon, Mārā of Aggēl, and Zenobius of Gĕzīrtā,[4] to whom we may add Isaac[5] and Jacob.[6] Two, on the other hand, are named with decided reprobation as heretics, namely, Paulonas (Παυλωνᾶς) or Paulinus (Παυλῖνος) and Arwadh or Arwaṭ.[7] Of these, Abhā is cited by later writers and compilers as the author of a commentary on the Gospels, a discourse on Job, and an exposition of Ps. xlii. 9.[8] Paulonas or Paulinas is probably the same who is mentioned by 'Abhd-īshō'[9] as having written "*madhrāshē* or metrical homilies, discourses against inquirers, disputations against Marcion, and a treatise concerning believers and the creed." Zenobius, who was deacon of the church of Edessa, according to the same authority,[10] composed treatises against Marcion and Pamphylius (?), besides sundry epistles. He was also the teacher of Isaac of Antioch, of whom we shall speak shortly.

Balai and Cyrillōnā.

Better known than any of these disciples of Ephraim are two writers who belong to the close of this century and the beginning of the next, Balai and Cyrillōnā. The date of Balai or Balæus, chorepiscopus (as it seems) of the diocese of Aleppo, is fixed by his being mentioned by Bar-Hebræus[11] after Ephraim, but before the time of the council of Ephesus (431). Acacius, bishop of Aleppo, whom he celebrates in one of his poems, must, therefore, as Bickell says,[12] be the same Acacius who had a share in converting Rabbūlā to Christianity,[13] and died at an extreme old age (it is said 110 years) in 432. His favorite metre was the pentasyllabic, which is known by his name, as the heptasyllabic by that of Ephraim, and the twelve-syllable line by that of Jacob of Sĕrūgh. Some of his poems have been edited by Overbeck in the often cited collection *S. Ephraemi Syri*, etc., *Opera Selecta*, pp. 251–336, namely, a poem on the dedication of the newly built church in the town of Ḳenneshrīn (Ḳinnesrīn), five poems in praise of Acacius, the late bishop of Aleppo, the first and eighth homilies on the history of Joseph, specimens of prayers, and a fragment on the death of Aaron.[14] Cyrillōnā composed a poem "on the locusts, and on (divine) chastisement, and on the invasion of the Huns,"[15] in which he says: "The North is distressed and full of wars; and if Thou be neglectful, O Lord, they will again lay me waste. If the Huns, O Lord, conquer me, why do I seek refuge with the martyrs? If their swords lay me waste, who do I lay hold on Thy great Cross? If Thou givest up my cities unto them, where is the glory of Thy holy Church? A year is not yet at an end since they came forth and laid us waste and took my children captive; and lo, a second time they threaten our land that they will humble it." Now the invasion of the Huns took place in 395,[16] and this poem must have been written in the following year (396). The few remaining writings of Cyrillōnā, composed in various metres, have been edited by Bickell in the *Z.D.M.G.*, xxvii. p. 566 *sq.*, and translated by him in Thalhofer's *Bibliothek*, 41, pp. 9–63.[17] Bickel[18] is inclined to identify this Cyrillōnā with another writer of the same period, 'Abhsamyā, a priest of Edessa, Ephraim's sister's son and a pupil of Zenobius; but his reasons do not seem to us sufficient. The *Chron. Edess.* (*B.O.*, i. 401) states that 'Abhsamyā composed his hymns and discourses on the invasion of the Huns in 404; and Dionysius of Tell-Maḥrē (*B.O.*, i. 160) speaks of him in the year 397. Bar-Hebræus is less precise as to the date; after mentioning the death of Chrysostom (in 407), he adds that about this time Theodore of Mopsuestia died (429) and 'Abhsamyā flourished, who "composed many discourses in the (heptasyllabic) metre of Mār Ephraim" on the invasion of the Huns.[19] That 'Abhsamyā may have taken the name of Cyrillōnā at his ordination is of course possible, but it seems strange that none of these three writers should have mentioned it, if such were the case. On Bar-Hebræus's statement regarding the metre which he used in his discourses we do not insist; he might easily make a mistake in such a matter.

'Abhsamyā.

Abbot Gregory.

During the latter part of the 4th century, too, there lived in the island of Cyprus the abbot Gregory, who appears to have been sent thither from some monastery in Palestine as the spiritual head of the Syriac-speaking monks in the island.[20] He cherished friendly relations with Epiphanius, afterwards bishop of Salamis or Constantia (367–403), and a monk named Theodore. To these are addressed several of his discourses and letters; others are general exhortations to the monks under his charge.[21] The discourses seem to be only portions of a work on the monastic life, which has not come down to us in a complete form, the "book" mentioned by 'Abhd-īshō' in *B.O.*, iii. 1, 191. In the letters he addresses Epiphanius as an older man speaking with authority to a younger; it is to be presumed, therefore, that they were written before Epiphanius became bishop.

Lives of saints and martyrs.

With the 5th century commences the native historical literature of Syria. Previous to this time there existed martyrologies and lives of saints, martyrs, and other holy men, drawn up, in part at least, to meet the requirements of the services of the church. Such are, for example, the ancient martyrology in a manuscript of 411[22]; the *Doctrine of Addai*, in its present shape a product of the latter half of the 4th century[23]; the *Hypomnemata of Sharbēl*; and the *Martyrdoms of Bar-samyā, Bishop of Edessa, and the Deacon Ḥabbībh*, which all belong to about the same period.[24] This

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(*B. O.*, *loc. cit.*, No. 30). Zingerle has rendered many of Ephraim's works into German, *e.g.*, *Die heilige Muse der Syrer: Gesänge des h. Kirchenvaters Ephraem*, 1833; *Gesänge gegen die Grübler über die Geheimnisse Gottes*, 1834; *Festkränze aus Libanons Gärten*, 1846; *Des h. Kirchenvaters Ephraem ausgewählte Schriften, aus d. Griechischen und Syrischen uebersetzt*, 6 vols., 2d ed., 1845–47; *Die Reden des h. Ephraem gegen die Ketzer*, 1850; *Reden des h. Ephraem des Syrers über Selbstverläugnung und einsame Lebensweise, mit einem Briefe desselben an Einsiedler*, 1871. Translations into English have been attempted, though with less success, by Morris (*Select Works of S. Ephraem the Syrian*, 1847) and Burgess (*Select Metrical Hymns and Homilies of Ephraem Syrus*, 1853; *The Repentance of Nineveh*, etc., 1853).

[1] Comp. Bickell, *Conspectus*, p. 28, note 21.

[2] See *B.O.*, i. 141, No. 8.

[3] That it has been interpolated by a later hand is shown by the long and purposeless digression on Moses and Pharaoh (*Op. Gr.*, ii. 405) and the story of Lamprotate at the end (*ibid.*, p. 409), as also by the stanzas regarding the vine which Ephraim saw growing out of his mouth when he was an infant (*ibid.*, p. 408).

[4] *B.O.*, i. 38, 144.

[5] *Ibid.*, i. 165.

[6] See Wright, *Catal.*, p. 992, col. 2, No. 36.

[7] Also written ܐܪܢܘܛ = Ārnūṭ and ܐܘܪܝܛ — Ūrīṭ. See Overbeck's text, p. 147, and the variants, p. xxx. The name seems to have been hopelessly corrupted by the scribes.

[8] See Wright, *Catal.*, pp. 831, col. 1, and 1002, col. 1.

[9] *B.O.*, iii. 1, 170.

[10] *Ibid.*, i. 168; iii. 1, 43.

[11] In a passage cited by Assemani, *B.O.*, i. 166. Cardāhi (*Liber Thes.*, pp. 25–27) places Balai's death in 460, but gives, as usual, no authority. This seems too late.

[12] *Conspectus*, p. 21; Thalhofer, *Bibliothek der Kirchenvater*, 41, p. 68.

[13] Overbeck, *S. Ephraemi Syri*, etc., *Opera Selecta*, p, 162, l. 20.

[14] See also Wenig, *Schola Syriaca, Chrestomathia*, pp. 160–162; Bickell, *Conspectus*, p. 46, note 5; Thalhofer, *Bibliothek*, 41, p. 67, and 44.

[15] See Wright, *Catal.*, p. 671, col. 1, No. 5, *a*.

[16] See *Chron. Edess.* in *B.O.*, i. 400, No. xl.; Dionysius of Tell-Maḥrē, *ibid.*, note 1; and an anonymous continuer of Eusebius in Land's *Anecd. Syr.*, i. 8, l. 2. Joshua Stylites (ed. Wright, p. 10, l. 1) specifies A. Gr. 707, which began with October, 395.

[17] See also Wright, *Catal.*, pp. 670–671; Overbeck, *S. Ephraemi*, etc., *Opera Selecta*, pp. 379–381; Bickell, *Conspectus*, p. 34; Cardāhi, *Liber Thes.*, pp. 27–29, who places his death in 400.

[18] See his *Conspectus*, p. 21; Thalhofer, *Bibl.*, 41, pp. 13, 16 (in the note).

[19] Bar-Hebræus, *Chron. Eccles.*, i. 133.

[20] See *B.O.*, i. 170–171.

[21] *Ibid.*, i. 172.

[22] Brit. Mus. Add. 12150, f. 252, edited by Wright in the *Journal of Sacred Literature*, 1865–66, viii. 45, 423; see the *Acta Sanctorum*, October, vol. xii. 183–185. It can hardly be later than the middle of the 4th century.

[23] Edited in part by Cureton, in his *Ancient Syriac Documents*, from MSS. of the 5th and 6th centuries in the British Museum; and in full by Phillips from a MS. of the 6th century at St. Petersburg, 1876. See also *Lettre d'Abgar ou Histoire de la Conversion des Édesséens*, translated from the Armenian version, Venice, 1868; Lipsius, *Die Edessenische Abgar-Sage*, 1880; Matthes, *Die Edessenische Abgar-Sage*, 1882; Mösinger, *Acta SS. Martyrum Edessenorum Sarbelii*, etc., No. 1, 1874.

[24] See Cureton, *Anc. Syr. Doc.*, and Lipsius, *Die Edess. Abgar-Sage*, p. 41 *sq.*

Mārūthā of Maiperkaṭ.

Aḥā.

sort of legendary writing was carried on to a much later date.[1] The *History of Bēth Sĕlōkh and its Martyrs*, for instance, can hardly have been composed before the 6th century, if so early;[2] and the *Acts of Mārī* must be still later.[3] No larger collection of such documents had, however, been attempted before the time of Mārūthā, bishop of Maiperkaṭ,[4] a man of much weight and authority, who was twice sent by the emperor Theodosius II. on embassies to the Persian monarch Yazdegerd I., and presided at the councils of Seleucia or Ctesiphon, under the catholics Isaac and Yabhalāhā respectively.[5] He is said, too, to have been a skilful physician.[6] To him 'Abhd-īshō' assigns the following works,[7]—"A book of martyrdoms, anthems and hymns on the martyrs, and a translation of the canons of the council of Nicæa, with a history of that council." The last named of these he undertook at the request of Isaac, catholicus of Seleucia, who died in 416.[8] The canons which pass under his name are those of the council of Seleucia in 410.[9] But his great work was the *Book of Martyrs*, containing accounts of those who suffered for the Christian faith under Sapor II., Yazdegerd I., and Bahrām V., to which he prefixed two discourses on the glory of the martyrs and on their torments. One of these narratives claims to have been recorded by an eye-witness, Isaiah, the son of Ḥadhbō (or Ḥadhabhū), of Arzan ('Αρζανηνή), one of the Persian king's horsemen.[10] Portions of this work survive in the British Museum in MSS. of the 5th and 6th centuries, as well as in some of later date both there and in the Vatican. They have been edited by S. E. Assemani in the first volume of the *Acta Sanctorum Martyrum*, 1748.[11] The commentary on the Gospels mentioned by Assemani is really by Mārūthā, the maphriān of Taghrīth (Tekrīt), who is also the author of the anaphora or liturgy.[12] Of him we shall have occasion to speak afterwards (see p. 838 *infra*). It is possible too that some of the above-mentioned Acts may belong not to the work of Mārūthā but to that of Aḥā, the successor of Isaac in the see of Seleucia, who likewise wrote a history of the Persian martyrs and a life of his teacher 'Abhdā, the head of the school in the monastery of Dōr-Ḳōnī or Dair-Ḳunnā (where the apostle Mārī was buried).[13]

Nestorian schism.

Rabbūlā.

About this time evil days came upon the Christian church in Syria. Paul of Samosāta, Diodore of Tarsus, and Theodore of Mopsuestia had paved the way for Nestorius. The doctrines of these writers were warmly espoused by many of the Syrian theologians; and the warfare raged for many years in and around Edessa, till it ended in the total destruction of the great Persian school by the order of the emperor Zeno (488–489).[14] Rabbūlā, a native of Ḳen-neshrīn (Ḳennesrīn), whose father was a heathen priest but his mother a Christian, was converted to Christianity by Eusebius, bishop of Ḳen-neshrīn, and Acacius, bishop of Aleppo. He voluntarily gave up all his property, forsook his wife, and became a monk in the convent of Abraham near his native city. On the death of Diogenes, bishop of Edessa, he was appointed his successor (411–412). His admiring biographer depicts him as a model bishop, and he certainly appears to have been active and energetic in teaching and preaching and attending to the needs of the poor.[15] In the theological disputes of the day he seems at first to have sided, if not with Nestorius, at least with those who were averse to extreme measures, such as John, patriarch of Antioch, and his partisans; but afterwards he joined the opposite party, and became a warm champion of the doctrines of Cyril, which he supported at the council of Edessa (431). From this time onward he was a stanch opponent of Nestorianism, and even resorted to such an extreme measure as burning the writings of Theodore of Mopsuestia. Hence Ibas in his letter to Mārī speaks of him as "the tyrant of Edessa," and Andrew of Samosāta, writing to Alexander of Hierapolis in 432, complains bitterly of his persecution of the orthodox (*i.e.*, the Nestorians). He died in August, 435.[16] Of the writings of Rabbūlā but little has come down to us. There is a sermon extant in manuscript,[17] enjoining the bestowing of alms on behalf of the souls of the dead and prohibiting all feasting on the occasion of their commemoration. Another sermon, preached at Constantinople, is directed against the errors of Nestorius.[18] There are also extant canons and orders addressed to the monks and clergy of his diocese,[19] and a number of hymns, of which Overbeck has printed some specimens.[20] He also rendered into Syriac Cyril's treatise *De Recta in Dominum nostrum J. C. Fide ad Theodosium Imperatorem*[21] from a copy which was sent to him by the author.[22] His biographer intended to translate into Syriac a collection of forty-six of his letters, written in Greek "to priests and emperors and nobles and monks[23];" but of these only a few remain, *e.g.*, to Andrew of Samosāta, condemning his treatise against the twelve anathemas of Cyril[24]; to Cyril, regarding Theodore of Mopsuestia[25]; and to Gemellinus of Perrhē, about certain monks and other persons who misused the sacred elements as ordinary food.[26]

Ibas.

Rabbūlā was succeeded in the see of Edessa (435) by Īhībhā or Hībhā (Græcized) Ibas,[27] who in his younger days had been one of the translators of Theodore's works in the Persian school.[28] This, with his letter to Mārī the Persian[29] and other utterances, led to his being charged with Nestorianism. He was acquitted by the two synods of Tyre and Beirūt, but condemned by the second council of Ephesus (449),[30] and Nonnus was substituted in his room. He was restored, however, at the end of two years by the council of Chalcedon, and sat till October, 457, when he was succeeded by Nonnus,[31] who in his turn was followed by Cyrus in 471. Besides the writings above-mentioned, 'Abhd-īshō' attributes to Ibas[32] "a commentary on Proverbs, sermons and metrical homilies (*madhrāshē*), and a disputation with a heretic"; but none of these appear to have come down to us.

Acacius of Āmid.

During this stormy period the name of Acacius, bishop of Āmid, is mentioned as the author of certain epistles.[33] The great event of his life, which is referred by Socrates (bk. vii. 21) to the year 422, is thus briefly recorded in the *Martyrologium Romanum Gregorii XIII.* (Malines, 1859), 9th April: "Amidæ in Mesopotamia sancti Acatii episcopi, qui pro redimendis captivis etiam ecclesiæ vasa conflavit ac vendidit." The said captives were Persian subjects, who were thus ransomed and sent back to their king and country.[34]

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[1] See Hoffmann, *Auszüge aus syr. Akten pers. Märtyrer*.

[2] See Mösinger, *Monumenta Syr.*, ii. 63, and Hoffmann, *op. cit.*, p. 45.

[3] See Abbeloos, *Acta S. Maris*, 1885, p. 47, where, as Nöldeke has pointed out, the writer confounds Ardashēr, the first king of the Sâsânian dynasty, with the last king of that line, Yazdegerd III., who was overthrown by the Arabs in the battle of Nihâwand, A.H. 21 (642 A.D.).

[4] Called by the Greeks Martyropolis, in Syriac Mēdhīnath Sāhdē, and by the Arabs Maiyâfârikîn.

[5] See *B.O.*, i. 174 *sq.*; Bar-Hebræus, *Chron. Eccles.*, i. 121, ii. 45, 49.

[6] *B.O.*, iii. 1, 73, and note 4.

[7] *Ibid.*, *loc. cit.*

[8] *Ibid.*, i. 195.

[9] See Lamy, *Concilium Seleuciæ et Ctesiphonti habitum anno* 410; comp. S. E. Assemani, *Codd. MSS. Orient. Bibl. Palat. Medic.*, p. 94.

[10] *B.O.*, i. 15.

[11] See also *B.O.*, i. 181–194. There is a German translation by Zingerle, *Echte Acten der h. Märtyrer des Morgenlandes*, 2 vols., 1836.

[12] *B.O.*, i. 179.

[13] *Ibid.*, ii. 401, iii. 1, 369; also Abbeloos, *Acta S. Maris*, pp. 72 *sq.*, 88.

[14] *B.O.*, i. 353, 406.

[15] See his biography in Overbeck, *S. Ephraemi*, etc., *Opera Selecta*, p. 159 *sq.*, especially pp. 170–181; translated by Bickell, in Thalhofer's *Bibliothek*, Nos. 102–104.

[16] *B.O.*, i. 403.

[17] *Codd. MSS. Orient. Bibl. Palat. Medic.*, p. 107.

[18] See Overbeck, *S. Ephraemi*, etc., *Opera Selecta*, pp. 239–244; translated by Bickell.

[19] *Ibid.*, pp. 210–221.

[20] *Ibid.*, pp. 245–248, 362–378.

[21] See Wright, *Catal.*, p. 719.

[22] Comp. the letter of Cyril to Rabbūlā, Overbeck, *op. cit.*, pp. 226–229.

[23] See Overbeck, *op. cit.*, p. 200.

[24] *Ibid.*, p. 222.

[25] *Ibid.*, p. 223, a fragment.

[26] *Ibid.*, pp. 230–238. The shorter fragment should follow the longer one.

[27] *B.O.*, i. 199.

[28] *Ibid.*, iii. 1, 85; Wright, *Catal.*, pp. 107, col. 2, 644, col. 1.

[29] See Labbe, *Concil.*, ix. 51; Mansi, vii. 241.

[30] The so-called λῃστρικὴ σύνοδος or *latrocinium Ephesinum*. Of the first session of this council a portion is extant in Syriac in Brit. Mus. Add. 12156 ff. 51b-61a (written before 562), containing the acta in the cases of Flavian of Antioch and Eusebius of Dorylæum. Add. 14530 (dated 535) contains the second session, comprising the acta in the cases of Ibas, his nephew Daniel of Harrân, Irenæus of Tyre, Aquilinus of Byblus, Sophronius of Tellâ or Constantina, Theodoret of Cyrrhus, and Domnus of Antioch. These documents have been translated into German by Hoffmann, *Verhandlungen der Kirchenversammlung zu Ephesus am* xxii. *August* CDXLIX., etc., 1873; into French by Martin, *Actes du Brigandage d'Éphèse*, 1874; and into English (with the assistance of a German scholar) by the Rev. S. G. F. Perry, *The Second Synod of Ephesus*, 1881. See also Martin, *Le Pseudo-Synode connu dans l'Histoire sous le nom de Brigandage d'Éphèse*, etc., 1875; and Perry, *An Ancient Syriac Document purporting to be the record in its chief features of the Second Synod of Ephesus*, etc., part i., 1867. Mr. Perry printed a complete edition of the Syriac text at the Clarendon Press, Oxford, but no one seems to know what has become of the copies. The copies of the English translation were purchased at the sale of Mr. Perry's library by Mr. Quaritch.

[31] *B.O.*, i. 257.

[32] *Ibid.*, iii. 1, 86. These are of course utterly ignored by Assemani in vol. i.

[33] *Ibid.*, iii. 1, 51.

[34] *Ibid.*, i. 195–196.

Acacius was doubtless a favorer of Nestorianism, for his letters were thought worthy of a commentary by Mārī, bishop of Bēth Hardashēr,[1] the correspondent of Ibas.[2]

Isaac of Antioch.

About the same time rose one of the stars of Syriac literature, Isaac, commonly called the Great, of Antioch.[3] He was a native of Āmid, but went as a young man to Edessa, were he enjoyed the teaching of Zenobius, the disciple of Ephraim.[4] Thence he removed to Antioch, where he lived as priest and abbot of one of the many convents in its immediate neighborhood. In his younger days he would seem to have travelled farther than most of his countrymen, as it is stated that he visited Rome and other cities.[5] With this agrees what is recorded by Dionysius of Tell-Maḥrē[6] as to his having composed poems on the secular games celebrated at Rome in 404, and on the capture of the city by Alaric in 410, which shows that he took a more than ordinary interest in the Western capital. Isaac died in or about 460, soon after the destruction of Antioch by the earthquake of 459, on which he wrote a poem.[7] Isaac's works are nearly as voluminous and varied as those of Ephraim, with which indeed they are often confounded in MSS. and in the Roman edition.[8] They were gathered into one corpus by the Jacobite patriarch John bar Shūshan or Susanna, who began in his old age to transcribe and annotate them, but was hindered from completing his task by death (1073).[9] Assemani has given a list of considerably more than a hundred metrical homilies from MSS. in the Vatican.[10] Of these part of one on the Crucifixion was edited by Overbeck,[11] and another on the love of learning by Zingerle.[12] But it has been left to Bickell to collect and translate all the extant writings of this Syrian father and to commence the publication of them. Out of nearly 200 metrical homilies his first volume contains in 307 pages only fifteen, and his second brings us in 353 pages only as far as No. 37.[13] Some of these poems have a certain historical value, such as the second homily on fasting, probably written soon after 420,[14] the two homilies on the destruction of the town of Bēth Ḥūr by the Arabs (*c.* 457),[15] and the two against persons who resort to soothsayers.[16] Others possess some interest as bearing on the theological views of the author, who combats the errors of Nestorius and Eutyches.[17] One of the longest and most wearisome is a stupendous poem of 2137 verses on a parrot which proclaimed ἅγιος ὁ Θεός in the streets of Antioch.[18] Another on repentance runs to the length of 1929 verses. In prose Isaac seems to have written very little; at least Bickell[19] mentions only "various questions and answers, an ascetic narrative and ascetic rules."

Dādhā.

Concerning Isaac's contemporary Dādhā we know but little.[20] He was a monk from the neighborhood of Āmid, who was sent by the people of that city to Constantinople on account of the ravages of war and famine, to obtain remission of the taxes or some similar relief, and was well received by the emperor. He is said to have written about three hundred tracts on various topics connected with the Scriptures and on the saints, besides poems (*madhrāshē*).

Simeon the Stylite.

Here, too, we may record the name of Simeon the Stylite, who died in 459 or soon after.[21] The Monophysites contend that he held their theological views, and accordingly we find in a MS. of the 8th century a letter of his to the emperor Leo regarding Theodoret of Cyrrhus, who had come to him and tried to pervert him to the opinions of the Dyophysites,[22] and in another MS., of about the same age, three letters to the emperor Leo, to the abbot Jacob of Kaphrā Rĕḥīmā, and to John I., patriarch of Antioch, all tending to prove that he rejected the council of Chalcedon.[23] A third MS., of the 6th century, contains certain "precepts and admonitions" addressed by him to the brethren.[24] There is extant in very old MSS.[25] a *Life* of Simeon, full of absurd stories, which has been edited by S. E. Assemani in the *Acta Sanctorum Martyrum*, vol. ii. 268 *sq.* At the end of it (p. 394) there is a letter by one Cosmas,[26] priest of the village of Panīr, written in the name of his congregation to the Stylite, promising implicit obedience to all his precepts and orders, and requesting his prayers on their behalf; but there is nothing whatever to show that this Cosmas was the author of the *Life* or had any share in writing it.[27]

Dādh-īshō'.

About this time we find Dādh-īshō', the catholicus of Seleucia (421–456),[28] composing his commentaries on the books of Daniel, Kings, and Bar-Sīrā or Ecclesiasticus.[29] But the chief seat of Nestorian scholarship and literary activity was still the Persian school of Edessa, where Bar-ṣaumā and other teachers were actively engaged in defending and propagating their peculiar tenets.

Bar-ṣaumā of Nisībis.

Bar-ṣaumā, if we may believe the scurrilous Monophysite Simeon of Bēth-Arshām,[30] was originally the slave of one Mārā of Bēth Kardū,[31] and bore at Edessa the nickname of *Sāḥē bēth ḳĕnaiyā.*[32] He was at Edessa in 449, when his expulsion was called for by the rabble.[33] In what year it actually took place we do not know, but we afterwards find him busy in the East under the catholicus Bābhōyah or Babusæus (from about 457 to 483)[34] and his successor Acacius (from about 484 to 496), during which period he was bishop of Nisībis.[35] Of his personal character and worth this is not the place to attempt to form a judgment; but the reader should beware of placing implicit trust in the statements of bitter and unscrupulous theological opponents like Simeon of Bēth Arshām, Bar-Hebræus, and Assemani. Bar-Ṣaumā does not appear to have written much, as 'Abhd-īshō'[36] mentions only parænetic and funeral sermons, hymns of the class called *turgāmē*,[37] metrical homilies (*madhrāshē*), letters, and an anaphora or liturgy.

Narsai.

A fellow-worker with him both at Edessa and Nisībis was Narsai (or Narsē), of Ma'allĕ'thā or Ma'althāyā.[38] whom Simeon of Bēth Arshām calls "the Leper,"[39] whereas his co-sectarians style him "the Harp of the Holy Spirit." He was especially famous as a writer of hymns and other metrical compositions, his favorite metre being that of six syllables.[40] He fled from Edessa to escape the wrath of the bishop Cyrus (471–498), probably in the year 489, and died at Nisībis early in the next century.[41] Narsai's works, as enumerated by 'Abhd-īshō',[42] consist of commentaries on the first four books of the Pentateuch, Joshua, Judges, and Ecclesiastes, Isaiah and the twelve minor prophets, Jeremiah, Ezekiel, and Daniel, twelve volumes of metrical discourses (360 in number),[1] a liturgy, expositions of the order of celebrating the Eucharist and of baptism, parænetic and funeral sermons, hymns of several sorts,[2] and a book entitled *On the Corruption of Morals*.

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[1] Bēth Hardashēr or Bēth Hartashēr, in Persian Weh-Ardashēr or Beh-Ardashēr, Arabicized Bahurasīr, close by Seleucia, on the right bank of the Tigris. See Hoffmann, *Verhandlungen der Kirchenversammlung zu Ephesus*, etc., p. 93, note 160.

[2] *B.O.*, iii. 1, 172.

[3] *Ibid.*, i. 207–234; Bickell, in Thalhofer's *Bibliothek*, No. 44, and *Conspectus*, p. 22.

[4] That he is identical with Isaac, the disciple of Ephraim (as some have supposed), seems wholly unlikely. He may possibly have seen Ephraim in the flesh, but this is very doubtful, considering the date of his own death. Even Jacob of Edessa appears to have got into some confusion on this subject (see Wright, *Catal.*, p. 603, col. 2).

[5] Land, *Anecd. Syr.*, iii. 84.

[6] *B.O.*, i. 208–209; see *Dionysii Telmahharensis Chronici liber I.*, ed. Tullberg, 1850, p. 52, and *Eusebii Canonum Epitome ex Dionysii Telm. Chronico petita*. by C. Siegfried and H. Gelzer, 1884, p. 29. The difficulty was first cleared up by Scaliger, who in his *Thesaurus Temporum, Animadv.* No. MDLXIV., proposed σηκλαρίων.

[7] *B.O.*, i. 211.

[8] See Bickell, *Conspectus*, p. 23, note.

[9] *B.O.*, i. 214–215, ii. 355; Bar-Hebræus, *Chron. Eccles.*, i. 447.

[10] *B.O.*, i. 214–234.

[11] *S. Ephraemi Syri*, etc., *Opera Selecta*, pp. 379–381.

[12] *Monumenta Syriaca*, i. 13–20; see also some extracts in Zingerle's *Chrestom. Syr.*, pp. 299 *sq.*, 387 *sq.* Zingerle has translated large portions of the homilies on the Crucifixion into German in the *Tübinger Theolog. Quartalschrift*, 1870, i. Further, Cardāḥī *Liber Thes.*, pp. 21–25.

[13] *S. Isaaci Antiocheni, Doctoris Syrorum, Opera Omnia*, ed. G. Bickell, part i., 1873; part ii., 1877. We hope soon to receive the remaining parts at his hands.

[14] *B.O.*, i. 227; Bickell, i. 280.

[15] *B.O.*, i. 225; Bickell, i. 207, 227.

[16] Bickell, ii. 205 *sq.*

[17] See Bickell's translations in Thalhofer's *Bibliothek*, 44.

[18] Bickell, i. 85.

[19] *Opera*, i. p. viii.

[20] See Land, *Anecd. Syr.*, iii. 84.

[21] See Bar-Hebræus, *Chron. Eccles.*, i. 142, 181, and note 2; *B.O.*, i. 252, 405.

[22] Wright, *Catal.*, p. 951, No. xxix.

[23] *Ibid.*, p. 966, No. 33.

[24] *Ibid.*, p. 1158, col. 1.

[25] *E.g.*, Cod. Vat. clx., transcribed 473; Brit. Mus. Add. 14484, of the 6th century.

[26] *B. O.*, i. 237.

[27] Assemani is also mistaken in supposing that the *Life* was composed at the request of Simeon, the son of Apollonius, and Bar-Ḥāṭar (?), the son of Ūdhān (Uranius ?). These are merely the persons who paid for the writing of this portion of Cod. Vat. clx.

[28] See Bar-Hebræus, *Chron. Eccles.*, ii. 57, note 1.

[29] *B.O.*, iii. 1, 214.

[30] *Ibid.*, i. 351.

[31] On the left bank of the Tigris, over against Jazīrat Ibn 'Omar.

[32] "The Swimmer, or Bather, among the Reeds," meaning "the wild boar." See Hoffmann, *Verhandl. d. Kirchenversam. zu Ephesus*, etc., p. 91, note 114.

[33] Hoffmann, *op. cit.*, p. 14; Bar-Hebræus, *Chron. Eccles.*, ii. 55, note 1.

[34] Bar-Hebræus, *Chron. Eccles.*, ii. 57, note 1.

[35] See *B.O.*, iii. 1, 66, note 7, compared with i. 351, note 4, and ii. 407, note 2.

[36] *Ibid.*, iii. 1, 66.

[37] See Badger, *The Nestorians*, ii. 19.

[38] Hoffmann, *Auszüge*, p. 208; Badger, *The Nestorians*, i. 174.

[39] Perhaps in a spiritual sense only, though Assemani thinks otherwise; see *B.O.*, i. 352, and note 5, 354; iii. 1, 63.

[40] *B.O.*, iii. 1, 65, note 6.

[41] See Bar-Hebræus, *Chron. Eccles.*, ii. 77; *B.O.*, ii. 407.

[42] *B.O.*, iii. 1, 65, 66.

Māri the Persian.

Māri the Persian has been already mentioned as the correspondent of Ibas. Besides the commentary on the epistles of Acacius (see above, p. 869), he wrote a commentary on the book of Daniel and a controversial treatise against the magi[3] of Nisibis.[4]

Acacius of Seleucia.

Acacius, catholicus of Seleucia (*c.* 484–496), composed discourses on fasting and on the faith, as also against the Monophysites, and translated into Persian for the king Ķawādh a treatise on the faith by Elisha, bishop of Nisibis, the successor of Bar-ṣaumā.[5] Assemani tries hard to cleanse Acacius from the stain of Nestorianism, but, as Abbeloos remarks,[6] "vereor ne Æthiopem dealbare voluerit; nam omnia tum Jacobitarum tum Nestorianorum monumenta, quæ ipse recitat, contrarium testantur."

Mīkhā.

Mīkhā or Micah, another member of the band of exiled Edessenes,[7] became bishop of Lāshōm.[8] He wrote a commentary on the books of Kings, a discourse on his predecessor Sabhr-ishō', another on a person whose name is written Ķnṭropos,[9] and a tract entitled *The Five Reasons of the Mautĕbhĕ*.[10]

Yazīdādh.

To these writers may be added two others,—Yazīdādh,[11] who is also said to have belonged to the Edessene school and to have compiled "a book of collectanea (*luķķāṭē*)"[12] and Ara, who wrote a treatise against the magi or Persian priesthood, and another against the followers of Bardesānes with the contemptuous title of *Ḥabhshōshyāthā* or "the Beetles."[13]

Translations from Greek.

The Persian school at Edessa was, as we have already hinted, the chief seat of the study of Greek during the early days of the Syrian literature. Of the most ancient translators we know nothing; but the oldest MSS. are Edessene, viz., the famous MS. in the British Museum, Add. 12150, dated towards the end of 411, and the equally well known codex at St. Petersburg, written in 462. The former contains the *Recognitiones* of Clement, the discourses of Titus of Bostra against the Manichees, the *Theophania* of Eusebius, and his history of the confessors in Palestine; the latter, the *Ecclesiastical History* of Eusebius. Now, as the text presented by these MSS. has evidently passed through the hands of several successive scribes, it seems to follow that these books were translated into Syriac in the lifetime of the authors themselves, or very soon after, for Eusebius died in 340 and Titus in 371. Very likely the one or the other may have had a friend at the chief seat of Syriac learning who was willing to perform for him the same kind office that Rabbūlā undertook for Cyril.[14] A little later on our information becomes fuller and more exact.

Ma'nā.

Ma'nā,[15] a Persian by race,[16] from the town of Bēth Hardashēr, was resident at Edessa in the earlier part of the 5th century, and is mentioned by Simeon of Bēth Arshām among the distinguished Nestorian scholars whom he holds up to ridicule.[17] His nickname was *Shāthē ķeṭmā*, "the Drinker of Ashes." Ma'nā devoted himself to the task of translating into Syriac the commentaries of Theodore of Mopsuestia during the lifetime of that great theologian, who did not die till 429. He must, however, have withdrawn from Edessa at a comparatively early period, as he was bishop of Persis[18] prior to 420, in which year (the last of his reign) Yazdegerd I. made him catholicus of Seleucia in succession to Yabh-alāhā.[19] He had, it appears, translated a number of books from Syriac into Persian (Pahlavī), and thus probably ingratiated himself with the king.[20] However, he soon fell under the royal displeasure, was degraded from his office, and ordered to retire to Persis, where he resumed his former duties,[21] and so incurred the anger of Yazdegerd's successor, Pērōz.[22] Ma'nā's work, the exact extent of which is not known to us, was carried on and completed by other members of the Persian school,—such as Acacius the catholicus and Yazīdādh; John of Bēth Garmai, afterwards bishop of Bēth Sārī (or Sĕrāi ?), and Abraham the Mede, disciples of Narsai; Mīkhā, afterwards bishop of Lāshōm in Bēth Garmai; Paul bar Ķaķai (or Ķaķī), afterwards bishop of Lādhān in al-Ahwāz; 'Abhshoṭā (?) of Nineveh, and others,[23]—who are expressly said to have "taken away with them" (*appĕķ 'ammĕhōn*) from Edessa, and disseminated throughout the East, the writings of Theodore and Nestorius.[24] Ibas himself was one of these translators in his younger days (see above, p. 829). About the same time with Ma'nā's translations began the Aristotelian studies of the Syrian Nestorians. To understand and translate the writings of their favorite Greek theologians, Paul of Samosāta, Diodore of Tarsus, Theodore of Mopsuestia, and Nestorius himself, not to mention Theodoret[25] of Cyrrhus, required a considerable knowledge of the Aristotelian logic.

Probus.

Hence the labors of Probus (Πρόβος, in Syriac *Prōbhos*, *Prōbhā*, or *Prōbhē*), who translated and commented on the Περὶ ἑρμηνείας,[26] and probably treated in a similar manner other parts of the *Organon*.[27] It is not easy to fix this date precisely. 'Abhd-ishō'[28] makes him contemporary with Ibas and another translator named Kūmī. If the Berlin MS. Sachau 226 can be trusted, he was archdeacon and archiater at Antioch. Hoffmann[29] has assigned reasons for supposing him not to be anterior to the Athenian expositor Syrianus (433–450 ?).

Monophysite schism.

Whilst the Nestorians were thus making rapid progress all over the East, another heresy was spreading in the West. Eutyches had found followers in Syria, among others Bar-ṣaumā the archimandrite, a man famous for his piety and asceticism,[30] who represented the abbots of Syria, at the second council of Ephesus,[31] and was afterwards condemned by the council of Chalcedon.[32]

Bar-ṣaumā, the archimandrite.

He died in 458.[33] His life was written by his disciple Samuel, in much the same style as that of Simeon Stylites, and is extant in several MSS. in the British Museum.[34] His memory has always been held in the greatest reverence by the Jacobites. The Armenians, according to

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[1] Some of these are probably contained in the Berlin MSS. Sachau, 174–176 (*mēmrē dha-mĕdhabbĕrānūthā*, on the life of our Lord) and 219 (two poems on Joseph, and two others).

[2] Two of them are often found in the Nestorian Psalter. See, for example, Brit. Mus. Add. 7156 (Rosen. *Catal.*, p. 12, col. 2, No. 3a, c) and Add. 17219 (Wright, *Catal.*, p. 134, col. 2, No. 3 a, c).

[3] *Mĕghūshē*, from *magu*, *mag*, the Persian priesthood, the head of whom in each district was the *magupat*, *mogpet*, or *mōbedh*. See Nöldeke, *Geschichte der Perser und Araber zur Zeit der Sasaniden*, p. 450.

[4] *B.O.*, iii. 1, 171.

[5] *Ibid.*, iii. 1, 389. Elisha is called by some authorities Hosea; *ibid.*, ii. 407, iii. 1, 429.

[6] Bar-Hebræus, *Chron. Eccles.*, ii. 74, note 2.

[7] *B.O.*, i. 352–353. His enemies gave him the nickname of Dagon.

[8] Now Lāsim, a short distance southwest of Dāķūķ or Tā'ūķ, in Bēth Garmai; see Hoffmann, *Auszüge*, p. 274.

[9] Vocalized Ķentropos or Ķantropos; *B.O.*, iii. 1, 170, l. 2.

[10] Meaning probably the division of the Psalter into three kathismata (Bickell, *Conspectus*, p. 92); see *B.O.*, iii. 1, 71, note 2.

[11] For Yazed-dādh or Izad-dādh, like Yazed-panāh, Yazed-bōzedh; see Hoffmann, *Auszüge*, p. 88, No. 796.

[12] *B.O.*, iii. 1, 226.

[13] Of Ara we seem to know absolutely nothing; his very *floruit* is uncertain, and he may have belonged to the previous century; *B.O.*, iii. 1, 230.

[14] See above, p. 869, and compare Merx, "De Eusebianæ Historiæ Eccles. Versionibus, Syriaca et Armeniaca," in *Atti del IV. Congresso Internazionale degli Orientalisti*, Florence, 1880, i. 199 *sq.*, especially pp. 201–202. It may here be mentioned that the literature of Armenia is largely indebted in its earliest days to that of Syria, not only for the translation of Eusebius's *Eccles. History*, but for such works as the *Doctrine of Addai* and the *Homilies* of Aphraates, wrongly ascribed to Jacob of Nisibis.

[15] So the name is written by Māri bar Shĕlēmōn, whom Assemani follows, *B.O.*, iii. 1, 376, pronouncing it, however, Ma'nē or Maanes. Elias of Nisibis also gives Ma'nā (Bar-Hebræus, *Chron. Eccles.*, ii. 53, note 2); but Bar-Hebræus himself (*loc. cit.*) has Maghnā, which Abbeloos Latinizes Magnes.

[16] His Persian name is unknown to us.

[17] *B.O.*, i. 352.

[18] Bar-Hebræus, *Chron. Eccles.*, ii. 55, 63.

[19] *B.O.*, ii. 401.

[20] *Ibid.*, iii. 1. 376.

[21] Bar-Hebræus, *Chron. Eccles.*, ii. 63.

[22] *B.O.*, ii. 402; iii. 1, 377.

[23] *Ibid.*, i. 351–354.

[24] *B.O.*, i. 350; iii. 1, 226, note 8.

[25] His *Eranistes* (of which the fourth book is a *demonstratio per syllogismos* of the incarnation) appears as the name of an *author* in 'Abhd-ishō''s *Catalogue* (*B.O.*, iii. 1, 41), under the form of Eranistatheos, or something similar.

[26] See Hoffmann, *De Hermeneuticis apud Syros Aristoteleis*, 1869. MSS.,—Berlin, Alt. Best. 36, 9, 10; Brit. Mus. Add. 14660. The translation may possibly be even anterior to Probus.

[27] Berlin, Sachau 226, 1, is described as "Isagoge des Porphyrius, von Probus, Presbyter, Archidiacon, und Archiater in Antiochien"; and in the same MS., No. 8, is "Erklärung der Analytica von Probus," with an "Einleitung in d. Erkl. d. Anal. von Probus," No. 7.

[28] *B.O.*, iii. 1, 85.

[29] *Op. cit.*, pp. 144–145. The name of Fūbri or Phubrius, which appears as a variation of Probus in Hottinger (*B.O.*) in Assemani (*B.O.*, iii. 1, 85, note 5), in Renan (*De Philosophia Peripatetica apud Syros*, p. 14), and in other books on this subject, has nothing to do with that of Probus, but is an error for Ķuwairī, Abū Isḥāķ Ibrāhīm, a Syro-Arabian Aristotelian who lived about the beginning of the 10th century. See the *Fihrist*, p. 262; Ibn Abī Oṣaibi'ah, i. 234; Wüstenfeld, *Gesch. d. Arab. Aerzte*, p. 24, No. 62, "Futheri oder Fubri."

[30] All "hypocrisy" in the eyes of Assemani, *B.O.*, ii. 2; "scelestissimus pseudo-monachus," p. 9.

[31] Bar-Hebræus, *Chron. Eccles.*, i. 161–165; Hoffmann, *Verhandl. d. Kirchenversammlung zu Ephesus*, etc., p. 4, l. 39.

[32] Bar-Hebræus, *loc. cit.*, 179.

[33] *Ibid.*, 181.

[34] *B.O.*, ii. 296, also p. cxlviii. No. 3; Wright, *Catal.*, p. 1123.

Assemani,[1] keep his commemoration on the 1st of February, the Syrians and Copts on the 3d. The decisions of the council of Chalcedon produced an immediate and irreparable breach in the Eastern Church; and the struggle of the rival factions was carried on with desperate fury alike at Constantinople, Antioch, and Alexandria. In Syria the persecution of the Monophysites was violent during the years 518–521, under the emperor Justin, and again in 535 and the following years, under Justinian, when they seemed in a fair way of being completely crushed by brute force.

Jacob of Sĕrūgh.

The first name to be mentioned here, as belonging to both the 5th and 6th centuries, is that of Jacob of Sĕrūgh, one of the most celebrated writers of the Syrian Church,[2] "the flute of the Holy Spirit and the harp of the believing church." There are no less than three biographies of him extant in Syriac,—the first, by his namesake Jacob of Edessa;[3] the second, anonymous;[4] the third, a lengthy metrical panegyric, said to have been written for his commemoration[5] by a disciple of his named George.[6] This, however, seems, from the whole tone of the composition, to be unlikely, and Bickell is probably right in supposing the author to be George bishop of Sĕrūgh, a contemporary of Jacob of Edessa.[7] Jacob was born at Kurtam, "a village on the river Euphrates," probably in the district of Sĕrūgh, in 451. His father was a priest, and, as his parents had been childless for many years, his birth was regarded as a reward for their alms, prayers, and vows. Whether he was educated at Edessa or not, he soon acquired a great reputation for learning and eloquence. He appears to have led a life of quiet work and study, and to have devoted himself in particular to literary composition. He became periodeutes of Ḥaurā in Sĕrūgh, whence we find him writing to the Christians of Najrān, and to the city of Edessa when threatened by the Persians.[8] As periodeutes he is mentioned in eulogistic terms by Joshua the Stylite[9] (503). In 519, when sixty-eight years old, he was made bishop of Baṭnān, the chief town of Sĕrūgh, where he died on 29th November, 521. Jacob's prose writings are not numerous.[10] A liturgy is ascribed to him, and an order of baptism, the former of which has been translated by Renaudot,[11] the latter edited by J. A. Assemani.[12] Further, he composed six festal homilies, one of which has been published by Zingerle,[13] who has also translated the whole of them into German;[14] a discourse showing that we should not neglect or despise our sins;[15] another for the night of Wednesday in the third week of Lent;[16] and some short funeral sermons.[17] To him we also owe a life of Mār Ḥannīnā (died in 500), addressed to one Philotheus.[18] Of his letters a considerable number have been preserved, particularly in two MSS. in the British Museum, Add. 14587 and 17163, ff. 1–48.[19] Of these Martin has edited and translated the three epistles to the monks of the convent of Mār Bassus at Ḥārim,[20] with a reply by the monks, and another letter to Paul, bishop of Edessa, from all of which it is evident that Jacob always was a Monophysite, and continued such to his death.[21] The letter to Stephen bar Ṣūdh-ailē is given, with an English version, by Frothingham;[22] and that to the Himyarite Christians of Najrān has been edited and translated by Schröter in the *Z.D.M.G.*, xxxi. (1877), p. 360 *sq.* It belongs to the year 519 or 520.[23] According to Bar-Hebræus,[24] he also wrote "a commentary on the six centuries of Evagrius, at the request of Mār George, bishop of the (Arab) tribes, who was his disciple." As George, bishop of the Arab tribes, was a contemporary of Jacob of Edessa, this statement seems to rest on some misapprehension; at all events no such work now exists. The paucity of Jacob's prose writings is more than compensated by a flood of metrical compositions, mostly in dodecasyllabic verse, or the four-syllable line thrice repeated. "He had," says Bar-Hebræus,[25] "seventy amanuenses to copy out his metrical homilies, which were 760[26] in number, besides commentaries and letters and odes (*madhrāshē*) and hymns (*sughyāthā*)." Of these homilies more than the half have perished, but nearly 300 are still preserved in European collections.[27] Very few of them have as yet been published, though many of them are by no means devoid of interest.[28] Indeed Jacob is on the whole far more readable than Ephraim or Isaac of Antioch.

Philoxenus of Mabbōgh.

Very different from the gentle and studious bishop of Sĕrūgh was his contemporary and neighbor, the energetic and fiery Philoxenus of Mabbōgh. Aksĕnāyā or Philoxenus was a native of Taḥal, somewhere in Bēth Garmai, and studied at Edessa in the time of Ibas.[29] He was ordained bishop of Hierapolis or Mabbōgh (Manbij) by Peter the Fuller, patriarch of Antioch, in 485, and devoted his life to the advocacy of Monophysite doctrine. Twice he visited Constantinople in the service of his party, and suffered much (as was to be expected) at the hands of its enemies, for thus he writes in later years to the monks of the convent of Sĕnūn near Edessa: "What I endured from Flavian and Macedonius, who were archbishops of Antioch and of the capital, and previously from Calendion, is known and spoken of everywhere. I keep silence both as to what was plotted against me in the time of the Persian war among the nobles by the care of the aforesaid Flavian the heretic, and also as to what befell me in Edessa, and in the district of the Apameans, and in that of the Antiochians, when I was in the convent of the blessed Mār Bassus, and again in Antioch itself; and when I went up on two occasions to the capital, like things were done to me by the Nestorian heretics."[30] He succeeded at last in getting rid of his enemy Flavian in 512, and in the same year he presided at a synod in which his friend Severus was ordained patriarch of Antioch.[31] His triumph, however, was but short-lived, for Justin, the successor of Anastasius, sentenced to banishment in 519 fifty-four bishops who refused to accept the decrees of the council of Chalcedon, among whom were Severus, Philoxenus, Peter of Apamea, John of Tellā, Julian of Halicarnassus, and Mārā of Āmid. Philoxenus was exiled to Philippopolis in Thrace,[32] and afterwards to Gangra in Paphlagonia, where he was murdered about the year 523. The Jacobite Church commemorates him on 10th December, 18th February, and 1st April. Philoxenus, however, was something more than a man of action and of strife: he was a scholar and an elegant writer. Even Assemani, who never misses an opportunity of reviling him,[1] is obliged to own (*B.O.*, ii. 20) "scripsit Syriace, si quis alius, elegantissime, atque adeo inter optimos hujusce linguæ scriptores a Jacobo Edesseno collocari meruit." Unfortunately scarcely any of his numerous works have as yet been printed.[2] To him the Syriac Church owed its first revised translation of the Scriptures (see above, p. 865); and he also drew up an anaphora[3] and an order of baptism.[4] Portions of his commentaries on the Gospels are contained in two MSS. in the British Museum.[5] Besides sundry sermons, he composed thirteen homilies on the Christian life and character, of which there are several ancient copies in the British Museum. Of his controversial works the two most important are a treatise *On the Trinity and the Incarnation* in three discourses,[6] and another, in ten discourses, showing "that one (Person) of the Trinity became incarnate and suffered"[7]; but there are many smaller tracts against the Nestorians and Dyophysites.[8] His letters are numerous and may be of some value for the ecclesiastical history of his time. Assemani enumerates and gives extracts from several of them,[9] but none of them have as yet been printed in full, with the exception of that to Abū Nafīr of Ḥērtā (al-Ḥīrah),[10] to the monks of Tell-ʽAddā,[11] and to the priests Abraham and Orestes of Edessa regarding Stephen bar Ṣūdhailē.[12]

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[1] *B.O.*, ii. 9; comp. Wright, *Catal.*, p. 175, col. 2, No. 8, and p. 311, No. ccclxxxvii.

[2] *B. O.*, i. 283 *sq.*; Matagne, in *Acta Sanctorum*, October, vol. xii. 824, 927; Abbeloos, *De Vita et Scriptis S. Jacoby Batnarum Sarugi in Mesopotamia epi.*, 1867; Bickell, *Conspectus*, p. 25; Bickell in Thalhofer, *Bibl. d. Kirchenväter*, 58; Martin, "Lettres de Jacques de Saroug aux Moines du Couvent de Mar Bassus, et à Paul d'Edesse," in *Z.D.M.G.*, xxx. (1876), p. 217.

[3] *B.O.*, i. 286, 299; Martin, in *Z.D.M.G.*, xxx. p. 217, note 3.

[4] Abbeloos, *op. cit.*, p. 311.

[5] See Wright, *Catal.*, p. 311, No. ccclxxxix. The Armenians hold it on 25th September, the Jacobites on 29th June, 29th July, and 29th October.

[6] Abbeloos, *op. cit.*, p. 24, *B.O.*, i. 286, 340.

[7] See Bickell in Thalhofer, *Bibl.*, 58, p. 196.

[8] Wright, *Catal.*, p. 520, Nos. 15, 16.

[9] *Chronicle*, ed. Wright, ch. liv. Joshua wrote in 507.

[10] *B.O.*, i. 300–306.

[11] *Liturgg. Orientt. Collectio*, ii. 356.

[12] *Cod. Liturg. Eccl. Univers.*, ii. 309, iii. 184.

[13] *Mon. Syr.*, i. 91.

[14] *Sechs Homilien des h. Jacob von Sarug*, 1867.

[15] Wright, *Catal.*, p. 826, No. 16; comp. the Index, p. 1293, col. 1.

[16] *Ibid.*, p. 844, No. 32.

[17] *Ibid.*, p. 864, col. 2.

[18] *Ibid.*, p. 1113, No. 14; p. 1126, No. 16.

[19] *Ibid.*, Nos. dclxxii., dclxxiii., and comp. the Index, p. 1293, col. 1.

[20] *Ibid.*, p. 602, col. 2.

[21] See Martin, *Z.D.M.G.*, xxx. (1876), pp. 217–219.

[22] See his *Stephen bar Sudaili the Syrian Mystic and the Book of Hierotheos*, Leyden, 1886, p. 10 *sq.*

[23] See Guidi, *La Lettera di Simeone Vescovo di Bēth-Arsām sopra i Martiri Omeriti*, 1881, p. 11.

[24] *Chron. Eccles.*, i. 191.

[25] *Loc. cit.*

[26] Jacob of Edessa says 763, of which that on the chariot of Ezekiel was the first, and that on Mary and Golgotha the last, which he left unfinished; see *B.O.*, i. 299; Abbeloos, *De Vita*, etc., p. 312.

[27] Comp. *B.O.*, i. 305–339; Abbeloos, *op. cit.*, pp. 106–118.

[28] Zingerle has given extracts in the *Z.D.M.G.*, xii., xiii., xiv., xv., and xx., and in his *Chrest. Syr.*, pp. 360–386. The homily on Simeon Stylites has been published by Assemani in the *Acta S. Martyrum*, ii. 230 *sq.*; that on virginity, fornication, etc., by Overbeck, *S. Ephraemi Syri*, etc., *Opera Selecta*, p. 385 *sq.*; that on Alexander the Great (perhaps spurious) by Knös, *Chrest. Syr.*, 1807, p. 66 *sq.* (there is a German translation by A. Weber, *Des Môr Yakûb Gedicht über den gläubigen König Alexandrûs*, 1852); on Habbībh and on Guryā and Shamûnā, Edessene martyrs, with a *sūghīthā* on Edessa, by Cureton, *Ancient Syriac Documents*, pp. 86–96; on Sharbēl by Mösinger, *Mon. Syr.*, ii. 52, and on the chariot of Ezekiel, with an Arabic translation, *ibid.*, p. 76; two on the Blessed Virgin Mary by Abbeloos, *De Vita*, etc., pp. 206–301; on Jacob at Bethel, on our Lord and Jacob, the church and Rachel, Leah and the synagogue, on the two birds (Lev. xiv. 4), on the two goats (Lev. xvi. 7), and on Moses's vail (Exod. xxxiv. 33) by Zingerle, *Mon. Syr.*, i. 21–90; on Tamar by J. Zingerle, 1871; on the palace which St. Thomas built for the king of India in Heaven (perhaps spurious) by Schröter, in *Z.D.M.G.*, xxv. 321, xxviii. 584; on the fall of the idols by Martin, in *Z.D.M.G.*, xxix. 107; on the baptism of Constantine (perhaps spurious) by Frothingham, in the *Atti della Accademia dei Lincei* for 1881–82 (Rome, 1882). Bickell has translated into German (in Thalhofer, *Bibl.*, 58) the first homily on the Blessed Virgin Mary, that on Jacob at Bethel, on Moses's vail, and on Guryā and Shamûnā. Some of Jacob's homilies are extant in Arabic, and even in Ethiopic. His prayer as a child see in Overbeck, *op. cit.*, p. 382.

[29] *B.O.*, i. 353.

[30] *Ibid.*, ii. 15; comp. the mention of him at Edessa by Joshua the Stylite in 498, *Chronicle*, ed. Wright, chap. xxx.

[31] *Ibid.*, pp. 17, 18.

[32] He was living there when he wrote to the monks of Sĕnūn in 522; *B. O.*, ii. 20.

Stephen bar Sūdhailē.

Contemporary with Jacob of Sĕrūgh and Philoxenus of Mabbōgh was the pantheist Stephen bar Sūdhailē,[13] with whom both of these writers corresponded,[14] and regarding whom the latter wrote the above-mentioned letter to the priests Abraham and Orestes. This man was the author of the work entitled *The Book of Hierotheus*, which he published under the name of Hierotheus, the teacher of St. Dionysius of Athens,[15] and exercised a strong influence on the whole pseudo-Dionysian literature.[16] Theodosius, patriarch of Antioch (887–896), wrote a commentary on the *Hierotheus*.[17] Bar-Hebræus too made copious extracts from it, which he arranged and illustrated with a commentary chiefly derived from that of Theodosius.[18]

Joshua the Stylite.

At the same time with Jacob of Sĕrūgh and Philoxenus, and in the same neighborhood, lived one of the earliest and best of the Syrian historians, the Stylite monk Yēshūʽ or Joshua. Of him we know nothing but that he originally belonged to the great convent of Zuḳnīn near Amid, that at the beginning of the 6th century he was residing at Edessa, and that he dedicated his *Chronicle* of the Persian War[19] to an abbot named Sergius. His approving mention of Jacob[20] and Philoxenus[21] shows that he was a Monophysite. Joshua's *Chronicle* would have been entirely lost to us, had it not been for the thoughtfulness of a later writer, Dionysius of Tell-Maḥrē (d. 845), who incorporated it with his account of the reign of Anastasius in the smaller redaction of his own *History*. It was first made known to us by Assemani (*Bibl. Orient.*, i. 260–283), who gave a copious analysis with some extracts; and it is now generally acknowledged to be one of the best, if not actually the best, account of the great war between the Persian and Byzantine empires during the reigns of Ḳawādh and Anastasius (502–506).[22] To the indefatigable Abbé Martin belongs the credit of publishing the *editio princeps* of the Syriac text.[23] The work was written in the year 507, immediately after the conclusion of the war, as is shown by the whole tone of the last chapter; and it is much to be regretted that the author did not carry out his intention of continuing it, or, if he did, that the continuation has perished.

Simeon Ḳūḳāyā.

The interest which Jacob of Sĕrūgh took in every branch of literature was the means of bringing into notice a hymn-writer of humble rank, the deacon Simeon Ḳūḳāyā, a potter by trade, as his name denotes. This man lived in the village of Gēshīr,[24] not far from the convent of Mār Bassus, and while he worked at his wheel composed hymns, which he wrote down on a tablet or a scroll, as might be convenient. Jacob heard of him from the monks, paid him a visit, admired his hymns, and took away some of them with him, at the same time urging the author to continue his labors.[25] A specimen of these *Ḳūḳāyāthā* has been preserved in the shape of nine hymns on the nativity of our Lord, Brit. Mus. Add. 14520, a MS. of the 8th or 9th century.[26]

Simeon of Bēth Arshām.

About the same time flourished Simeon, bishop of Bēth Arshām,[27] commonly called *Dārōshā Phārsāyā* or "the Persian Disputant." This keen Monophysite[28] was one of the few representatives of his creed in the Persian territory, and exhibited a wonderful activity, mental and bodily, on behalf of his co-religionists, traversing the Babylonian and Persian districts in all directions, and disputing with Manichees, Daisanites, Eutychians, and Nestorians.[29] After one of these disputations, at which the Nestorian catholicus Bābhai (498–503) was present,[30] Simeon was made bishop, a dignity which he had declined on several previous occasions. He visited Ḥērtā (al-Ḥīrah) more than once, and died during his third residence at Constantinople, whither he had come to see the empress Theodora.[31] Assemani states, on the authority of Dionysius of Tell-Maḥrē, that he was bishop of Bēth Arshām from 510 to 515, but the Syriac passage which he quotes merely gives the *floruit* of 510. If, however, the statements of John of Ephesus, who knew him personally, be correct, he was probably made bishop before 503, the date of Bābhai's decease.[32] His death must have taken place before 548, in which year Theodora departed this life. Besides an anaphora,[33] we possess only two letters of Simeon, which are both of considerable interest. The one is entitled *On Bar-ṣaumā and the Sect of the Nestorians*;[34] it deals with the origin and spread of Nestorianism in the East, but from the bitterest and narrowest sectarian point of view.[35] The other, which is much more valuable, is addressed to Simeon, abbot of Gabbūlā,[36] and treats of the persecution of the Christians at Najrān by Dhū Nuwās, king of al-Yaman, in the year 523.[37] It is dated 524, in which year the writer was himself at Ḥērtā (al-Ḥīrah).

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[1] "Scelestissimus hæreticus" (*B. O.*, ii. 11); "flagitiosissimus homo" (p. 12); "ecclesiam Dei tanquam ferus aper devastaverit" (p. 18).

[2] *B. O.*, ii. 28 *sq.*; Wright, *Catal.*, Index, p. 1315.

[3] Renaudot, ii. 310; *B. O.*, ii. 24.

[4] *B. O.*, ii. 24.

[5] Add. 17126, dated 511, and Add. 14534, probably of equal age.

[6] The Vatican MS. (Assemani, *Catal.*, iii. p. 217, No. cxxxvii.) is dated 564; see *B. O.*, ii. 25 *sq.*

[7] *B. O.*, ii. 27 *sq.* The Vatican MS. is dated 581; that in the British Museum Add. 12164 is at least as old.

[8] See *B. O.*, ii. 45, Nos. 15–17, and Wright, *Catal.*, p. 1315.

[9] *B. O.*, ii. 30–46. Others may be found in Wright, *Catal.*, p. 1315.

[10] See Martin, *Grammatica Chrestomathia et Glossarium Linguæ Syriacæ*, p. 71.

[11] Ign. Guidi, *La Lettera di Filosseno ai Monaci di Tell ʽAddâ (Teleda)*, Reale Accademia dei Lincei, anno cclxxxii., 1884–85, Rome, 1886. In the Ethiopic literature there is extant a book entitled *Filkesyūs*, *i.e.*, Philoxenus, from the name of its author, "Philoxenus the Syrian, bishop of Manbag" (see, for example, Wright, *Catal.*, p. 177). It is a series of questions and answers on the *Paradise* of Palladius, like the Syriac work described in Wright, *Catal.*, p. 1078.

[12] See *B.O.*, ii. 30; Frothingham, *Stephen bar Sudaili*, p. 28 *sq.*

[13] So in a MS. of the 7th century (Brit. Mus. Add. 17163; see Wright, *Catal.*, p. 524). The MSS. of Bar-Hebræus (*Chron. Eccles.*, i. 221), have ܨܘܕܗܝܠܐ or ܨܘܕܥܝܠܐ. Assemani writes ܨܘܕܝܠܐ (*Sudaili*). "Hunt the deer" can of course be only a nickname of the father. See Frothingham, *op. cit.*, p. 56 *sq.*

[14] *B. O.*, i. 303, ii. 32; comp. Bar-Hebræus, *Chron. Eccles.*, i. 221.

[15] *B. O.*, ii. 120, 290, 302; Frothingham, *op. cit.*, p. 63 *sq.* The existence of any good Greek text seems to be very doubtful, see Frothingham, p. 70.

[16] *B. O.*, iii. 1, 18; Frothingham, *op. cit.*, pp. 2 and 81.

[17] See MS. Brit. Mus. Add. 7189 (apparently the very copy used by Bar-Hebræus); Rosen, *Catal.*, p. 74 *sq.*; Frothingham, *op. cit.*, p. 84.

[18] Brit. Mus. Or. 1017 (Wright, *Catal.*, pp. 893–895); Bibl. Nation. Anc. fonds 138 (Zotenberg, *Catal.*, pp. 175–176); Frothingham, *op. cit.*, p. 87.

[19] Ed. Wright, p. ix.

[20] *Ibid.*, chap. liv.

[21] *Ibid.*, chap. xvi.

[22] See, for example, the use that has been made of it in De Saint-Martin's notes to Lebeau's *Hist. du Bas-empire*, vol. vii.

[23] *Chronique de Josué le Stylite*, 1876, in vol. vi. of the *Abhandlungen für de Kunde d. Morgenlandes.* Another edition was published by Wright, *The Chronicle of Jochua the Stylite*, 1882.

[24] ܓܫܝܪ or ܓܝܫܝܪ.

[25] See the narrative by Jacob of Edessa in Wright, *Catal.*, p. 602; and comp. *B. O.*, i. 121, ii. 322; Bar-Hebræus, *Chron. Eccles.*, i. 191.

[26] Wright, *Catal.*, p. 363.

[27] A village near Seleucia and Ctesiphon; Bar-Hebræus, *Chron. Eccles.*, ii. 85.

[28] Assemani has tried to whitewash him, but with little success; *B.O.*, i. 342 *sq.* If he had had before him the account of Simeon by John of Ephesus (Land, *Anecd. Syr.*, ii. 76–88), he would probably have abandoned the attempt in disgust. See Guidi, *La Lettera di Simeone Vescovo di Bêth-Arsâm sopra i Martiri Omeriti*, 1881, pp. 4–7.

[29] See Bar-Hebræus, *Chron. Eccles.*, ii. 85, i. 189; comp. *B. O.*, i. 341, ii. 409, iii. 1, 403.

[30] Land, *Anecd. Syr.*, ii. 82, l. 12.

[31] *Ibid.*, ii. 87, last line.

[32] *B. O.*, iii. 1, 427.

[33] *Ibid.*, i. 345.

[34] *Ibid.*, i. 346.

[35] First printed in *B. O.*, i. 346 *sq.*, from the Vatican MS. cxxxv. (*Catal.*, iii. 214).

[36] Al-Jabbūl. Or is it Jabbul, on the east bank of the Tigris, between an-Nuʽmāniyah and Wāsiṭ?

[37] First printed in *B. O.*, i. 364 *sq.*, according to the text offered by John of Ephesus in his *History*. There is, however, a longer and better text in a MS. of the Museo Borgiano and in Brit. Mus. Add. 14650, from which it has been re-edited (with an excellent introduction, translation, and notes) by Guidi, *La Lettera di Simeone*, etc., Reale Accademia dei Lincei, 1881. To this work the reader is referred for all the documents bearing on the subject.

John bar Cursus.

To the same age and sect as Simeon belonged John bar Cursus (Κοῦρσος)[1], bishop of Tellā or Constantina. He was a native of Callinicus (ar-Raḳḳah), of good family, and was carefully educated by his widowed mother, who put him into the army at the age of twenty. He would not, however, be hindered from quitting the service after a few years and becoming a monk. Subsequently, in 519, he was raised to the dignity of bishop of Tellā, whence he was expelled by Justin in 521. In 533 he visited Constantinople, and on his return to the East was seized by his enemies in the mountains of Sinjār, and dragged to Nisībis, Rās'ain, and Antioch, where he died in 538, at the age of fifty-five, having been for a year and six days a close prisoner in the convent of the Comes Manassē by order of the cruel persecutor Ephraim, patriarch of Antioch (529–544). His life was written by his disciple Elias (of Dārā?).[2] The Jacobite Church commemorates him on the 6th of February. Canons by John of Tellā are extant in several MSS. in the British Museum and elsewhere.[3] The questions put to him by Sergius with his replies have been published by Lamy.[4] His creed or confession of faith, addressed to the convents in and around Tellā, is found in Brit. Mus. Add. 14549 (*Catal.*, p. 431), and an exposition of the Trisagion in Cod. Vat. clix. (*Catal.*, iii. 314) and Bodl. Marsh. 101 (Payne Smith, *Catal.*, p. 463, No. 20).

Mārā III. of Āmid.

Another of the unfortunate Monophysite bishops whom Justin expelled from their sees (in 519) was Mārā of Āmid, the third bishop of the name. He was banished, with his syncelli and with Isidore, bishop of Ḳen-neshrīn (Ḳinnesrīn), in the first instance to Petra, but was afterwards allowed to go to Alexandria,[5] where he died in about eight years.[6] According to Assemani (*Bibl. Orient.*, ii. 52; comp. p. 169), Mārā wrote a commentary on the Gospels. It would seem, however, from a passage of Zacharias Rhetor,[7] that Mārā merely prefixed a short prologue in Greek to a copy of the Gospels which he had procured at Alexandria,[8] and that this MS. contained (as might be expected) the pericope on the woman taken in adultery (John viii. 2–11). That the Syriac translations of the prologue and pericope were made by himself is nowhere stated.

John bar Aphtōnyā.

Yet another sufferer at the hands of Justin was John bar Aphtōnyā (Aphthonia, his mother's name).[9] He was abbot of the convent of St. Thomas at Seleucia (apparently in Pieria, on the Orontes), which was famous as a school for the study of Greek literature. Being expelled thence, he removed with his whole brotherhood to Ḳen-neshrē (the Eagles' Nest) on the Euphrates, opposite Europus (Jerābīs), where he founded a new convent and school that more than rivalled the parent establishment, for here Thomas of Heraclea, Jacob of Edessa, and others received their training in Greek letters.[10] His *Life*, written by a disciple, is extant in Brit. Mus. Add. 12174.[11] According to Dionysius of Tell-Maḥrē, as quoted by Assemani (*loc. cit.*), he died in 538. He wrote a commentary on the Song of Songs, some extracts from which are preserved in a *Catena Patrum* in the British Museum (Add. 12168, f. 138a), a considerable number of hymns,[12] and a biography of Severus of Antioch,[13] which must have been his last work, as he survived Severus only about nine months.

Jacob Burdĕ'ānā.

We now come to the man who was the real founder of the Jacobite Church in Asia, and from whom the Jacobites took their name, Jacob bar Theophilus, surnamed "Burdĕ'ānā"[14], because his dress consisted of a *barda'thā* or coarse horse-cloth, which he never changed till it became quite ragged.[15] What Assemani could learn regarding him he has put together in the *Bibl. Orient.*, ii. 62–69[16]; since then our sources of information have been largely increased, especially by the publication of the *Ecclesiastical History* of John of Ephesus by Cureton and of the same writer's *Lives* in Land's *Anecd. Syr.*, ii.[17] On a careful study of these is based Kleyn's excellent book *Jacobus Baradæüs, de Stichter der Syrische Monophysietische Kerk*, 1882. Jacob was the son of Theophilus bar Ma'nū, a priest of Tellā or Constantina, and the child of his old age. After receiving a good education, he was entered at the monastery of Pĕsīltā (or the Quarry),[18] close by the village of Gummĕthā in Mount Īzalā (or Izlā),[19] not far from Tellā. About 527–528 he and another monk of Tellā, named Sergius, were sent to Constantinople in defence of their faith, and, being favorably received by the empress Theodora, they remained there fifteen years. Meantime the persecutions of the Monophysites, more especially that of 536–537 by Ephraim of Antioch, seemed to have crushed their party, despite all the efforts of the devoted John of Tellā and John of Hephæstus.[20] This state of matters excited the religious zeal of al-Ḥārith ibn Jabalah, the Arab king of Ghassān, who came to Constantinople in 542–543, and urged Theodora to send two or three bishops to Syria. Accordingly two were consecrated by Theodosius, the exiled patriarch of Alexandria, namely Theodore as bishop of Bostra, with jurisdiction over the provinces of Palestine and Arabia, and Jacob as bishop of Edessa, with jurisdiction over all Syria and Asia. From this time forward Jacob's life was one of ceaseless toil and hardship. He visited in person and on foot almost every part of his vast diocese, consecrating deacons and priests, strengthening the weak, and bringing back those who had erred from the true faith. But to restore the Monophysite Church bishops were necessary, and the consecration of a bishop required the presence of at least three others. Selecting a priest named Conon from Cilicia and another named Eugenius from Isauria, he travelled with them to Constantinople and thence to Alexandria, with letters of recommendation from the patriarch Theodosius. At Alexandria Conon was ordained bishop of Tarsus in Cilicia and Eugenius bishop of Seleucia in Isauria, whilst Antoninus and Antonius were consecrated for dioceses in Syria. On his return to Syria other bishops were appointed to sees there and in Asia, among the latter the historian John of Ephesus; and so the work progressed, till at last Jacob's efforts were crowned by the enthroning of his old friend Sergius as patriarch of Antioch (in 544). Sergius died in 547, and the see remained vacant for three years, after which, by the advice of Theodosius, Jacob and his bishops chose Paul, an abbot of Alexandria, to be their patriarch. Of the subsequent internal strifes among the Monophysites themselves we cannot here speak. The aged Jacob set out once more in the year 578 to visit Damian, patriarch of Alexandria, but died on the Egyptian frontier in the convent of Mār Romanus or of Casion. Here his remains rested in peace till 622, when they were stolen by the emissaries of Zacchæus, bishop of Tellā, and buried with much pomp in the monastery of Pĕsīltā.[21] His commemoration takes place on 28th November, 21st March, and 31st July. Jacob's life was too active and busy to admit of his writing much. We may mention an anaphora,[22] sundry letters,[23] a creed or confession of faith, preserved in Arabic and a secondary Ethiopic translation,[24] and a homily for the feast of the annunciation, also extant only in an Arabic translation.[25]

Sergius of Rās'ain.

Conspicuous among the scholars of this age for his knowledge of Greek, and more especially of the Aristotelian philosophy, was Sergius, priest and archiater of Rās'ain. He was, however, if Zacharias Rhetor may be trusted, a man of loose morals and avaricious.[26] He journeyed in 535 from Rās'ain to Antioch to lodge a complaint before the patriarch Ephraim against his bishop Asylus.[27] Just at this time the exiled Severus of Antioch and Theodosius of Alexandria, as well as the Stylite monk Zĕ'ōrā, were living with Anthimus of Constantinople under the protection of the empress Theodora. This alarmed Ephraim, who seems to have found a willing tool in Sergius. At any rate he sent him to Rome with letters to Agapetus, who travelled with him to Constantinople in the spring of 536, and procured the deposition and banishment of the Monophysites. Sergius died at Constantinople almost immediately afterwards, and Agapetus followed him in a few days, wherein John of Ephesus and Zacharias Rhetor clearly see the judgment of Heaven.[1] As a man of letters Sergius was to the Monophysites what Probus was to the Nestorians: he was the first[2] to make them acquainted with the works of Aristotle by means of translations and commentaries. ‘Abhd-īshō‘, it is true, gives Sergius a place in his catalogue of Nestorian writers,[3] and states that he composed "expositions of logic" or "dialectics"; but he merely does so in the same way and on the same grounds that he registers the name of Jacob of Edessa as the author of "annals and a chronicle."[4] The books were too valuable for him to insist on the heresy of the writers. In the case of Sergius there was an additional reason. The man was well known in the East,[5] many of his works being dedicated to his friend and pupil Theodore, afterwards Nestorian bishop of Marū or Merv (see p. 879 *infra*).[6] What remains of Sergius's labors is mostly contained in a single MS. of the 7th century (Brit. Mus. Add. 14658).[7] Of translations from the Greek we find in this volume the *Isagoge* of Porphyry, followed by the so-called *Tabula Porphyrii*,[8] the *Categories* of Aristotle,[9] the Περὶ κόσμου πρὸς Ἀλέξανδρον,[10] and a treatise on the soul,—not the well-known Περὶ ψυχῆς, but a wholly different tractate in five short sections. It also contains Sergius's own treatise on logic, addressed to Theodore, which is unfortunately imperfect; a tract on negation and affirmation; a treatise, likewise addressed to Theodore, *On the Causes of the Universe, according to the views of Aristotle, showing how it is a circle*; a tract *On Genus, Species, and Individuality*; and a third tract addressed to Theodore, *On the Action and Influence of the Moon*, explanatory and illustrative of Galen's Περὶ κρισίμων ἡμερῶν, bk. iii.,[11] with a short appendix "On the Motion of the Sun." Here too we find part (sections 11, 12) of his version of the *Ars Grammatica* of Dionysius Thrax, a larger portion (sections 11–20) being contained in Brit. Mus. Add. 14620 (Wright, *Catal.*, p. 802).[12] There is a scholion of Sergius on the term σχῆμα in Brit. Mus. Add. 14660 (see Wright, *Catal.*, p. 1162). In his capacity of physician, Sergius translated part of the works of Galen. Brit. Mus. Add. 14661 contains books vi.–viii. of the treatise *De Simplicium Medicamentorum Temperamentis ac Facultatibus* (Wright, *Catal.*, p. 1187),[13] addressed to Theodore; and in Brit. Mus. Add. 17156 there are three leaves, two of which contain fragments of the *Ars Medica*, and one of the treatise *De Alimentorum Facultatibus* (Wright, *Catal.*, p. 1188).[14] As one of the clergy, he wasted his time in making a translation of the works which passed under the name of Dionysius the Areopagite.[15] Brit. Mus. Add. 12151[16] contains this version with the introduction and notes of Phocas bar Sergius of Edessa,[17] a writer of the 8th century, as appears from his citing Athanasius II. and Jacob of Edessa. In Brit. Mus. Add. 22370[18] we find Sergius's own introduction and the commentary of a later writer, Theodore bar Zarūdī.[19]

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[1] The name of the father is also given as Curcus and Cyriacus. Assemani's Barsus (*B.O.*, ii. 54) is a misreading.

[2] There are two copies in the British Museum, edited by Kleyn, *Het Leven van Johannes van Tellā door Elias*, 1882; see also the *Life* by John of Asia in Land, *Anecd. Syr.*, ii. 169.

[3] *B.O.*, ii. 54.

[4] *Dissert. de Syrorum Fide et Disciplina in Re Eucharistica*, 1859, pp. 62–97.

[5] See Land, *Anecd. Syr.*, ii. 105.

[6] *Ibid.*, p. 108.

[7] *Ibid.*, iii. 250 *sq.*

[8] Compare what is said of his fine library and of its ultimate deposition at Āmid, *ibid.*, p. 245.

[9] *B.O.*, ii. 54.

[10] See Bar-Hebræus, *Chron. Eccles.*, i. 267, 289, and comp. pp. 258, 295, 321; Hoffmann, *Auszüge*, p. 162, note 1260.

[11] Wright, *Catal.*, p. 1124, No. 5.

[12] See for example, Brit. Mus. Add. 17134 (Wright, *Catal.*, p. 330).

[13] Cited in Brit. Mus. Add. 14731 (Wright, *Catal.* p. 855).

[14] Usually corrupted into Baradæus; the form Burdĕ'āyā seems to be incorrect; see Bar-Hebræus, *Chron. Eccles.*, ii. 97.

[15] See Land, *Anecd. Syr.*, ii. 375.

[16] Comp. also ii. 326, 331.

[17] The life at p. 249 is of course by John of Asia; that at p. 364 can hardly be called his in its present form, though he may have collected most of the materials; see Kleyn, *op. cit.*, pp. 34, 105 *sq.*

[18] Land, *op. cit.*, p. 365, ll. 6, 7.

[19] *Ibid.*, p. 372, l. 2.

[20] *Ibid.*, p. 176.

[21] See the account of this "translation" by Cyriacus, bishop of Mardē (Māridīn), in Brit. Mus. Add. 12174 (Wright, *Catal.*, p. 1131).

[22] Translated by Renaudot, ii. 333.

[23] Translated from the *Greek* originals in Brit. Mus. Add. 14602; see Wright, *Catal.*, p. 701; Kleyn, *op. cit.*, pp. 164–194.

[24] See the Arabic text in Kleyn, *op. cit.*, p. 121 *sq.*; the Ethiopic version has been edited by Cornill in *Z.D.M.G.*, xxx. 417 *sq.*

[25] Bodl. Hunt. 199 (Payne Smith, *Catal.*, p. 448, No. 5).

[26] Land, *Anecd. Syr.*, iii. 289, ll. 13–15; comp. Bar-Hebræus, *Chron. Eccles.*, i. 207.

[27] Bar-Hebræus (*Chron. Eccles.*, i. 205) has Ascolius (see also *B. O.*, ii. 323), but Asylus is correct; see *Anecd. Syr.*, iii. 289, l. 6, and Kleyn, *Johannes van Tella*, p. 59, l. penult.

Paul of Callinicus.

If Sergius was the Probus of the Monophysites, their Ma‘nā was Paul, bishop of Callinīcus (ar-Rakkah),[20] who, being expelled from his see in 519, betook himself to Edessa and there devoted himself to the task of translating the works of Severus into Syriac. We know for certain[21] that he edited versions of the correspondence of Severus and Julian of Halicarnassus on the corruptibility or incorruptibility of the body of Christ, with a discourse of Severus against Julian[22]; of the treatise against the *Additions* or *Appendices* of Julian,[23] and against the last apology of Julian[24]; of that against the Manichees; and of the *Philalethes*.[25] Probably by him are the older translations of the *Homiliæ Cathedrales*[26] and that of the correspondence of Sergius Grammaticus and Severus regarding the doctrine of the two natures in Christ,[27] possibly, too, the translation of the treatise against John Grammaticus of Cæsarea[28] and of some other works which are known to us only by a few scattered citations.[29] Hence he is called by the Jacobites *M'ĕphashshĕḳānā dhakhĕthābhĕ*, "the Translator of Books."[30]

Civil Laws of the Emperors.

This seems the proper place to make mention of a most important though anonymous work, the translation of the so-called *Civil Laws of the Emperors Constantine, Theodosius, and Leo*, which lies at the root of all subsequent Christian Oriental legislation in ecclesiastical, judicial, and private matters.[31] The Syriac version, made from a Greek original, exists in two manuscripts,[32] the older of which undeniably belongs to the earlier part of the 6th century. The work itself appears, according to the researches of Bruns (*op. cit.*, pp. 318–319), to date from the time of the emperor Basiliscus (Brit. Mus. Add. 475–477), who was a favorer of the Monophysites; the Syriac translation is ascribed to a Monophysite monk of Mabbōgh or Hierapolis (*ibid.*, p. 155). The Paris MS. probably represents a Nestorian revision of the 9th or 10th century at (Baghdad) Baghdādh (*ibid.*, p. 166). The oldest MS. of the secondary Arabic version is dated 1352 (*ibid.*, p. 164), but it has been traced back to the time of the Nestorian lawyer Abu 'l-Faraj ‘Abdallāh ibn aṭ-Ṭaiyib (who died 1043), whether made by him or not (*ibid.*, p. 177). It belongs to the same class as the London Syriac, but is based on a better text, such as that of the fragment in Brit. Mus. Add. 18295 (*ibid.*, p. 172).[1] Of the secondary Armenian translation the same is to be said as of the Arabic. The oldest MS. of it dates from 1328, but it probably goes as far back as the end of the 12th century (*ibid.*, p. 164). The Georgian version, of which there is a MS. at St. Petersburg, is most likely an offshoot of the Armenian.

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[1] Land, *Anecd. Syr.*, ii. 19; iii. 290.

[2] Bar-Hebræus, *Chron. Syr.*, 62 (trans., p. 59); see also the *Hist. Dynast.*, 150 (trans., p. 94) and 264 (trans., p. 172).

[3] *B. O.*, iii. i. 87.

[4] *Ibid.*, 229.

[5] He may even be identical with the Sergius mentioned by Agathias as residing at the Persian court, where he translated into Greek a history of the kings of Persia; see *B. O.*, iii. 1, 87, note 3; Renan, *De Philosophia Peripatetica apud Syros*, 1852, pp. 24–25.

[6] *B. O.*, iii. 1, 147; Renan, *op. cit.*, p. 29.

[7] Wright, *Catal.*, p. 1154 *sq.*; comp. Renan, *op. cit.*, p. 25 *sq.*; *Journ. Asiat.*, 1852, 4th series, vol. xix. p. 319 *sq.*

[8] There is a fragment of the *Isagoge* also in Brit. Mus. Add. 1618 (Wright, *Catal.*, p. 788).

[9] In the Vatican MS. clviii. (*Catal.*, iii. 306, No. vi.) this translation is wrongly ascribed to Jacob of Edessa, who could hardly have been more than a boy at the time when the MS. in the British Museum was transcribed. Besides, the version is not in his style. The Paris MS. Ancien fonds 161 naturally repeats this mistake (Zotenberg, *Catal.*, p. 202). In *Catal. Bibl. Palat. Medic.*, cod. cxcvi., it is likewise erroneously attributed to Ḥonain ibn Isḥāk (comp. Renan, *De Philos. Peripat. ap. Syros*, p. 34, note 3). The Berlin MS. Alt. Best. 36 contains as No. 7 a treatise of Sergius on the *Categories* addressed to Philotheus.

[10] Edited by Lagarde, *Anal. Syr.*, p. 134 *sq.*; see V. Ryssel, *Ueber den textkritischen Werth d. Syr. Uebersetzungen griechischer Klassiker*, part i. 1880, part ii. 1881. In part i. p. 4 Professor Ryssel speaks of this version as "ein Meisterwerk der Uebersetzungskunst"; and in part ii. p. 10 he says: "Die Uebersetzung der Schrift περὶ κόσμου schliesst sich aufs engste an den Text des griechischen Originales an. Dass wir deshalb diese Uebersetzung als eine im besten Sinne wortgetreue bezeichnen können, zeigt schon eine Vergleichung mit der lateinischen Bearbeitung des Apulejus von Madaura." This opinion serves to rectify the judgment of Ibn Abī Oṣaibi‘ah (i. 204) that Sergius was only a mediocre translator, and that his work needed revision by the later Ḥonain ibn Isḥāk.

[11] See Sachau, *Inedita Syr.*, pp. 101–126.

[12] This identification is due to Merx; see *Dionysii Thracis Ars Grammatica*, ed. Uhlig, p. xliv. *sq.* Merx has treated of an old, but independent, Armenian version in the same book, p. lvii. *sq.*

[13] See Merx's article in *Z.D.M.G.*, xxxix. (1885), p. 237 *sq.*

[14] See Sachau, *Ined. Syr.*, pp. 88–94.

[15] See Frothingham, *Stephen bar Sudaili*, p. 3.

[16] See Wright, *Catal.*, p. 493.

[17] *B. O.*, i. 468. Assemani erroneously places him before Jacob of Edessa.

[18] See Wright, *Catal.*, p. 500.

[19] There are also old MSS. of Sergius's version in the Vatican, *Catal.*, iii. Nos. cvii. (p. 56), ccliv. (p. 542). Bar-Hebræus states (*Hist. Dynast.*, p. 158; transl., p. 99) that Sergius translated into Syriac the *Syntagma* of the Alexandrian priest and physician Aaron, and added to it two books; but Steinschneider (*Al-Fārābī*, p. 166, note 2) says that this is a mistake, and that the real author of the two additional books was the Arabic translator Māsarjawaihi or Māsarjis. The translator of the Geoponica, *Al-Falāḥah ar-Rūmīyah* (Leyden, cod. 414 Warn.; *Catal.*, iii. 211) and joint translator of the Μεγάλη σύνταξις of Ptolemy (Leyden, cod. 680 Warn.; *Catal.*, iii. 80), by name Serjis or Serjūn (Sergius or Sergōnā) ibn ar-Rūmī, seems to be a quite different person of later date.

[20] *B. O.*, ii. 46. He is to be distinguished from his namesake and contemporary, Paul, bishop of Edessa, who was banished to Euchaita in 522 (*B. O.*, i. 409–411), restored to his see in 526 (*ibid.*, p. 413), and died in the following year; whereas Paul of Callinicus was working at Edessa in 528 (see p. 880 *infra*).

[21] Thanks in part to a note at the end of Cod. Vat. cxl. (*Catal.*, iii. 223; comp. *B.O.*, *loc. cit.*).

[22] Completed in 528; Cod. Vat. cxl.; Brit. Mus. Add. 17200 (Wright, *Catal.*, p. 554).

[23] Cod. Vat. cxl.; Brit. Mus. Add. 12158 (Wright, *Catal.*, p. 556), dated 588.

[24] Brit. Mus. Add. 12158.

[25] There is a long extract from this work in Cod. Vat. cxl. (*Catal.*, iii. 282).

[26] Brit. Mus. Add. 14599, dated 569; Cod. Vat. cxlii., dated 576; cxliii., dated 563; cclvi.

[27] Brit. Mus. Add. 17154.

[28] Brit. Mus. Add. 17210–11, 12157.

[29] Compare, for example, Wright, *Catal.*, p. 1328. The translation of the *Octoëchus* is the work, not of Paul of Callinicus, but of an abbot Paul, who executed it in the island of Cyprus (see p. 880 *infra*).

[30] The passage quoted by Assemani (*B.O.*, i. 409, note 2) seems, however, to confound him with his namesake of Edessa.

[31] *B.O.*, iii. 1, 267, note 6, 278, 338–339, 351 col. 2; comp. Bruns and Sachau, *Syrisch-Römisches Rechtsbuch*, 1880, pp. 175–180.

[32] Brit. Mus. Add. 14528 (Wright, *Catal.*, p. 177), and Paris, Suppl. 38 (Zotenberg, *Catal.*, p. 75 col. 1. No. 46). The text of the former was first published by Land (*Anecd. Syr.*, i. 30–64), with a Latin translation. Both have been edited and translated, along with the Arabic and Armenian versions, with translations and a learned apparatus, by Bruns and Sachau, *op. cit.*

Aḥū dh'emmēh.

Another scholar, besides Sergius, whom 'Abhd-īshō' wrongly claims as a Nestorian is Aḥū-dh'emmēh, metropolitan of Taghrīth (Tekrīt). He appears, on the contrary, to have been the head of the Monophysites in the Persian territory. According to Bar-Hebræus,[2] he was appointed by Christopher, catholicus of the Armenians, to be bishop of Bēth 'Arbāyē,[3] but was promoted by Jacob Burdĕ'ānā in 559 to the see of Taghrīth, where he ordained many priests and founded two monasteries. Among his numerous converts from heathenism was a youthful member of the royal family of Persia, whom he baptized by the name of George. This excited the anger of Khosrau I. Anōsharwān, who ordered the bishop to be beheaded (2d August, 575). As a writer Aḥū-dh'emmēh seems to have been more of a philosopher than a theologian.[4] He wrote against the Persian priesthood and against the Greek philosophers, a book of definitions, a treatise on logic, on freewill in two discourses, on the soul and on man as the microcosm, and a treatise on the composition of man as consisting of soul and body.[5] He is also mentioned by later authors as a writer on grammar.[6]

Anonymous historical romances.

Somewhat before this time a monk of Edessa whose name is unknown to us, tried his hand at the composition of a tripartite historical romance,[7]—a history of Constantine and his three sons; an account of Eusebius, bishop of Rome, and his sufferings at the hands of Julian the Apostate; and a history of Jovian or, as the Orientals usually call him, Jovinian, under Julian and during his own reign. The whole purports to be written by one Aplōrīs or Aplōlārīs (Apollinarius?), an official at the court of Jovian, at the request of 'Abhdēl, abbot of Sndrūn (?) Māḥōzā, with a view to the conversion of the heathens. All three parts contain but a very small quantity of historical facts or dates, and deal in the grossest exaggerations and inventions. Yet the Syriac style is pure, and we gain from the book a good idea of the way in which the author's countrymen thought and spoke and acted. This romance has been published by Hoffmann,[8] and Nöldeke has given a full account of it, with an abridged translation, in *Z. D. M. G.*, xxviii. p. 263 *sq.* He places the time of composition between 502 and 532. It is curious to find that this romance must have been known in an Arabic translation to the historian aṭ-Ṭabarī, who treats it as a genuine historical document.[9] From him it has passed to the *Kāmil* of Ibn al-Athīr, i. 283 *sq.*, and the *Akhbār al-Bashar* of Abu 'l-Fidā (*Hist. Anteislamica*, ed. Fleischer, p. 84). Ibn Wāḍih al-Ya'ḳūbī seems in his *Annals*[10] to have drawn from the same source, though independently of aṭ-Ṭabarī, and so also al-Mas'ūdī, *Murūj adh-Dhahab*, ii. 323. Bar-Hebræus has also made some use of it in his *Chronicon*, ed. Bruns and Kirsch, pp. 68–69. No doubt, too, it is the work attributed by 'Abhd-īshō' to the grave ecclesiastical historian Socrates, who, as he says,[11] wrote "a history of the emperors Constantine and Jovinian."

Another, but much inferior, romance, of which Julian is the hero, is contained in Brit. Mus. Add. 7192, a manuscript of the 7th century. It has been edited by Hoffmann, *op. cit.*, pp. 242–259, and translated by Nöldeke, *Z. D. M. G.*, xxviii. 660–674. We shall not be far wrong in assigning it likewise to the 6th century, though it is probably rather later than that just noticed.

Chronicon Edessenum.

Of real historical value, on the contrary, is the anonymous *Chronicon Edessenum*, fortunately preserved to us in the Vatican MS. clxiii.,[12] and edited by Assemani in *B.O.*, i. 388–417. There is an English translation of it in the *Journ. of Sacred Lit.*, 1864, vol. v. (new ser.), p. 28 *sq.* It begins with A.Gr. 180, but the entries are very sparse till we reach A.Gr. 513 (202 A.D.). The last of them refers to the year 540, about which time the little book must have been compiled. The author made use of the archives of Edessa and other documents now lost to us, as well as of the *Chronicle* of Joshua the Stylite (see above, p. 873). In religious matters he is not a violent partisan, nor given to the use of harsh words, a thing to be noted in the age in which he lived.

John of Asia or Ephesus.

Another writer of first-rate importance as a historian is John, bishop of Asia or Ephesus, "the teacher of the heathen," "the overseer of the heathen," and "the idol-breaker," as he loves to style himself.[13] He was a native of Āmid,[14] and must have been born early in the 6th century, according to Land about 505. He was ordained deacon in the convent of St. John in 529, when he must have been at least twenty years of age.[15] In 534 the terrible pestilence of the reign of Justinian broke out, and at that time John was in Palestine,[16] having, doubtless, fled from Āmid to avoid the persecution of the Monophysites by Abraham bar Kīlī (?) of Tellā, bishop of Āmid (from about 520 to 546), and Ephraim bar Appian of Āmid, patriarch of Antioch (529–544), "a much worse persecutor than Paul or Euphrasius."[17] In 535 we find him at Constantinople, where in the following year, according to Bar-Hebræus,[18] he became bishop of the Monophysites in succession to the deposed Anthimus. Be this as it may, he was certainly received with great favor by Justinian, whose friendship and confidence he enjoyed for thirty years, and "had the administration of the entire revenues of all the congregations of the believers (*i.e.*, the Monophysites) in Constantinople and everywhere else."[19] Wishing to root out heathenism in Asia Minor, obviously for political as well as religious reasons, the emperor appointed John to be his missionary bishop.[20] In this task he had great success, to which his faithful friend and fellow-laborer for thirty-five years, Deuterius, largely contributed.[21] He interested himself, too, in the missionary efforts of Julian, Theodore, and Longinus among the Nubians and Alodæi.[22] In 546 the emperor employed him in searching out and putting down the secret practice of idolatry in Constantinople and its neighborhood.[23] After the death of his patron the fortunes of John soon underwent a change. Bk. i. of the third part of his *History* commences with the persecution under Justin in 571, in which he suffered imprisonment.[24] His friend Deuterius, whom he had made bishop of Caria, was also persecuted, and died at Constantinople.[25] From this time forward John's story is that of his party, and the evidently confused and disordered state of his *History* is fully explained and excused by his own words in bk. ii. 50, where he tells us[26] "that most of these histories were written at the very time when the persecution was going on, and under the difficulties caused by its pressure; and it was even necessary that friends should remove the leaves on which these chapters were inscribed, and every other particle of writing, and conceal them in various places, where they sometimes remained for two or three years. When therefore matters occurred which the writer wished to record, it was possible that he might have partly spoken of them before, but he had no papers or notes by which to read and know whether they had been described or not. If therefore he did not remember that he had recorded them, at some subsequent time he probably again proceeded to their detail; and therefore occasionally the same subject is recorded in more chapters than one; nor afterwards did he ever find a fitting time for plainly and clearly arranging them in an orderly narrative." Some of the chapters are actually dated at various times from A.Gr. 886 (575 A.D.) to 896 (585). The time and place of his death are unknown, but he cannot have lived long after 585, being then about eighty years of age.[1] His greatest literary work is his *Ecclesiastical History* in three parts, the first two of which, as he himself tells us,[2] embraced, in six books each, the period from Julius Cæsar to the seventh year of Justin II., whilst the third, also in six books, carried on the tale to the end of the author's life. The first part is entirely lost. Of the second we have copious excerpts in the *Chronicle* of Dionysius of Tell-Maḥrē[3] and in two MSS. in the British Museum.[4] The third has fortunately come down to us, though with considerable lacunæ, in Brit. Mus. Add. 14640 (of the 7th century).[5] This book is worthy of all praise for the fulness and accuracy of its information and the evident striving of the author after impartiality. The Syriac style, however, is very awkward and involved, and abounds in Greek words and phrases. Of scarcely less value for the history of his own time is another work entitled *Biographies of Eastern Saints*, men and women, contained in Brit. Mus. Add. 14647, ff. 1–135.[6] These lives were gathered into one corpus about 569, as appears from the account of the combination of the monasteries of Āmid during the persecution of 521, which was put on paper in 567,[7] and from the history of the convent of St. John, extending from its foundation in 389 to 568.[8] To these lives Land has added three more, which are ascribed in MSS. to John, but do not seem to have been included in this collection.[9]

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[1] Wright, *Catal.*, p. 1184.

[2] *Chron. Eccles.*, ii. 99; comp. *B.O.*, ii. 414, iii. 1, 192, note 3.

[3] Bā-'arbāyā, the district between Nisibis and the Tigris.

[4] *B. O.*, iii. 1, 192.

[5] Of this last part is extant in Brit. Mus. Add. 14620 (Wright, *Catal.*, p. 802).

[6] See *B.O.*, iii. 1, 256, note 2.

[7] Contained in Brit. Mus. Add. 14641, ff. 1–131, a MS. of the 6th century.

[8] *Julianos der Abtrünnige*, 1880.

[9] Aṭ-Ṭabari. *Annales*, i. 840 *sq.*; see Nöldeke, in *Z.D.M.G.*, xxviii. 291–292, and *Geschichte der Perser und Araber zur Zeit der Sasaniden*, p. 59 *sq.*

[10] Ed. Houtsma, i. 182–183.

[11] *B.O.*, iii. 1, 41.

[12] See *Catal.*, iii. 329.

[13] See *Eccles. Hist.*, ed. Cureton, bk. ii. ch. 4 and bk. iii. ch. 36: Land, *Anecd. Syr.*, ii. 256, l. 25.

[14] *B.O.*, ii. 83; Bar-Hebræus, *Chron. Eccles.*, i. 195.

[15] *B.O.*, ii., *Dissert. de Monophysitis*, p. cxxv.; Land, *Anecd. Syr.*, 174, ll. 8, 9.

[16] *B.O.*, ii. 85-86.

[17] *E.H.*, ed. Cureton, bk. i. ch. xli.: comp. *B.O.*, ii. 51.

[18] *Chron. Eccles.*, i. 195.

[19] *E.H.*, ed. Cureton, bk. v. ch. 1.

[20] *Ibid.*, bk. ii. ch. 44; bk. iii. ch. 36, 37; comp. *B.O.*, ii. 85.

[21] *E. H.*, ed. Cureton, bk. ii. ch. 44.

[22] *Ibid.*, bk. iv. ch. 6-8, 49-53; comp. Bar-Hebræus, *Chron. Eccles.*, i. 229. How just his views were as a missionary may be seen from bk. iv. ch. 50, where he says "that it was not right that to an erring and heathen people, who asked to be converted to Christianity and to learn the fear of God, there should be sent by letter, before everything that was necessary for their edification, confusion and offence and the revilings of Christians against Christians."

[23] *B.O.*, ii. 85.

[24] *E. H.*, ed. Cureton, bk. i. ch. 17; bk. ii. ch. 4–7. Of unjust legal proceedings he complains in bk. ii. ch. 41, where he loses his προάστειον, etc.

[25] *E.H.*, ed. Cureton, bk. ii. ch. 44.

[26] Payne Smith's translation, p. 163.

Zacharias Rhetor.

The name of Zacharias Rhetor or Scholasticus, bishop of Mitylēnē in Lesbos,[10] must next be mentioned, for, though a Greek author, his work has entered into the Syriac literature as part of a compilation by a Syrian monk. The *Ecclesiastical History* of Zacharias seems to have terminated about the year 518, whereas his Syriac translator was writing as late as 569,[11] and even later. The MS. in the British Museum, Add. 17202,[12] cannot be younger than the beginning of the 7th century, and is clearly the compilation of a Monophysite, who used Zacharias as his chief authority in books iii.–vi.; whereas books i., ii., and vii.–xii. were gathered from different sources, such as Moses of Aggēl (about 550–570), Simeon of Bēth Arshām (see above, p. 873), Mārā of Āmid (see above, p. 873), the correspondence of Julian of Halicarnassus and Severus of Antioch (see above, p. 875), the history of John of Ephesus,[13] etc. In a Syriac MS. in the Vatican (No. cxlv.)[14] we find a series of extracts from this Syriac work (f. 78 *sq.*) as a continuation of copious excerpts from the Greek histories of Socrates and Theodoret. The last of these, on the public buildings, statues, and other decorations of the city of Rome, has been carefully re-edited and annotated by Guidi.[15]

John Sābhā.

We turn from the historians to the ascetic writers of this century, who seem to have been more prized by their countrymen, though far less valuable to us. And first we mention the author who is commonly called John Sābhā[16] or "the Aged," placing him here on the authority of Assemani (*B.O.*, i. 433), for 'Abhd-īshō' claims him as a Nestorian (*B.O.*, iii. 1, 103). His *floruit* is given as about 550. His writings consist of short sermons or tracts, exclusively intended for the training and study of monks and cœnobites, and a number of letters. 'Abhd-īshō' (*loc. cit.*) says: "he composed two volumes, besides mournful epistles, on the monastic life." They were collected[17] by his brother, who has prefixed a brief apology, at the end of which the reader may find a curious example of affected humility (*B.O.*, i. 435).[18] Two short specimens of the style of "the spiritual old man," *ash-Shaikh ar-rūḥānī*, are printed in Zingerle's *Monumenta Syr.*, i. 102–104.

Isaac of Nineveh.

A little junior to John Sābhā was the even more widely known Isaac of Nineveh,[19] to whom the Nestorians also lay claim.[20] His date is fixed, as Assemani points out, by the facts of his citing Jacob of Sĕrūgh and corresponding with Simeon Stylites the younger or Thaumastorites, who died in 593. According to the Arabic biography, printed in *B.O.*, i. 444, he was a monk of the convent of Mār Matthew at Mosul, and afterwards became bishop of that city, but soon resigned his office and retired to the desert of Skētē in Egypt, where he composed his ascetic works. According to 'Abhd-īshō' (*B.O.*, iii. 1, 104), Isaac "wrote seven volumes on the guidance of the Spirit, and on the Divine mysteries and judgments and dispensation." Many of his discourses and epistles have been catalogued by Assemani, *B.O.*, i. 446–460. The MS. Vat. cxxiv. contains the first half of his writings (*Catal.*, iii. 143), and similarly MSS. Brit. Mus. Add. 14632 and 14633.[21] The Arabic translation is divided into four books; the Ethiopic is naturally derived from the Arabic. A Greek version was made from the original Syriac by two monks of St. Saba, near Jerusalem, named Patricius and Abraamius, on which see Assemani, *B.O.*, i. 445, and Bickell, *Conspectus*, p. 26. The only printed specimens of his discourses are two in Zingerle's *Monumenta Syr.*, i, 97–101.

Abraham of Nephtar.

Another author of this class, but of less mark, is Abraham of Nephtar,[22] who flourished towards the end of the 6th century and in the early part of the 7th.[23] Him, too, the Nestorians claim as theirs.[24] 'Abdh-īshō' speaks of "various works" of his,[25] but our libraries seem to contain only eight short discourses, the titles of which are given by Assemani, *B.O.*, i. 464.[26] They have been translated into Arabic, and there was also a Persian version of them by Job the monk (*B.O.*, iii. 1, 431).

Moses of Aggēl.

We record here the name of Moses of Aggēl as being one of those who, after Rabbūlā, undertook the translation of the writings of Cyril of Alexandria into Syriac. He made a version of the *Glaphyra*, at the request of a monk named Paphnutius, from whose letter[27] we learn that the treatise *On Worship in Spirit and in Truth* had been already translated[28], whilst from the reply of Moses, as quoted in *B.O.*, ii. 82–83, it is obvious that he was writing after the death of Philoxenus and the chorepiscopus Polycarp. Hence we may place him soon after the middle of the century, say from 550 to 570. Much later he cannot be, because his translation of the History of Moses and Āsyath (see above, p. 866) has been admitted into the Syriac compilation that passes under the name of Zacharias Rhetor (see above, p. 877).[29]

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[1] See Land, *Joannes Bischof von Ephesos, der erste Syrische Kirchenhistoriker*, 1856. A very useful book.

[2] *E.H.*, ed. Cureton, bk. i. ch. 3.

[3] *B.O.*, ii. 100; comp. pp. 85–90.

[4] Add. 14647 (dated 688), ff. 136–139; Add. 14650 (dated 875), ff. 189–206. Edited by Land, *Anecd. Syr.*, ii. 289–329 and 385–391. See also a small fragment, *ibid.*, 363, from Add. 12154, f. 201 b.

[5] Edited by Cureton, 1853. There is an English translation by R. Payne Smith, 1860, and a German one by Schönfelder, 1862.

[6] Edited by Land, *Anecd. Syr.*, ii. 1–288.

[7] *Anecd. Syr.*, ii. 212, l. 17; see also p. 191, last two lines.

[8] *Ibid.*, ii. 288, ll. 2, 3.

[9] *Ibid.*, ii. 343–362. That of Jacob Burdĕ'ānā (*ibid.*, p. 364) is not his, at least in its present shape (see above, p. 833). There is a slightly different redaction of it in the Bibl. Nation. at Paris, Anc. fonds 144 (Zotenberg, *Catal.*, p. 187).

[10] See Land, *Joannes Bischof von Ephesos*, p. 35 *sq.*, and *Anecd. Syr.*, iii., Preface.

[11] Land, *Anecd. Syr.*, iii. pp. xi., xii., and p. 5, l. 21 *sq.*

[12] See Wright, *Catal.*, p. 1046 *sq.*

[13] Not a few chapters in books vii.–x. seem to be derived, in part at any rate, from the second part of the *Ecclesiastical History*.

[14] *Catal.*, iii. 253; *B.O.*, ii. 54 *sq.*; Mai, *Scriptorum Veterum Nova Collectio*, x. pp. xi.–xiv., 332–388. The MS., which Assemani calls "pervetustus, Syriacis literis stronghylis exaratus" (p. 253), is not likely to be earlier than the middle of the 8th century, as it contains the work of the patriarch Elias, who sat from 708 to 728.

[15] *Il Testo Siriaco della Descrizione di Roma*, etc., from the *Bullettino della Commissione Archeologica di Roma*, fasc. iv. anno 1884 (Rome, 1885). It is also extant in a shorter form in Brit. Mus. Add. 12154, f. 158a (See Wright, *Catal.*, p. 984; Guidi, p. 235 *sq.*).

[16] There is some uncertainty about his name. In *B.O.*, i. 434, Assemani gives ܝܘܚܢܢ ܗܘ ܕܕܠܝܬܐ, John of Dileita, which, he says (p. 433), is a convent at Nineveh, on the opposite bank of the Tigris from Mosul. In vol. iii. 1, 103 he prints ܝܘܚܢܢ ܗܘ ܕܕ̈ܠܝܬܗ, which he renders Joannes Daliathensis, *i.e.*, from ad-Daliyah, الدالية, probably meaning Daliyat Mālik ibn Ṭauk, on the right bank of the Euphrates below ar-Rakkah and Raḥbat Mālik ibn Ṭauk. In the Vatican *Catalogue* he calls him Daliathensis, writing, however, in Syriac ܕܕܠܝܬܐ. But how can ܕܕ̈ܠܝܬܗ mean "of ad-Daliyah" (ܕܕܠܝܐ)? Following the analogy of ܝܘܚܢܢ ܕܩܘ̈ܪܝܗ, ܩܘܪܝܣ, ܕܟܠܒܘܢܘܣ, and the like, it ought rather to mean "John of the Vine-Branches," or "John with the Varicose Veins," or (as in Arabic) "John of the Buckets."

[17] See Wright, *Catal.*, p. 868, *j*. In the *B.O.*, i. 434, Assemani gives an Arabic version of it from a Vatican MS.

[18] For a list of them in Syriac and Arabic, see *B.O.*, i. 435–444, and comp. Wright, *Catal.*, pp. 582, 584, 860, 870 (No. 16). There is also an Ethiopic version, *Aragāwī Manfasāwī*, made from the Arabic; see Zotenberg, *Catal. des MSS. Ethiopiens de la Bibl. Nation.*, No. 115, p. 134.

[19] *B.O.*, i. 444.

[20] *Ibid.*, iii. 1, 104.

[21] Wright, *Catal.*, pp. 569, 576.

[22] Also written Nethpar and Nephrath; see Assemani, *Catal. Vat.*, iii. 138. But, as we can find no trace of any such town as Nephtar, the name of ܢܦܬܪܐ may have some other origin.

[23] *B.O.*, iii. 1. 191, note 1.

[24] Compare Wright, *Catal.*, p. 187, No. 154.

[25] *B.O.*, iii. 1, 191.

[26] There seem to be ten in Cod. Vat. ccccxix.; see Mai, *Scriptt. Vett. Nova Coll.*, v. 65.

[27] Cod. Vat. cvii. (*Catal.*, iii. 53); Guidi, *Rendiconti della R. Accademia dei Lincei*, May and June, 1886, p. 399 *sq.*

[28] Brit. Mus. Add. 12166, ff. 155–258, bears date 553 (Wright, *Catal.*, p. 491).

[29] Of the Vatican MS. of the *Glaphyra* only five leaves remain (*Catal.*, iii. 54), and the MS. in the British Museum, Add. 14555, is very imperfect (Wright, *Catal.*, p. 488). As Guidi has shown, these two MSS. are merely the *disjecta membra* of one codex.

Peter of Callinicus.

Peter of Callinicus (ar-Rakkah), Jacobite patriarch of Antioch, 578–591,[1] deserves mention on account of his huge controversial treatise against Damian, patriarch of Alexandria, manuscripts of parts of which, of the 7th and 8th centuries, are extant in the Vatican and the British Museum.[2] Other writings of his are an anaphora,[3] a short treatise against the Tritheists,[4] sundry letters,[5] and a metrical homily on the Crucifixion of our Lord.[6] In the dispute between him and Damian was involved his syncellus and successor Julian, who defended Peter against an attack made upon him by Sergius the Armenian, bishop of Edessa, and his brother John.[7]

Of the numerous Nestorian writers of the 6th century we unfortunately know but little more than can be learned from the catalogue of ‘Abhd-īshō‘. Their works have either been lost, or else very few of them have as yet reached our European libraries.

Abraham of Nisibis.

The successor of Narsai (above, p. 870) in the school of Nisībis was his sister's son Abraham,[8] who must have fled from Edessa with his uncle.[9] His principal writings are commentaries on Joshua, Judges, Kings, Ecclesiasticus, Isaiah, the twelve minor prophets, Daniel, and the Song of Songs.[10]

John of Nisibis.

To him succeeded as teacher John, also a disciple of Narsai.[11] He wrote commentaries on Exodus, Leviticus, and Numbers, Job, Jeremiah, Ezekiel, and Proverbs; also controversial treatises against the Magi or Persian priesthood, the Jews, and (Christian) heretics; a book of questions on the Old and New Testaments; and various hymns. If the discourses on the plague at Nisībis[12] and the death of Khosrau I. Anōsharwān be really by him, he was alive as late as 579, in the spring of which year that monarch died.[13]

Joseph Hūzāyā.

John was followed by Joseph Hūzāyā,[14] another disciple of Narsai,[15] and the first Syriac grammarian. Of him Bar-Hebræus observes[16] that "he changed the Edessene (or Western) mode of reading into the Eastern mode which the Nestorians employ; otherwise during the whole time of Narsai they used to read like us Westerns." He was the inventor of some of the Syriac signs of interpunction,[17] and wrote a treatise on grammar[18] and another on words that are spelled with the same letters but have different meanings.[19]

Mār-abhā I.

Of Mār-abhā[20] the Elder, catholicus from 536 to 552, we have already spoken above as a translator of the Scriptures (p. 865). He was a convert from the Zoroastrian religion, and seems to have been a man of great talent and versatility, as he mastered both the Greek and Syriac languages. Receiving baptism at Ḥērtā (al-Ḥīrah) from a teacher named Joseph, he went for the purposes of study to Nisībis, and afterwards to Edessa, where he and his teacher Thomas[21] translated into Syriac the liturgy of Nestorius.[22] They visited Constantinople together, and escaping thence at some risk of their lives, betook themselves to Nisībis, where Mār-abhā became eminent as a teacher. On being chosen catholicus he opened a college at Seleucia and lectured there. Unluckily, he got into controversy, it is said, with the Persian monarch Khosrau I. Anōsharwān (531–579), who banished him to Ādharbāigān (Azerbijan) and destroyed the Nestorian church beside his palace at Seleucia. Mār-abhā, however, had the temerity to return to Seleucia, was thrown by the king into prison, and died there.[23] His dead body was carried by one of his disciples to Ḥērtā, where it was buried and a monastery erected over the grave. He wrote[24] commentaries on Genesis, the Psalms, and Proverbs, and the epistles of St. Paul to the Romans, Corinthians, Galatians, Ephesians, Philippians, and Hebrews; various homilies; synodical epistles;[25] and ecclesiastical canons.[26] In these last he opposed the practice of marriage at least among the higher orders of the clergy, the bishops and catholics. What is meant by his "canones in totum Davidem" may be seen from such MSS. of the Psalter as Brit. Mus. Add. 7156[27] and Munich, cod. Syr. 4 (Orient. 147).[28] Hymns of his are also extant.[29]

Abraham of Kashkar

Under Mār-abhā flourished Abraham of Kashkar (al-Wāsiṭ), distinguished for his acquaintance with philosophy and for his ascetic virtues. He introduced certain reforms into the Persian monasteries. After living for some time in a cave at Ḥazzah,[30] he betook himself to Jerusalem and thence to Egypt. Returning to his old haunt, he led the life of a hermit for thirty years, travelling into the far north as a missionary. He died at Ḥazzah, but his body was secretly removed to his native place Kashkar. He wrote a treatise on the monastic life, which was translated into Persian by his disciple Job the monk.[31]

He must, it would seem, be distinguished from another Abraham of Kashkar, who lived about the same time, and with whom Assemani has confounded him.[32] This Abraham was a student at Nisībis under Abraham the nephew of Narsai. Thence he went to Ḥērtā (al-Ḥīrah), where he converted some of the heathen inhabitants, visited Egypt and Mount Sinai, and finally settled down as a hermit in a cave on Mount Īzlā, near Nisībis, where a great number of followers soon gathered about him and a large monastery was built. He introduced stricter rules than heretofore among the cœnobites.[33] His death did not take place till towards the end of the century.[34]

Theodore of Merv.

Theodore, bishop of Marū or Merv, was appointed to this see by Mār-abhā in place of David, whom he had deposed, about 540. He seems to have been much addicted to the study of the Aristotelian dialectics, since several of the translations and treatises of Sergius of Rās‘ain are dedicated to him.[35] Among his own works[36] there is mentioned "a solution of the ten questions of Sergius." He also composed a commentary on the Psalms and a metrical history of Mār Eugenius and his companions,[37] who came from Klysma and introduced asceticism into Mesopotamia about the beginning of the 4th century. What may have been the contents of the "liber varii argumenti" which he wrote at the request of Mār-abhā himself it is hard to guess, in the default of any copy of it.

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[1] *B.O.*, ii. 69, 332, Bar-Hebræus, *Chron. Eccles.*, i. 250.

[2] *B.O.*, ii. 77–82; com. Bar-Hebræus, *Chron. Eccles.*, i. 257.

[3] *B.O.*, ii. 77.

[4] Brit. Mus. Add. 12155, f. 231 b (Wright, *Catal.*, p. 951).

[5] Wright, *Catal.*, p. 1314.

[6] Brit. Mus. Add. 14591 (Wright, *Catal.*, p. 671).

[7] *B.O.*, ii. 333; Bar-Hebræus, *Chron. Eccles.*, i. 259.

[8] *B. O.*, iii. 1, 71. Assemani would seem to have confounded him with a later Abraham of Bēth Rabban; see his note, *B. O.*, iii. 1, 631.

[9] There seems to be no reason for identifying him with Abraham "the Mede," whom Simeon of Bēth Arshām nicknames "the Heater of Baths" (*B. O.*, i. 352).

[10] The hymn appended to Nestorian copies of the Psalter probably pertains to this Abraham and not to the later Abraham of Bēth Rabban (see, for example, Brit. Mus. Add. 7156, f. 157b); comp. Bickell, *Conspectus*, p. 37, and Hoffmann, *Opusc. Nestor.*, xi., note 2.

[11] *B. O.*, iii. 1, 72. Here again Assemani seems to have mixed up this John with a later John of Bēth Rabban and with John Sābhā of Bēth Garmai; see his additional notes in *B. O.*, iii. 1, 631, 708.

[12] During the time of the catholics Joseph and Ezekiel, from 552 to 578; see *B. O.*, ii., 413, 433, note 2.

[13] The hymn in the Nestorian MSS. of the Psalter (mentioned in note 23 above) is probably by this John and not by the later John of Bēth Rabban; comp. Hoffmann's note referred to above. The monastery of Rabban Zĕkhā-ishō‘ (or Īshō‘zĕkhā) in Dāsen was not founded till about 590, and Zĕkhā-ishō‘ himself did not die till the thirteenth year of Khosrau II. Parwēz, 603; see *B. O.*, iii. 1, 472.

[14] *I. e.*, of al-Ahwāz or Khūzistān. He must not be confounded with Joseph Ḥazzāyā, of whom we shall speak hereafter (see p. 880 *infra*).

[15] Bar-Hebræus, *Chron. Eccles.*, ii. 78, says that Joseph Hūzāyā was the immediate successor of Narsai; but the Nestorian writer cited by Assemani (*B. O.*, iii. 1, 64) is likely to be better informed. The passage quoted *ibid.*, p. 82, points in the same direction; comp. also *B. O.*, iii. 2, cmxxvii.

[16] *Loc. cit.*; comp. *B. O.*, ii. 407.

[17] See Wright, *Catal.*, p. 107, col. 2. Assemani (*B. O.*, iii. 1, 64, col. 2) has mistranslated the words وهو صاحب الفخام بتسعة نقطا. Comp. Hoffmann, *Opusc. Nestor.*, viii. xi.

[18] Berlin, Royal Library, Sachau 226, 4.

[19] Bar-Hebræus, *Œuvres grammaticales*, ed. Martin, ii. 77.

[20] Properly Mār(i)-abhā, but we shall write Mār-abhā.

[21] Probably the same who is mentioned among his disciples in *B. O.*, ii. 412, and some of whose writings are enumerated by ‘Abhd-ishō‘ in *B. O.*, iii. 1, 86–7.

[22] So ‘Abhd-ishō‘ in *B. O.*, iii., 1, 36; but in Brit. Mus. Add. 7181 the same remark is made as to the liturgy of Theodore of Mopsuestia (see Rosen, *Catal.*, p. 59).

[23] *B. O.*, ii. 411–412, iii. 1, 75, notes 1, 2; Bar-Hebræus, *Chron. Eccles.*, ii. 89–95.

[24] *B. O.*, iii. 1, 75.

[25] *Ibid.*, iii. 1, 76, note 4.

[26] *Ibid.*, iii. 1, 81, and note 1; comp. Cod. Vat. cccvi. in Mai, *Scriptt. Vett. Nova. Coll.*, v. 21.

[27] Rosen, *Catal.*, p. 12.

[28] *Verzeichniss d. orient. Handschriften d. k. Hof-u. Staats-Bibl.*, etc., p. 111.

[29] See Bickell, *Conspectus*, p. 37, and comp. Brit. Mus. Add. 17219, f. 165b (beg., *Glory to Thee, Lord; how good Thou art!*).

[30] A village near Arbēl or Irbil, in Ḥēdhaiyabh.

[31] *B.O.*, iii. 1, 155, col. 1, 431; iii. 2, dccclxxiii.

[32] Comp. *B.O.*, iii. 1, 154, note 4, with Hoffman, *Auszüge*, p. 172.

[33] *B. O.*, iii. 1, 93.

[34] See Hoffmann, *loc. cit.*

[35] See Brit. Mus. Add. 14658 (Wright, *Catal.*, p. 1154); Renan, *De Philosophia Peripat. ap. Syros*, p. 29.

[36] *B.O.*, iii. 1, 147.

[37] See *B.O.*, iii. 1, 147, note 4, and 633; iii. 2, dccclxii.; Bar-Hebræus, *Chron. Eccles.*, i. 85, with note 5; Hoffmann, *Auszüge*, p. 167. If the poem mentioned by Assemani (*B.O.*, iii. 1, 147, note 4) really speaks of Abraham of Kashkar and still more of Bābhai of Nisībis, it must be of later date, and Hoffmann is inclined to ascribe it to George Wardā, a writer of the 13th century (see *Auszüge*, p. 171, note 1327).

Gabriel of Hormizdshēr.

Theodore's brother Gabriel, bishop of Hormizdshēr, is[1] stated by 'Abhd-īshō'[2] to have written two controversial books against the Manichees and the Chaldæans (astrologers), as also about 300 chapters on various passages of Scripture which needed elucidation and explanation.

Joseph of Seleucia.

The successor of Mār-abhā in the see of Seleucia was Joseph, in 552. He studied medicine in the West and practiced in Nisībis, where he lived in one of the convents. Having been introduced by a Persian noble to the notice of Khosrau I., he cured that monarch of an illness, and ingratiated himself with him so much that he favored his appointment to the office of catholicus. Of his strange pranks and cruelties as archbishop, some account, doubtless highly colored, may be read in *B.O.*, iii. 1, 432–433, and Bar-Hebræus, *Chron. Eccles.*, ii. 95–97. He was deposed after he had sat for three years, but he lived twelve years longer, during which time no successor was appointed. He promulgated twenty-three canons,[3] and, according to Elias, bishop of Damascus (893),[4] after his deposition drew up a list of his predecessors in the dignity of catholicus, wherein he would seem to have paid special attention to those who had shared the same fate with himself. At least Bar-Hebræus[5] (perhaps not a quite trustworthy witness in this case) gives currency to the charge of his having forged the consolatory epistles of Jacob of Nisībis and Mār Ephraim to Pāpā of Seleucia on his deposition.

Paul the Persian.

A little later in the century, under the sway of his successor Ezekiel (a disciple of Mār-abhā and the son-in-law of his predecessor Paul), 567–580,[6] there flourished Paul the Persian,[7] of Dērshar or Dērshahr,[8] a courtier of Khosrau I. Anōsharwān.[9] He is said by Bar-Hebræus[10] to have been distinguished alike in ecclesiastical and philosophical lore, and to have aspired to the post of metropolitan bishop of Persia, but, being disappointed, to have gone over to the Zoroastrian religion. This may or may not be true; but it is certain that Paul thought more of knowledge than faith, for thus he speaks:[11] "Scientia enim agit de rebus proximis et manifestis et quæ sciri possunt, fides autem de omnibus materiis quæ remotæ sunt, neque conspiciuntur neque certa ratione cognoscuntur. Hæc quidem cum dubio est, illa autem sine dubio. Omne dubium dissensionem parit, dubii absentia autem unanimitatem. Scientia igitur potior est fide, et illam præ hac eligendum est." Bar-Hebræus speaks of Paul's "admirable introduction to the dialectics (of Aristotle),"[12] by which he no doubt means the treatise on logic extant in a single MS. in the Brit. Mus.[13] It has been edited, with a Latin translation and notes, by Land.[14]

Bōdh.

About this same time Assemani[15] places the periodeutes Bōdh, who is said to have had the charge of the Christians in the remoter districts of the Persian empire as far as India. Among his writings are specified "discourses on the faith and against the Manichees and Marcionites," as well as a book of "Greek questions," probably philosophical, bearing the strange title of *Aleph Mīgīn*.[16] All these have perished, but his name will go down to remote posterity as the translator into Syriac of the collection of Indian tales commonly called *Kalīlah and Dimnah*.[17] Of this work a single copy has come down to our time, preserved in an Oriental library. A transcript of it was first procured by Bickell,[18] who, in conjunction with Benfey, edited the book (Leipsic, 1876); and since then three additional copies of the same original have been got by Sachau.[19] That Bōdh made his Syriac translation from an Indian (Sanskrit) original as 'Abhd-īshō' asserts, is wholly unlikely; he no doubt had before him a Pahlavī or Persian version.[20]

Ḥannānā of Ḥĕdhaiyabh.

Just at this period the Nestorian Church ran a great risk of disruption from an internal schism. Ḥannānā of Ḥĕdhaiyabh, the successor of Joseph Hūzāyā in the school of Nisībis, who had, it is said, a following of 800 pupils,[21] had dared to assail the doctrines and exegesis of Theodore of Mopsuestia and to follow in some points those of Chrysostom.[22] He commenced his work at Nisībis, under the metropolitan Aḥā-dh'abhū(hī),[23] by publishing a revised edition of the statutes of the school.[24] During the time of the catholicus Ezekiel (567–580),[25] he brought forward his theological views, which were condemned at a synod held under the next catholicus, Ishō'-yabh of Arzōn (581–595),[26] and at another synod presided over by his successor, Sabhr-īshō' (596–604).[27] On the death of this latter a struggle took place between the rival factions, the orthodox Nestorians putting forward as their candidate Gregory of Tell-Besmē,[28] bishop of Nisībis, whilst the others supported Gregory of Kashkar, a teacher in the school of Māḥōzē or Sĕlīk (Seleucia).[29] The influence of the Persian court decided the matter in favor of the latter, who was a *persona grata* in the eyes of the queen Shīrīn and her physician Gabriel of Shiggār (Sinjār),[30] a keen Monophysite, who naturally availed himself of this opportunity to harm the rival sect of Christians. Gregory was not, however, a partisan of Ḥannānā, but an orthodox Nestorian, as appears from the account given of the synod over which he presided,[31] by which the Nicene creed was confirmed, the commentaries of Theodore of Mopsuestia approved, and the memory and writings of Bar-ṣaumā vindicated against his assailants. He died at the end of three years (607), and the archiepiscopal see remained vacant till after the murder of Khosrau II. Parwēz in 628, during which time of persecution Bābhai the archimandrite distinguished himself as the leader and guide of the Nestorian Church. In the overthrow of Khosrau the oppressed Nestorians bore a part, more especially Shamṭā[32] and Ḳurṭa, the sons of the noble Yazdīn, who had been the director of the land-tax of the whole kingdom and had amassed an enormous fortune, which the king confiscated.[33] To return to Ḥannānā, his works, as enumerated by 'Abhd-īshō',[34] are—commentaries on Genesis, Job, Psalms, Proverbs, Ecclesiastes, the Song of Songs, the twelve minor prophets, the Gospel of St. Mark, and the epistles of St. Paul; expositions of the (Nicene) creed and the liturgy; on the occasions of the celebration of Palm Sunday, Golden Friday,[35] rogations,[36] and the invention of the cross; a discourse on Palm Sunday; and various other writings in which he attacked the teaching of Theodore of Mopsuestia, and which the church, therefore, placed on its *index expurgatorius*.[37]

Joseph of Ḥazzā.

The doctrines of Ḥannānā found a warm champion in Joseph of Ḥazzā (Arbēl or Irbil),[38] with whom Bābhai the archimandrite entered into controversy.[39] He is said to have composed some 1900 tracts, of which 'Abhd-īshō' mentions about a dozen as "profitable," whence we may conjecture that the rest were more or less deeply tinged with heresy. The chief of them are—on theory (or speculation) and practice; the book of the treasurer, containing the solution of abstruse questions; on misfortunes and chastisements; on the reasons of the principal feasts of the church; the book of the histories of the Paradise of the Orientals, containing many notices of ecclesiastical history; an exposition of the vision of Ezekiel and of the vision of St. Gregory; of the book of the merchant;[1] of (pseudo-)Dionysius (the Areopagite); and of the *capita scientiæ* or heads of knowledge (of Evagrius); besides epistles on the exalted character of the monastic life. Joseph appears to have been made a bishop in his latter days, and to have taken the name of 'Abhdīshō'; at least a MS. in the India office (No. 9) contains a tract on Zech. iv. 10 (f. 241b), and three series of questions addressed by a pupil to his teacher, by "Mār 'Abhd-īshō', who is Joseph Ḥazzāyā" (f. 293a).[2]

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[1] A corruption of Hormizd-Ardashēr, still further shortened by the Arabs into Hormushīr. It is identical with Sūḳ al-Ahwāz, or simply al-Ahwāz, on the river Kārūn. See Nöldeke, *Gesch. d. Perser u. Araber*, p. 19, with note 5.

[2] *B.O.*, iii. 1, 147.

[3] *Ibid.*, iii. 1. 435. Elias bar Shīnāyā cites his "synod"; see Bar-Hebræus, *Chron. Eccles.*, ii. 96, note 1.

[4] In his *Nomocanon*, quoted by Assemani, *B.O.*, iii. 1, 434.

[5] *Chron. Eccles.*, ii. 81.

[6] See *B.O.*, iii. 1, 435–439; Bar-Hebræus, *Chron. Eccles.*, ii. 97, 103.

[7] *B.O.*, iii. 1, 439; Renan, *De Philos. Peripat. ap. Syros*, pp. 16–22.

[8] ܕܪܫܗܪ, a place not known to the present writer.

[9] See Nöldeke, *Gesch. d. Perser u. Araber*, p. 160, note 3.

[10] *Chron. Eccles.*, ii. 97.

[11] In the Preface to his *Logic*, as translated by Land (see note 14 below).

[12] *Chron. Eccles.*, ii. 97.

[13] Add. 14660, f. 55b; see Wright, *Catal.*, p. 1161.

[14] *Anecd. Syr.*, iv., Syr. text, pp. 1–32; transl., pp. 1–30; notes, pp. 99–113.

[15] *B.O.*, iii. 1, 219.

[16] Assemani, *loc. cit.*, note 1, proposes to read *Aleph Mellīn*, "the Thousand Words"; but *Aleph Mīgīn* is more likely to be a corruption of some Greek word.

[17] The Syriac title keeps the older forms Ḳalīlagh and Damnagh.

[18] Göttingen, university library, MS. Orient. 18 d.

[19] Berlin, Royal Library, Sachau 139, 149, 150.

[20] See Keith-Falconer, *Kalīlah and Dimnah*, Introd., xlii. *sq.*

[21] *B.O.*, iii. 1, 81, note 2, 437.

[22] *Ibid.*, iii. 1, 84, note 3.

[23] Who was probably, therefore, the immediate predecessor of Gregory (596).

[24] *B.O.*, iii. 1, 83, at the end of the first note.

[25] *Ibid.*, ii., 413; iii. 1, 435.

[26] *Ibid.*, ii. 415, iii. 1, 108; Bar-Hebræus, *Chron. Eccles.*, ii. 105, note 3.

[27] *B.O.*, ii. 415; iii. 1, 82, 441.

[28] Not *aromatarius*, as Assemani translates *Besmāyā*.

[29] *B.O.*, ii. 416; iii. 1, 449. We need not believe the statements of Bar-Hebræus, *Chron. Eccles.*, ii. 107.

[30] See *B.O.*, ii. 404–406, 416, 472; Bar-Hebræus, *Chron. Eccles.*, ii. 109; Nöldeke, *Gesch. d. Perser u. Araber*, p. 358, in the note; Hoffmann, *Auszüge*, pp. 118–121.

[31] *B.O.*, iii. 1, 452.

[32] See *B.O.*, iii. 1, 471.

[33] See Hoffmann, *Auszüge*, pp. 115–121; Nöldeke, *Gesch. d. Perser u. Araber* p. 383. To Yazdīn is ascribed a hymn which appears in Nestorian Psalters, *e.g.*, Wright, *Catal.*, p. 135; Zotenberg, *Catal.*, p. 9.

[34] *B.O.*, iii. 1, 83–84.

[35] The first Friday after Pentecost or Whitsunday, with reference to Acts iii. 6.

[36] See *B.O.*, ii. 413.

[37] *Ibid.*, iii., 1, 84, note 3.

[38] *Ibid.*, iii. 1, 100; Hoffmann, *Auszüge*, p. 117. Assemani confounds Joseph Ḥazzāyā with the older Joseph Hūzāyā, and translates Ḥazzāyā by "videns" instead of "Hazzæus."

[39] *E.g.*, his letters to Joseph of Ḥazzā, *B.O.*, iii. 1, 97, and the tract *De Unione*, *ib.*, 95.

Īshō'-yabh I. of Arzōn.

The successor of Ezekiel as catholicus of the Nestorians was Īshō'-yabh of Arzōn, 581–595.[3] He was a native of Bēth 'Arbāyē, educated at Nisībis under Abraham (see above, p. 878), and subsequently made bishop of Arzōn (Ἀρζανηνή). He managed to ingratiate himself with the Persian monarch Hormizd IV. (579–590), by whose influence he was raised to the archiepiscopate; and he continued to stand in favor with his son and successor Khosrau II. Parwēz, as well as with the Greek emperor Maurice. Doubtless both found the Christian archbishop a convenient ambassador and agent in public and private affairs, for Maurice had given his daughter Maria in marriage to Khosrau.[4] He was also a friend of the Arab king of Ḥērtā (al-Ḥīrah), Abū Ḳābūs Nu'mān ibn al-Mundhir, who had been converted to Christianity, with his sons, by Simeon, bishop of Ḥērtā, Sabhr-īshō', bishop of Lāshōm, and the monk Īshō'-zĕkhā.[5] On a pastoral visit to this part of his diocese, the catholicus was taken ill, and died in the convent of Hind (the daughter of Nu'mān) at al-Ḥīrah. Among his works are mentioned[6] a treatise against Eunomius, one against a heretical (Monophysite) bishop who had entered into argument with him, twenty-two questions regarding the sacraments of the church,[7] an apology,[8] and synodical canons and epistles.

Mĕshīḥā-zĕkhā.

Mĕshīḥā-zĕkhā, also called Īshō'-zĕkhā or Zĕkhā-īshō', was a monk of Mount Īzlā.[9] When many of his brotherhood were expelled from their convent by Bābhai the archimandrite,[10] he betook himself to the district of Dāsen,[11] and founded there a monastery, which was henceforth known as Bēth Rabban Zĕkhā-īshō' or, for shortness' sake, Bēth Rabban simply.[12] He was the author of an ecclesiastical history, which 'Abdh-īshō' praises as being "exact."

Dādh-īshō'.

Dādh-īshō' was the successor of Abraham of Kashkar as abbot of the convent on Mount Īzlā,[13] apparently during the lifetime of the latter, who lived to a great age (see above, p. 878).[14] He composed a treatise on the monastic life and another entitled *On Silence in Body and in Spirit*, a discourse on the consecration of the cell, besides funeral sermons and epistles. He also translated or edited a commentary on *The Paradise of the Western Monks* (probably meaning the *Paradise* of Palladius and Jerome), and annotated the works of Isaiah of Scete.[15]

Bar-'idtā.

Hereabout too is the date of the monk Bar-'idtā,[16] the founder of the convent which bears his name,[17] a contemporary of Bābhai of Īzlā and Jacob of Bēth 'Ābhē.[18] He was the author of a monastic history, which is often quoted by Thomas of Margā,[19] and seems to have been a work of considerable value. He must be distinguished from a later Bar-'idtā, of the convent of Ṣĕlībhā, near the village of Hēghlā on the Tigris,[20] with whom Assemani has confounded him.[21]

Simeon Barḳāyā.

In the *Bibl. Orient.*, iii. 1, 230, 'Abhd-īshō' mentions an historian whose name is given by Assemani as Simeon Karkhāyā, with the additional information that he was bishop of Karkhā and flourished under the patriarch Timothy I. about 800. His name seems, however, to have been wrongly read, and he appears to have lived at a much earlier date. At least Elias bar Shīnāyā speaks in his *Chronicle*[22] of one Simeon Barḳāyā[23] as the author of a chronicle (in at least two books), who wrote in the reign of the Persian king Khosrau II. Parwēz, A. Gr. 902 = 591 A.D.

Sabhr-īshō'.

The name of Sabhr-īshō' the catholicus carries us over into the 7th century. He was a native of Pērōz-ābādh in Bēth Garmai, became bishop of Lāshōm, and was raised to the archiepiscopate in 596 by the favor of Khosrau II. Parwēz.[24] On the murder of his father-in-law Maurice (November, 602), Khosrau resolved upon war, and took the field in 604, when he besieged and captured the fortress of Dārā, the first great success in a fearful struggle of twenty-five years. Bar-Hebræus states that Sabhr-īshō' accompanied him and died during the siege;[25] but other authorities say, doubtless more correctly, that he died at Nisībis.[26] He is said to have been the author of an ecclesiastical history, of which a fragment, relating to the emperor Maurice, was supposed to be extant in Cod. Vat. clxxxiii.; but Guidi has shown that this is incorrect, and that the said fragment is merely an extract from a legendary life of Sabhr-īshō' by some later hand (*Z.D.M.G.*, xl., pp. 559–561).[27]

Simeon of Bēth Garmai.

About the same time with Sabhr-īshō', if Assemani be right,[28] we may place Simeon of Bēth Garmai, who translated into Syriac the *Chronicle* of Eusebius. This version seems unfortunately to be entirely lost.

Period of Græco-Persian War.

With the 7th century begins the slow decay of the native literature of the Syrians, to which the frightful sufferings of the people during the great war with the Persians in its first quarter largely contributed.[29] During all those years we meet with scarcely a name of any note in letters, more especially in Western Syria. Paul of Tellā and Thomas of Ḥarḳel were, it is true, laboring at the revised versions of the Old and New Testaments in Alexandria,[30] but even there they were scared by the Persian hosts, who took possession of the city in 615 or 616, shortly after the capture of Jerusalem by another army in 614.[31] A third diligent worker under the same adverse circumstances was the abbot Paul, who fled from his convent in Syria to escape the Persian invasion, and took refuge in the island of Cyprus.

Abbot Paul.

Here he occupied himself with rendering into Syriac the works of Gregory Nazianzen.[32] Of this version, which was completed in two volumes in 624, there are several old MSS. in the British Museum.[33] This Paul was also the translator of the *Octoēchus* of Severus, of which there is a MS. in the British Museum, Add. 17134, dated 675.[34] To this collection he himself contributed a hymn on the holy chrism and a translation of the "Gloria in excelsis."

Mārūthā of Taghrith.

The name of Mārūthā[35] is the first that deserves mention here, more, however, on account of his ecclesiastical weight and position than his literary merit. He was a native of Shurzaḳ (?), a village in the diocese of Bēth Nuhādhrē,[36] was ordained priest in the convent of Nardus, lived for twenty years in the convent of Zakkāi or Zacchæus at Callinīcus (ar-Raḳḳah), and went thence to Edessa for purposes of study. On returning to the East, he resided in the convent of Mār Matthew at Mosul, where he occupied himself with remodelling its rules and orders. He sided with the Monophysite party at the Persian court, and, after the death of the physician Gabriel,[1] found it advisable to retire to 'Aḳōlā (al-Kūfah).[2] He was elevated to the dignity of metropolitan bishop of Taghrīth in 640, after the establishment of peace between the Greeks and Persians,[3] and was the first real maphriān (maphrĕyānā) and organizer of the Jacobite Church in the East, which so rapidly increased in numbers and influence that he was called upon to ordain bishops for such remote regions as Segestān (Sīstān) and Harēw (Herāt). Mārūthā died in 649. His life was written by his successor Denḥā.[4] Mārūthā compiled a liturgy and wrote a commentary on the Gospels, both of which are sometimes wrongly assigned to the elder Mārūthā of Maiperḳaṭ.[5] He was also the author of short discourses on New (or Low) Sunday, and on the consecration of the water on the eve of the Epiphany, as well as of some hymns and sedrās.[6]

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[1] According to Assemani, *B.O.*, iii. 1, 102, note 4, of Isaiah of Scete, who, according to Palladius, was originally a merchant.

[2] See Hoffmann, *Auszüge*, p. 117, note 1057.

[3] *B.O.*, ii. 415, iii. 1, 108; Bar-Hebræus, *Chron. Eccles.*, ii. 105, note 3; Nöldeke, *Gesch. d. Perser u. Araber*, p. 347, note 1.

[4] See Nöldeke, *op. cit.*, p. 283, note 2, and comp. p. 287, note 2.

[5] Bar-Hebræus (*Chron. Eccles.*, ii. 105) tries to make out that Nu'mān was a Monophysite, and that Īshō'-yabh was trying to pervert him at the time of his death. But in such matters he is hardly a trustworthy witness.

[6] *B.O.*, iii. 1, 108.

[7] See a specimen in Assemani's *Catal of the Vatican Library*, iii. 280, No. cl., v.

[8] Probably a defence of his doctrines addressed to the emperor Maurice; see *B.O.*, iii. 1, 109, in the note.

[9] *B.O.*, iii. 1, 216, note 1. See above, p. 878, note 13.

[10] *Ibid.*, iii. 1, 88–89.

[11] Hoffmann, *Auszüge*, p. 202 *sq.*

[12] *B.O.*, iii. 1, 216, note 1, 255 in the note; Hoffmann, *Auszüge*, p. 206.

[13] *B.O.*, iii. 1, 98, note 1

[14] Hoffmann, *Auszüge*, p. 173.

[15] *B.O.*, iii. 1, 99.

[16] *Ibid.*, ii. 415, col. 2. Pronounce Bar-'ittā.

[17] *B.O.*, iii. 2, dccclxxix.; Hoffmann, *Auszüge*, p. 181.

[18] Comp. Wright, *Catal.*, p. 187, No 152.

[19] *B.O.*, iii. 1, 453, 458, 471.

[20] See Hoffmann, *Auszüge*, p. 181. note 1414.

[21] *B.O.*, iii. 1, 458.

[22] See Rosen, *Catal.*, p. 88, col. 1, 2.

[23] The difference in writing between ܒܪܟܝܐ and ܒܪܩܝܐ is not great. The pronunciation of the word ܒܪܩܝܐ is not quite certain.

[24] *B.O.*, ii. 415, iii. 1, 441 *sq.*; Baethgen, *Fragmente syr. u. arab. Historiker*, pp. 36, 119.

[25] *Chron. Eccles.*, ii. 107.

[26] *Chron. Eccles.*, *loc. cit.*, note 2; *B.O.*, iii. 1, 441, col. 1.

[27] Assemani, *Catal.*, iii. 387.

[28] *B.O.*, iii. 1, 168, 633.

[29] See the remarks of Nöldeke in *Gesch. d. Perser u. Araber*, p. 299, note 4.

[30] See above, p. 865. Thomas of Ḥarḳel also compiled a liturgy (*B.O.*, ii. 92, col. 1), and is said to have translated from Greek into Syriac five other liturgies (*ibid.*, col. 2), viz., those of Gregory Nazianzen, Basil, Gregory Nyssen, Dionysius the Areopagite, and John Chrysostom.

[31] See Nöldeke, *Gesch. d. Perser u. Araber*, pp. 291–292; *Chronique de Michel le Grand*, p. 222; Bar-Hebræus, *Chron. Syr.*, p. 99.

[32] See *B.O.*, i. 171; iii. 1, 23.

[33] See the fine series of MSS. described in Wright's *Catal.*, pp. 423–435. One of these is dated 790, another 845. Two other MSS. (*ibid.*, pp. 436–438) seem to contain part of the older version of the Nestorians (*B.O.*, iii. 1, 24, note 1).

[34] Wright, *Catal.*, p. 330 *sq.* The translator is wrongly described in the codex as "bishop of Edessa" (see above, p. 875, note 20). His convent was probably that of Ḳen-neshrē, of which both John bar Aphtōnyā (see above, p. 874) and John Psaltēs or Calligraphus were abbots. Compare *B.O.*, ii. 54.

[35] *B.O.*, ii. 416, 418.

[36] See Hoffmann, *Auszüge*, pp. 208–216, but especially p. 215.

Severus Sēbōkht.

Contemporary with Mārūthā, under the patriarch Athanasius Gammālā (died in 631[7]) and his successor John, flourished Severus Sēbōkht[8] of Nisībis,[9] bishop of the convent of Ḳen-neshrē, at this time one of the chief seats of Greek learning in western Syria.[10] He devoted himself, as might be expected, to philosophical and mathematical as well as theological studies.[11] Of the first we have specimens in his treatise on the syllogisms in the *Analytica Priora* of Aristotle, his commentary on the Περὶ ἑρμηνείας, and his letters to the priest Aitīlāhā of Mosul on certain terms in the Περὶ ἑρμηνείας, and to the periodeutes Yaunān or Jonas on some points in the logic of Aristotle.[12] Of his astronomical and geographical studies there are a few examples in Brit. Mus. Add. 14538, ff. 153–155,[13] such as whether the heaven surrounds the earth in the form of a wheel or sphere, on the habitable and uninhabitable portions of the earth, on the measurement of the heaven and the earth and the space between them, and on the motions of the sun and moon.[14] In the Royal Library at Berlin there is a short treatise of his on the astrolabe.[15] More or less theological in their nature are his letter to the priest and periodeutes Basil of Cyprus, on the 14th of Nīsān, A. Gr. 976 (665 A.D.),[16] a treatise on the weeks of Daniel,[17] and letters to Sergius, abbot of Shiggār (Sinjār), on two discourses of Gregory Nazianzen.[18] He is also said to have drawn up a liturgy.[19]

John I.

John I., Jacobite patriarch of Antioch, was called from the convent of Eusēbhōnā at Tell-'Addā to the archiepiscopal throne in 631, and died in December, 648.[20] Bar-Hebræus tells us that he translated the Gospels into Arabic at the command of the Arab emīr 'Amr ibn Sa'd. He is better known as the author of numerous sedrās and other prayers, whence he is commonly called Yōhannān dĕ-sedhrau(hī), or "John of the Sedrās." He also drew up a liturgy.[21]

Muḥammadan conquest of Syria.

During the second quarter of this century, from 633 to 636, the Muḥammadan conquest of Syria took place. The petty Arab kingdoms of the Lakhmites (al-Ḥīrah), the Tha'labites and Kindites, and the Ghassānites, as well as the wandering tribes of Mesopotamia, were absorbed; and the Persians were beaten back into their own country, quickly to be overrun in its turn. The year 638 witnessed the last effort of the Greek empire to wrest Syria from the invaders; the Muslim yoke was no longer to be shaken off. The effects of this conquest soon begin to make themselves manifest in the literature of the country. The more the Arabic language comes into use, the more the Syriac wanes and wastes away; the more Muḥammadan literature flourishes, the more purely Christian literature pines and dwindles; so that from this time on it becomes necessary to compile grammars and dictionaries of the old Syriac tongue, and to note and record the correct reading and pronunciation of words in the Scriptures and other books, in order that the understanding of them may not be lost.

Jacob of Edessa.

Among the small band of Monophysite scholars who made themselves conspicuous during the latter half of the 7th century the most famous name is that of Jacob of Edessa.[22] He was a native of 'Ēn-dēbhā (the Wolf's well), a village in the district of Gumyah (al-Jūmah), in the province of Antioch. The date of his birth is not mentioned, but it may have been about 640 or a little earlier.[23] He studied under Severus Sēbōkht at the famous convent of Ḳen-neshrē, where he learned Greek and the accurate reading of the Scriptures. Thence he went to Alexandria, but we are not told how long he remained there. After his return to Syria he was appointed bishop of Edessa in 679–680;[24] but Bar-Hebræus says that he was ordained by the patriarch Athanasius II., 684–687, which seems more probable, as they were intimate friends. If he was appointed in 684, the three or four years for which he held this office would terminate in 687–688, in which latter year Julian Rōmāyā (or "the Soldier")[25] was elected patriarch. Apparently Jacob was very strict in the enforcement of canonical rules, and thereby offended a portion of his clergy. He would seem to have appealed to the patriarch and his fellow-bishops, who were in favor of temporizing; whereupon Jacob burnt a copy of the rules before the gate of Julian's convent, at the same time crying aloud, "I burn with fire as superfluous and useless the canons which ye trample under foot and heed not." He then betook himself to the convent at Kaisūm, a town near Samosāta, and Ḥabbībh was appointed to Edessa in his stead. After a while the monks of Eusēbhōnā invited Jacob to their convent, and there he taught for eleven years the Psalms and the reading of the Scriptures in Greek, the study of which language had fallen into desuetude. Owing to disputes with some of the brethren "who hated the Greeks," he left this house and went to the great convent at Tell-'Addā, where he worked for nine years more at his revised version of the Old Testament.[26] On the death of Ḥabbībh Jacob was recalled to Edessa, where he resided for four months, at the end of which time he returned to Tell-'Addā to fetch his library and pupils, but died there on 5th June, 708.[27] In the literature of his country Jacob holds much the same place as Jerome among the Latin fathers. He was, for his time, a man of great culture and wide reading, being familiar with Greek and with older Syriac writers. Of Hebrew he probably understood very little, but he was always ready, like Aphraates, to avail himself of the aid of Jewish scholars, whose opinion he often cites. He appears before us as at once theologian, historian, philosopher, and grammarian, as a translator of various Greek works, and as the indefatigable correspondent of many students who sought his advice and assistance from far and near. As a theologian, Jacob wrote commentaries on the Old and New Testaments, which are cited by later authors, such as Dionysius bar Ṣalībī[28] and Bar-Hebræus, as well as in the large *Catena* of the monk Severus,[29] further, scholia on the whole Scriptures, of which specimens may be found in *S. Ephraemi Opera Syr.*[30] and in Phillips's *Scholia on some Passages of the Old Testament* (1864).[31] His discourses on the six days of creation are extant at

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[1] See above, p. 879.

[2] Bar-Hebræus, *Chron. Eccles.*, ii. 111; *B.O.*, ii. 416.

[3] The circumstances are given in detail by Bar-Hebræus (*Chron. Eccles.*, ii. 119 *sq.*) and Assemani (*B.O.*, ii. 419).

[4] See Brit. Mus. Add. 14645, f. 198a (Wright, *Catal.*, p. 1113).

[5] See above, p. 869. From the commentary are taken the passages quoted in the *Catena* of Severus. See Assemani, *Catal.*, iii. 11 (on Exod., xv. 25), 24, and Wright, *Catal.*, p. 910.

[6] See Brit. Mus. Add. 14727, f. 140a; 17267, f. 17b; 17254, f. 164a; 17128, f. 91b.

[7] According to Bar-Hebræus, *Chron. Eccles.*, i. 275; *B.O.*, ii. 334. Dionysius of Tell-Maḥrē gives 644.

[8] On the Persian name *Sēbōkht* see Nöldeke, *Gesch. des Artachšîr i Pâpakân*, in *Beiträge z. Kunde d. indogerm. Sprachen*, iv. 49, note 4; *Gesch. d. Perser u. Araber*, p. 396, note 1.

[9] See Wright, *Catal.*, p. 598, col. 1.

[10] See *B.O.*, ii. 335; Bar-Hebræus, *Chron. Eccles.*, i. 275.

[11] Compare Renan, *De Philos. Peripat. ap. Syros*, pp. 29, 30.

[12] See Brit. Mus. Add. 14660 and 17156 (Wright, *Catal.*, pp. 1160–63), and the *Catal.* of the Royal Library of Berlin, Sachau 226, 6, 9.

[13] Wright, *Catal.*, p. 1008.

[14] See Sachau, *Ined. Syr.*, pp. 127–134.

[15] Alter Bestand 37, 2 (*Kurzes Verzeichniss*, p. 32).

[16] Same MS., 3.

[17] Wright, *Catal.*, p. 988, col. 2.

[18] *Ibid.*, p. 432, col. 2.

[19] *B.O.*, ii. 463.

[20] Bar-Hebræus, *Chron. Eccles.*, i. 275; *B.O.*, ii. 335. But Dionysius of Tell-Maḥrē says 650; *B.O.*, i. 425.

[21] Berlin, Sachau 185, 6.

[22] Bar-Hebræus, *Chron. Eccles.*, i. 289; *B.O.*, i. 468, ii. 335. Assemani tries hard in vol. i. to prove that he was not a Monophysite (p. 470 *sq.*), but in vol. ii. 337 he gives up the attempt in despair. Compare Lamy, *Dissert. de Syrorum Fide*, etc., p. 206 *sq.*

[23] The dates given in *B.O.*, i. 469, seem to be utterly wrong.

[24] According to the calculation of Dionysius of Tell-Maḥrē, 677; see *B.O.*, i. 426.

[25] So called because he had in his younger days served along with his father in the imperial army.

[26] See above, p 865.

[27] According to Dionysius of Tell-Maḥrē, *B.O.*, i. 426, A.D. 710; but Elias bar Shīnāyā confirms the earlier date. See Baethgen, *Fragmente Syr. u. arab. Historiker*, pp. 40, 121.

[28] See *Bibl. Med. Laurent. et Palat. Codd. Orientt. Catal.*, p. 85, No. xlviii.

[29] *B.O.*, i. 487–488; Cod. Vat. ciii. (*Catal.*, iii. 7); Brit. Mus. Add. 12144 (Wright, *Catal.*, p. 908). The former MS. contains a brief exposition of the Pentateuch, Job, Joshua, and Judges by Jacob, *loc. cit.*, pp. 9–11.

[30] *B.O.*, i. 489–493.

[31] See Brit. Mus. Add. 14483 and 17193, ff. 55a, 61a; compare Cod. Vat. v. (*Catal.*, ii. pp. 12, 13).

Leyden and Lyons.[1] This was his latest work, being unfinished at the time of his death; it was completed by his friend George, bishop of the Arab tribes. Like many other doctors of the Syrian Church, Jacob drew up an anaphora or liturgy,[2] and revised the liturgy of St. James, the brother of our Lord.[3] He also composed orders of baptism,[4] of the consecration of the water on the eve of the Epiphany,[5] and of the solemnization of matrimony,[6] with which we may connect his translation of the order of baptism of Severus[7] and the tract upon the forbidden degrees of affinity.[8] The *Book of Treasures*[9] contained expositions of the Eucharistic service, of the consecration of water, and of the rite of baptism, probably identical with or similar to those which are found separately in MSS.[10] He likewise arranged the horologium or canonical hours of the ferial days,[11] and drew up a calendar of feasts and saints' days for the whole year.[12] Of his numerous canons,[13] those addressed to the priest Addai have been edited by Lamy, *Dissert. de Syrorum Fide*, etc., p. 98 *sq.*, and De Lagarde, *Reliquiæ Juris Eccles. Antiquissimæ*, p. 117 *sq.*[14] Under this head we may mention the *Scholion de Diaconissis earumque Munere* (*Catal. Vat.*, ii. 319) and the *Scholion de Foribus Ecclesiæ dum Ordinationes aut alia Sacra celebrantur occludendis* (Cod. Vat. ccciv., in Mai, *Scriptt. Vett. Nova Coll.*, v.). Jacob also composed homilies, of which a few survive in manuscript: for example—(1) that Christians are not to offer a lamb after the Jewish fashion, nor oxen and sheep, on behalf of the deceased, nor to use pure wine and unleavened bread in celebrating the Eucharist; (2) against the use of unleavened bread; (3) against the Armenians as Dyophysites, and because they offend against these doctrines;[15] (4) against certain impious men and transgressors of the law of God, who trample under foot the canons of the church.[16] To these may be added his metrical discourses on the Trinity and the incarnation of the word[17] and on the faith against the Nestorians.[18] Whether the treatise *De Causa omnium Causarum*[19] really belongs to him can hardly be decided till it has been published. The remarks in the *Bodleian Catalogue*, p. 585, note, point to a writer of much later date. The loss of Jacob's *Chronicle* is greatly to be regretted; only a few leaves, all more or less mutilated, remain to us in Brit. Mus. Add. 14685.[20] The author's design was to continue the *Chronicle* of Eusebius on the same plan, from the twentieth year of the reign of Constantine down to his own time. The introduction was divided into four sections, the first of which treated of the canon of Eusebius and the error of three years in his calculation; the second of the dynasties contemporary with the Roman empire, but omitted by Eusebius; the third explained what dynasties were co-ordinated by Jacob with the Roman empire; and the fourth contained separate chronologies of each of these dynasties. Then followed the chronological canon, beginning with Olympiad cclxxvi. The last monarchs mentioned in the mutilated MS. are Heraclius I. of Constantinople, Ardashēr III. of Persia, and the caliph Abū Bakr. This work, which was finished by the author in 692,[21] has been extensively used by subsequent Syrian historians, both Jacobite and Nestorian, such as Bar-Hebræus,[22] Elias bar Shīnāyā,[23] etc., and it is therefore admitted by 'Abhd-ishō' into his list of books (*B.O.*, iii. 1, 229). As a translator of Greek works Jacob deserves notice, not so much on account of any Aristotelian labors of his,[24] as because of his version of the *Homiliæ Cathedrales* of Severus, a work of capital importance, which he finished in 701.[25] He also revised and corrected, with the help of Greek MSS., the abbot Paul's version of the *Octoēchus* of Severus (see above, p. 880).[26] The statement of Bar-Hebræus[27] that Jacob translated the works of Gregory Nazianzen seems to be erroneous. He merely retouched, we believe, the version of the abbot Paul (see above, p. 880), to which he probably added notes, illustrative extracts from the writings of Severus, and Athanasius's redaction of the Συναγωγὴ καὶ ἐξήγησις ἱστοριῶν appended to the homily *In Sancta Lumina*.[28] He made the Syriac version of the history of the Rechabites as narrated by Zosimus, which he is said to have translated from Hebrew into Greek and thence into Syriac.[29] Of philosophical writings of his we may specify the *Enchiridion*, a tract on philosophical terms.[30] The metrical composition on the same subject contained in two Vatican MSS. may perhaps also be by him.[31] As a grammarian Jacob occupies an important place in Syriac literature. Nestorian scholars, such as Narsai and his pupils, more especially Joseph Hūzāyā (see above, p. 878), had no doubt elaborated a system of accentuation and interpunction, which vies in minuteness with that of the Jews, and had probably begun to store up the results of their studies in Massoretic MSS. of the Bible, like those of which we have already spoken (above, p. 865). But Jacob was the first to give a decided impulse to these pursuits among the Western Syrians, and to induce the monks of Eusēbhōnā and Tell-'Addā to compile Massoretic MSS. like those of their brethren in the East, and to pay attention to minute accuracy in the matter of the diacritical points and the signs of interpunction. Hence we usually find appended to such MSS. of the Jacobite schools the epistle of Jacob to George, bishop of Sĕrūgh, on Syrian orthography,[32] and a tract by him on the pointing of verbal and nominal forms and on the signs of interpunction and accentuation, besides a tract of apparently earlier date on the same signs, with a list of their names, by Thomas the deacon.[33] Further, Jacob's acquaintance with the Greek language and Greek MSS. suggested to him a striking simplification of the system of vowel-points which was now probably beginning to be introduced among the Easterns.[34] He saw that all the vowel-sounds of the Syriac language, as spoken by the Edessenes, could be represented by means of the Greek vowel letters, a style of pointing which would be far clearer to the reader than a series of minute dots. Accordingly he, or his school, put Α for ă, Ο for ō (ā), Ε for e, Η for i, ΟΥ for u; and this system has been adhered to by the Western Syrians or Jacobites since his time.[35] Jacob wished, however, to go a step farther, and sought to introduce a reform for which his countrymen were not prepared. The constant perusal of Greek MSS. had accustomed him to see the vowels placed on an equality with the consonants as an integral part of the alphabet; and, considering how much this contributed to clearness of sense and facility of reading, he desired to see the like done in Syriac. For this purpose he himself designed a set of vowel-signs, to be written on a line with and between the consonants[1]; and for the purpose of making this invention known to his countrymen he wrote a *Syriac Grammar*,[2] in which he used them largely in the paradigms. The innovation, however, found no favor, and the work was supposed to be utterly lost, until a few fragments (partly palimpsest) were simultaneously discovered by the present writer and Dr. Neubauer.[3] Finally, amid all his labors as priest and bishop, teacher and author, Jacob found time to correspond with a large number of persons in all parts of Syria; and these epistles are often among his most interesting writings.[4] One of his principal correspondents was John the Stylite of the convent of Litarba (*Λίταρβα* plur., but also *Λιτάργον*, *Λιταργον*; al-Athārib, near Aleppo); others were Eustathius of Dārā, Kyrisōnā of Dārā, the priest Abraham, the deacon George, and the sculptor Thomas.[5] To the priest Addai he wrote on the orders of baptism and the consecration of the water,[6] to the deacon Bar-ḥadh-bĕ-shabbā against the council of Chalcedon,[7] to the priest Paul of Antioch on the Syriac alphabet, in reply to a letter about the defects of the said alphabet as compared with the Greek,[8] and to George, bishop of Sĕrūgh, on Syriac orthography (see above).

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[1] Leyden, Cod. 66 (1) Gol. (see *Catal. Codd. Orientt.*, v. 69, and Land, *Anecd. Syr.*, i. 2-4); Lyons, No. 2 (see Neubauer in *Archives des Missions scientifiques et littéraires*, 3 ser., vol. i. p. 568, Paris, 1878). The Paris MS. is merely a partial copy of the Leyden one (Zotenberg, *Catal.*, p. 197). It is cited in Brit. Mus. Add. 14731, f. 98b (Wright, *Catal.*, p. 854, col. 2, at the foot), and in the Bodleian *Catal.*, p. 462, No. 5. Another Paris MS. (Zotenberg, *Catal.*, p. 213) contains the punctuation and explanation of difficult words and phrases in this work.

[2] *B.O.*, i. 476. It is extant in many MSS.

[3] *Ibid.*; Brit. Mus. Add. 14691, f. 2b, and elsewhere. Whether he was the translator of the anaphora of Ignatius, we are unable to affirm or deny.

[4] *B.O.*, i. 477.

[5] *Ibid.*, 486, col. 1.

[6] *E.g.*, Zotenberg, *Catal.*, pp. 66, 67.

[7] *E.g.*, Rosen, *Catal.*, p. 61, col. 2.

[8] Cod. Vat. xxxvii. (*Catal.*, ii. 244).

[9] *B.O.*, i. 487.

[10] *E.g.*, the Eucharist, Berlin, Sachau 218, 4 (addressed to the Stylite George of Sĕrūgh); Brit. Mus. Add. 14496, f. 1a (Wright, *Catal.*, p. 224). The similar exposition edited by Assemani (*B.O.*, i. 479) is addressed to the priest Thomas; comp. Brit. Mus. Add. 17215, f. 22b. The consecration of the water, Cod. Vat. cccv., in Mai, *Scriptt. Vett. Nova Coll.*, v. The order of baptism, Brit. Mus. 14496, f. 23a (a mere fragment).

[11] Brit. Mus. Add. 14704; Paris, Anc. fonds 78.

[12] See *Catal. Vat.*, ii. 250-272; and comp. Berlin, Sachau 89, 4.

[13] *B.O.*, i. 477.

[14] See also Kayser, *Die Canones Jacob's von Edessa übersetzt und erläutert, zum Theil auch zuerst im Grundtext veröffentlicht*, 1886.

[15] See *Bibl. Med. Laurent. et Palat. Codd. MSS. Orientt. Catal.*, pp. 107-108.

[16] Wright, *Catal.*, pp. 984, col. 2; 996, col. 2.

[17] *Catal. Vat.*, ii. 516.

[18] *Ibid.*, iii. 353.

[19] See *B.O.*, i. 461-463. Besides the MS. described by Assemani, there are two in the Bodleian Library, Hunt. 128 (Payne Smith, *Catal.*, 585) and Bodl. Or. 732, and a third at Berlin, Sachau 180, with an excerpt in Sachau 203.

[20] See Wright, *Catal.*, p. 1062.

[21] See Elias bar Shīnāyā in Rosen, *Catal.*, p. 88, col. 1.

[22] *B.O.*, ii. 313-314.

[23] See, for example, the notes in Abbeloos, *Bar-Hebræi Chron. Eccles.*, ii. 55, 103, 107, 123; Baethgen, *Fragmente syr. u. arab. Historiker*, extracted from Elias bar Shīnāyā, p. 3; and the anonymous epitomizer in Land, *Anecd. Syr.*, i. 2-22, transl. pp. 103-121 (Brit. Mus. Add. 14643; Wright, *Catal.*, p. 1040).

[24] Even the translation of the *Categories* in Cod. Vat. clviii. (*Catal.*, iii. 306; comp. Renan, *De Philos. Peripat. ap. Syros*, p. 34) is not by him, but by Sergius of Rās'ain (see above, p. 875).

[25] See *B.O.*, i. 494; Cod. Vat. cxli.; Brit. Mus. Add. 12159, dated 868 (Wright, *Catal.*, p. 534 *sq.*).

[26] *B.O.*, i. 487; Cod. Vat. xciv., written between 1010 and 1033. Brit. Mus. Add. 17134, dated 675 (Wright, *Catal.*, p. 330 *sq.*).

[27] *B.O.*, ii. 307, col. 2; iii. 1, 23, col. 1.

[28] See Wright, *Catal.*, pp. 423-427.

[29] *Ibid.*, p. 1128.

[30] *Ibid.*, p. 984.

[31] Cod. Vat. xxxvi. and xcv. (*Catal.*, ii. 243 and 516). In the latter there are three other poems ascribed to him, the first theological, the second with the title *De Philosophis et Bonis Artibus*, and the third entitled *On the Mind*. In the MSS. these poems are said to be by Jacob of Sĕrūgh, which seems altogether unlikely.

[32] See *B.O.*, i. 477 (No. 6) and p. 478 (No. 8).

[33] See, for example, *Catal. Vat.*, iii. 290; Brit. Mus., Rosen, pp. 69, 70 (Wright, p. 110); Paris, Zotenberg, *Catal.*, p. 80. The letter and tracts have been published by Phillips, *A Letter by Mâr Jacob, Bishop of Edessa, on Syriac Orthography*, etc. (1869; the third Appendix, pp. 85-96, 1870), and Martin, *Jacobi epi. Edesseni Epistola ad Georgium episcoum Sarugensem de Orthographia Syriaca* (1869). On the possible indentity of Thomas the deacon with Thomas of Harkel, see Phillips, third Appendix, p. 90.

[34] In the year 899 we find the fully developed Nestorian system of vowel-points in use (Brit. Mus., Add. 12138, see the facsimile in Wright's *Catal.*, pl. xiii.). We may therefore fairly place its beginnings as early as Jacob's time.

[35] The credit of inventing this vowel-system is usually given to Theophilus of Edessa, who died in 785-786 (*B.O.*, i. 64, 521), though Wiseman brought forward to our mind convincing arguments in his *Horæ Syriacæ*, pp. 181-188, in favor of the claims of Jacob. We have now, however, a MS. of Jacob's own time in which these

Athanasius II. of Balad.

After Jacob we may name his friend Athanasius of Balad, who also studied under Severus Sēbōkht at Ḳenneshrē, and devoted himself to the translation of Greek works, philosophical and theological, in the convent of Mār Malchus in Ṭūr'Abhdīn or at Nisībis, where he for a time officiated as priest. He was advanced to the patriarchate in 684 and sat till 687 or 688.[9] In the year 645 he translated the *Isagōgē* of Porphyry, with an introduction, which seems to be chiefly derived from the preface of the Greek commentator Ammonius;[10] and he also edited a version of an anonymous *Isagōgē*, which is found in Brit. Mus. Add. 14660.[11] At the request of Matthew, bishop of Aleppo, and Daniel, bishop of Edessa, he undertook in 669 a translation of select epistles of Severus of Antioch, and of these the sixth book survives in two MSS.[12] He also busied himself with Gregory Nazianzen, as is evidenced by a scholion introductory to the homilies[13] and the version of the Συναγωγὴ καὶ ἐξήγησις ἱστοριῶν.[14] The only other writings of his with which we are acquainted are an encyclical letter, prohibiting Christians from partaking of the sacrifices of their Muḥammadan rulers,[15] and a couple of sedrās.[16]

Januarius Candidatus.

Contemporary with him, and probably an alumnus of the same school, was the translator of the poems of Gregory Nazianzen, in the year 655, whom Assemani calls Senorinus Chididatus of Āmid.[17] He has, however, misread the name. In the MS., as Professor Guidi informs us, it stands ܩܢܕܝܕܛܘܣ ܝܢܘܪܝܘܣ, not ܣܢܘܪܝܢܘܣ. The former part of the name seems to be Ἰανουάριος; the latter is apparently (as Guidi suggests) a corruption of Κανδίδατος. Whether the poems in Brit. Mus. Add. 18821 and 14547[18] belong to the translation of Januarius Candidatus or not, we cannot at present determine.

George, bishop of the Arab tribes.

Another scholar of note at this time is George, bishop of the Arab tribes, the pupil and friend of Athanasius II. and Jacob.[19] He was ordained, it would seem, in 687 or 688, two months after the death of Athanasius, and is said to have died in the first year of Athanasius III., who was consecrated in April 724. His diocese comprised the 'Āḳōlāyē or Arabs of 'Aḳōlā (al-Kūfah), the Ṭū'āye (?), the Tanūkh, the Tha'labites, the Taghlibites, and in general the nomad Arabs of Mesopotamia. Of his works the most important is his translation of the *Organon* of Aristotle, of which there is a volume in the British Museum, Add. 14659, comprising, in its imperfect condition, the *Categories*, Περὶ ἑρμηνείας, and the first book of the *Analytics*, divided into two parts, with introductions and commentaries.[20] Of this version a specimen has been edited by Hoffmann, *De Hermeneuticis*, etc., p. 22 *sq.*, besides small fragments at pp. 30, 38, 45, and 53. He also compiled a a large collection of scholia on the homilies of Gregory Nazianzen, which exhibits a wide range of reading,[21] and completed the *Hexaēmeron* of Jacob of Edessa (see above, p. 882).[22] His other writings are—a commentary, or more likely scholia, on the Scriptures, cited in the *Catena* of Severus and by Bar-Hebræus in his *Ausar Rāzē*;[23] a short commentary on the sacraments of the church, treating of baptism, the holy Eucharist, and the consecration of the chrism;[24] a homily in twelve-syllable metre on the holy chrism in two shapes;[25] another homily on solitary monks, in heptasyllabic metre;[26] and a treatise on the *Calendar* in twelve-syllable metre,[27] cited by Elias bar Shīnāyā.[28] Like Jacob of Edessa, he carried on an extensive literary correspondence, of which some specimens have luckily been preserved in Brit. Mus. Add. 12154, ff. 222–291, dated from 714 to 718. Several of them are addressed to John the Stylite of Litarba, one of whose letters to Daniel, an Arab priest of the tribe of the Tū'āyē, is appended, f. 291. The most important of them is one written to the priest and recluse Yēshū' of Innib (near 'Azāz, north of Aleppo), part of which relates to Aphraates and his works (see above p. 866).[29]

Daniel of Ṣalaḥ.

Contemporary with these scholars was Daniel of Ṣalaḥ (a village northeast of Midyād in Ṭūr-'Abhdīn),[30] who wrote commentaries on the Psalms and Ecclesiastes.[31] The former was in three volumes, and was composed at the request of John, abbott of the convent of Eusebius at Kaphrā dhĕ-Bhārthā (Kafr al-Bārah, near Apamea).[32] There is an abridgment

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Greek vowels are distinctly appended to Syriac words. See Brit. Mus. Add. 17134, f. 83b, in Wright's *Catal.*, p. 337, col. 2, and pl. vi. In this plate, the handwriting of which cannot well be placed later than about 700, we find in l. 1 the vowel υ (ypsilon) in the word ܦܘܪܡܠܐ and in l. 23 the vowel ο in ܩ̈ܠܠܡ, both in black ink, besides others in red ink in lines 6, 17, 18, 21, 22, and 31. No one can doubt, we think, that these vowels were added *a pr. manu*, especially if he compares their forms, particularly the *a*, with those of the Greek letters on the margin of pl. v.

[1] See Bar-Hebræus in his *Kĕthābhā dhĕ-Ṣemḥē*, as quoted by Martin, *Jacques d'Édesse et les Voyelles Syriennes* (*Journ. Asiat.* 1869, vol. xiii. pp. 458–459), or pp. 194–195 of Martin's edition. Jacob had already before him the example of the Mandaites, from whose alphabet his figure of ࡏ for *e* appears to be borrowed.

[2] *B.O.*, i. 475, 477.

[3] See Brit. Mus. Add. 17217, ff. 37, 38; 14665, f. 28; in Wright's *Catal.*, pp. 1168–78. These were reprinted, with the Oxford fragments (Bodl. 159), by Wright in *Fragments of the* ܬܘܪܨ ܡܡܠܠܐ ܢܗܪܝܐ *or Syriac Grammar of Jacob of Edessa* (1871).

[4] Some are metrical; see Brit. Mus. Add. 12172, ff. 65a; 17168, f. 154a.

[5] See all these in Brit. Mus. Add. 12172, ff. 65–135 (Wright, *Catal.*, pp. 592–604). Three of these letters have been published, two by Wright in the *Journal of Sacred Literature*, new series, x. (1867), p. 430 *sq.*, and one by Schröter in *Z.D.M.G.*, xxiv. (1870), pp. 261–300.

[6] *B.O.*, i. 486, No. 11; Brit. Mus. Add. 14715, f. 170a; see also Add. 12144, ff. 47a, 52b.

[7] Brit. Mus. Add. 14631, f. 14b.

[8] *B.O.*, i. 477. No. 7.

[9] *B.O.*, ii. 335; Bar-Hebræus, *Chron. Eccles.*, i. 287, 293. Dionysius of Tell-Maḥrē places his death as late as 704.

[10] Cod. Vat. clviii.; Paris, Anc. fonds 161. According to Renan, *De Philos. Peripat. ap. Syros*, p. 30, note 4, the MSS. clxxxiii. and cxcvi. of the Bibl. Palat. Medic. contain this translation and not that of Ḥonain.

[11] See Wright, *Catal.*, p. 1161, and comp. Renan, *op. cit.*, p. 31.

[12] Brit. Mus. Add. 12181 and 14600 (Wright, *Catal.*, pp. 558–569).

[13] Wright, *Catal.*, p. 441.

[14] *Ibid.*, p. 425.

[15] Zotenberg, *Catal.*, p. 28, col. 2.

[16] Wright, *Catal.*, p. 218 col. 1; Zotenberg, *Catal.*, p. 47, col. 1, No. 23, d.

[17] Cod. Vat. xcvi. (*Catal.*, ii. 521); see *B.O.*, ii. cxlix., 502, col. 2; iii. 1, 23, note.

[18] Wright, *Catal.*, pp. 775, 433, col. 1.

[19] *B.O.*, i. 494; Bar-Hebræus, *Chron. Eccles.*, i. 293, 303; Hoffmann, *De Hermeneuticis apud Syros Aristoteleis*, pp. 148–151; Renan, *De Philos. Peripat. ap. Syros*, pp. 32–33.

[20] See Wright, *Catal.*, p. 1163.

[21] Brit. Mus. Add. 14725, ff. 100–215. It was evidently written after the death of Athanasius II., as shown by the remark on f. 132a (Wright, *Catal.*, p. 443, col. 1). The commentary contained in Brit. Mus. Add. 17197, ff. 1–25 (Wright, *Catal.*, p. 441) is perhaps that of Elias, bishop of Shiggār (Sinjār), who flourished about 750, and is expressly stated (*B.O.*, ii. 339) to have compiled a commentary on the first volume of Gregory Nazianzen (as translated by Paul). He followed the older exposition of Benjamin, bishop of Edessa. This Benjamin was the writer of a letter on the Eucharistic service and baptism (Wright, *Catal.*, p. 1004, col. 2).

[22] See Land, *Anecd. Syr.*, i. p. 4.

[23] *B.O.*, i. 494–495; comp. Wright, *Catal.*, p. 909, col. 2.

[24] Wright, *Catal.*, p. 985.

[25] *B.O.*, i. 332; *Catal. Vat.*, iii. 102, No. 188; Wright, *Catal.*, p. 848, No. 78.

[26] *Bodleian Catal.*, p. 425, No. 88.

[27] *B.O.*, i. 495; *Catal. Vat.*, iii. 532.

[28] Rosen, *Catal.*, p. 88, Nos. 82, 83; comp. also the "Table of the New Moons," in *Catal. Vat.*, ii. 402.

[29] It has been printed by De Lagarde, *Anal. Syr.*, pp. 108–134, and partly reprinted by Wright, *The Homilies of Aphraates*, pp. 19–37. Ryssel has translated and annotated it in *Ein Brief Georgs, Bischofs der Araber, an d. Presbyter Jesus*, 1883.

[30] See Hoffmann in *Z.D.M.G.*, xxxii. 741.

[31] According to a note in Payne Smith's *Catal.*, p. 62, he was bishop of Tellā dhĕ-Mauzĕlath; but at the time when he wrote his commentary on the Psalms he was certainly only a priest and abbot of a convent (see Wright, *Catal.*, p. 606, col. 2).

[32] MSS.—part i., Pss. i.-l., Brit. Mus. Add. 17187; part ii., Pss. li.-c., Add. 14679, 14668 (only three leaves) (see Wright, *Catal.*, pp.

of it in Brit. Mus. Add. 17125, f. 81 *sq.* The commentary on Ecclesiastes is known to us only from the extracts preserved in Severus's *Catena.*[1]

George of Martyropolis.

Regarding George, bishop of Martyropolis,[2] we can add little or nothing to the scanty information collected by Assemani.[3] This scholar has, however, made a mistake in placing him so early as "circa annum Christi 580." About a century later would probably be nearer the mark. Two of his pupils were Constantine, bishop of Ḥarrān, who may have flourished during the latter part of the 7th century, and his successor Leo, who lived at the very end of it and the beginning of the 8th.[4] Constantine wrote several controversial works against the Monophysites, viz.,—an exposition of the creeds of the councils of Nicæa and Chalcedon, a treatise against Severus (of Antioch), an "anagnōsticon" concerning an alleged mutilation of the Trisagion,[5] and a reply to a treatise of Simeon (II., Monophysite bishop of Ḥarrān).[6] Leo's only literary effort appears to have been a letter to the Jacobite patriarch Elias, whom we have next to notice.

Patriarch Elias.

Elias belonged originally to the Dyophysite party in the Syrian Church, but was converted to the Monophysite sect by the study of the writings of Severus. He was a monk of the convent of Gubbā Barrāyā, and for eighteen years bishop of Apamea (or Fāmiyah), before he was raised to the patriarchate of Antioch (in 709). He died in 724.[7] The only work of his known to us is an *Apology*, addressed to Leo, bishop of Ḥarrān, in answer to a letter from him asking the reasons for Elias's change of creed.[8] It was probably written during the time of his episcopate. In it, besides George of Martyropolis and Constantine of Ḥarrān, he cites John of Damascus, among whose Greek works is a tract against the Jacobites, addressed to the bishop Elias in defence of Peter, archbishop of Damascus.

Lazarus of Bēth Ḳandasā.

Lazarus of Bēth Ḳandasā is known to us only through his disciple George of Bēth Nĕḳē as the compiler of a commentary on the New Testament, of which there are two volumes in the British Museum, the one (Add. 14682) containing the Gospels of St. John and St. Mark, the other (Add. 14683) the third and fourth parts of the Pauline epistles from Galatians to Hebrews.[9] The commentary on the epistles is merely an abridgment of Chrysostom; in that on the Gospels use is also made of Jacob of Sĕrūgh, and occasionally of Theodore of Mopsuestia,[10] Cyril of Alexandria, and Ephraim. He also quotes a passage of nine lines from the Sibylline oracles (ed. Friedlieb, viii. 287–296). At the end of part third of the Pauline epistles there is in Add. 14683 a chronological section, terminating with the accession of the 'Abbāsī caliph al-Mahdī in 775, which probably fixes the date of the author.[11] Much later he cannot haved lived, as Add. 14683 is a MS. of the 10th century, having been presented to the convent of St. Mary Deipara in Skete by the patriarch Abraham (or Ephraim), who sat from 977 to 981. In Brit. Mus. Add. 18295 there is a scholion by Lazarus explanatory of a passage in (pseudo-)Dionysius Areopagita.[12]

Daniel bar Moses.

About this time too may have lived the chronicler Daniel bar Moses the Jacobite, who is cited as an authority by Elias bar Shīnayā in the years 122, 127, and 131 of the Hijrah, *i.e.*, from 740 to 749 A.D.[13]

Theophilus of Edessa.

Theophilus bar Thomas of Edessa[14] is stated by Bar Hebræus[15] to have been by religious profession a Maronite. He was addicted to the study of astrology, and an anecdote is related by Bar-Hebræus of his correspondence with Ḥasanah, the concubine of the caliph al-Mahdī, which fixes the date of his death in 785. He was the author of a history, which Bar-Hebræus cites[16] and commends. He also translated into Syriac "the two books of the poet Homer on the conquest of the city of Ilion."[17] This evidently means a version of the entire *Iliad* and *Odyssey*, incredible as it may appear. De Lagarde was, we believe, the first to discover citations of this work by Jacob, or Severus, bar Shakkō, bishop of Mār Matthew, who died in 1241.[18] Cardāḥī (*Liber Thesauri*, p. 40) quotes the rendering of *Iliad* ii. 204, but without saying where he found it. Theophilus is often spoken of as the first to use the Greek vowels in pointing Syriac words, but we have seen above (p. 882, note 21) instances of their occurrence in MSS. older than his time. Perhaps, however, he may have finally settled some details of the system and assisted in bringing it into more general use.[19]

George of Bĕ'elthān.

George of Bĕ'elthān, a village near Ḥimṣ, was educated at the convent of Ḳen-neshrē, and became the syncellus of Theodore, bishop of Samosāta, who prophesied great things of him. On the death of Athanasius III. a synod was held at Mabbōgh, at the close of 758, when a large majority of those present raised George, who was only a deacon, to the see of Antioch.[20] At the instigation of the anti-patriarch David, the caliph al-Manṣūr scourged him and threw him into prison, where he remained for nine years, till he was set free by his son and successor al-Mahdī. He was taken ill during one of his diocesan journeys at Ḳalaudiyah (Claudia), in the far north of Mesopotamia, and died in the convent of Bar-ṣaumā near Melitēne (Malaṭyah), in 790.[21] During his long imprisonment George is said to have composed many discourses and metrical homilies. He was also the author of a commentary on the Gospel of St. Matthew, the unique but imperfect MS. of which has been described by Assemani in *Catal. Vat.*, iii. 293.

Cyriacus.

Cyriacus, a man of Taghrītan family[22] and a monk of the convent of Bīzōnā, otherwise called the convent of the Pillar, near Callinīcus was ordained patriarch of the Jacobites in 793, and died at Mosul in 817. The record of his troubled life may be read in Bar-Hebræus's *Chron. Eccles.*, i. 329 *sq.*; *B.O.*, ii. 116, 341–344. In the year 798 he endeavored to effect a union with the Julianists, whose patriarch was Gabriel, and a creed was drawn up and signed by them and sundry other bishops, which has been preserved in Brit. Mus. Add. 17145, f. 27b.[23] Besides an anaphora[24] and canons,[25] he wrote a homily on the parable of the vineyard[26] and a synodical epistle on the Trinity and the incarnation address to Mark, patriarch of Alexandria, which is extant only in Arabic.[27]

The number of Nestorian writers during the 7th and 8th centuries is relatively much larger than that of Jacobite, and the loss of many of their writings is much to be regretted, especially those bearing on ecclesiastical and political history. Want of space compels us, however, to omit many names which we would otherwise gladly have noticed.

Bābhai the archimandrite.

Our list begins with the name of Bābhai the archimandrite,[28] called Bābhai the Elder, to distinguish him from the later Bābhai bar Nĕṣībhnāyē. He was a native of the village of Bēth 'Aināthā or Bā-'aināthā in Bēth Zabhdai, and succeeded Mār Dādh-īshō' (see above, p. 880) as abbot of the great convent on Mount Īzlā. On the death of the catholicus Gregory of Kashkar in 607 (see above, p. 879) a time of persecution followed, during which the Nestorian Church

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605–606); Cod. Vat. clv., Pss. i.-lxviii. (*Catal. Vat.*, iii. 297); part iii., Pss. cl.-cl., in Arabic, Berlin, Sachau 55. It is frequently cited by Bar-Hebræus in the *Auṣar Rāzē* in Severus's *Catena*, and also by Antonius Rhetor (Wright, *Catal.*, p. 831, col. 1).

[1] *Catal. Vat.*, iii. 17; Wright, *Catal.*, p. 909.

[2] *I.e.*, Maiperḳaṭ or Maiyāfāriḳīn. Assemani calls him bishop of Taghrith or Tekrit.

[3] *B.O.*, i. 465; ii. 96. The epistles to Christopher against Probus and John Grammaticus of Alexandria, and to the monks of the convent of Mār Matthew, are also cited in Brit. Mus. Add. 17197 (Wright, *Catal.*, p. 607).

[4] Assemani places Constantine as early as 630 and Leo about 640 (*B.O.*, i. 466, 467). But in the *Catal. Vat.* they are more correctly described as "uterque S. Johannis Damasceni æqualis" (vol. iii. 255).

[5] These three are mentioned by Assemani, *B.O.*, i. 466.

[6] Wright, *Catal.*, p. 607, col. 2.

[7] *B.O.*, ii. 95, 337; Bar-Hebræus, *Chron. Eccles.*, i. 297; Baethgen, *Fragmente*, pp. 46, 123. Dionysius of Tell-Maḥrē wrongly places his death some years later, in 729.

[8] Two MSS. of this work survive, but both imperfect, the one at Rome, Cod. Vat. cxlv. (*Catal.*, iii. 253), the other in the British Museum, Add. 17197 (Wright, *Catal.*, p. 606).

[9] See Wright, *Catal.*, pp. 608–612.

[10] Sachau, *Theodori Mops. Fragmenta Syr.*, pp. 101 and 62.

[11] The words of George of Bēth Nĕḳē, *buhhānā dhĕ-dhogmā* (Wright, *Catal.*, p. 611, col. 2), probably refer to the liturgical disputes which arose among the Jacobites about this time (*B.O.* ii. 341) and attained considerable importance a little later (p. 348). See Bar-Hebræus, *Chron. Eccles.*, i. 331.

[12] See Wright, *Catal.*, p. 1184

[13] See Baethgen, *Fragmente*, p. 2; Bar-Hebræus, *Chron. Eccles.*, ii. 152, note 2.

[14] *B.O.*, i. 521: Cardāḥī, *Liber Thesauri*, p. 39.

[15] *Hist. Dynast.*, p. 228 (transl., p. 147).

[16] *Op. cit.*, p. 98 (transl., p. 63).

[17] *Op. cit.*, p. 228 (transl., p. 148). Also at p. 40 (transl., p. 26) Bar-Hebræus says that "the poet Homer bewailed her (fall) in two books, which Theophilus the astrologer of Edessa translated from Greek into Syriac."

[18] *E.g.*, *Iliad*, i. 225, 226; vi. 325; xvi. 745: *Odyssey*, xviii. 26; see *The Academy* for October 1, 1871, p. 467.

[19] Compare, *B.O.*, i. 64.

[20] The minority appointed as anti-patriarch John of Callinicus (ar-Raḳḳah), who held office for four years (*B.O.*, ii, 340, col. 2) and was succeeded by David, bishop of Dārā (*ibid.*).

[21] *B.O.*, ii. 340; Baethgen, *Fragmente*, pp. 57, 128; Bar-Hebræus. *Chron. Eccles.*, i. 319 *sq.*, ii. 175.

[22] Bar-Hebræus, *Chron. Eccles.*, i. 343.

[23] See Bar-Hebræus, *Chron. Eccles.*, i. 335.

[24] Wright, *Catal.*, pp. 206, 210.

[25] Wright, *Catal.*, p. 222, col. 2; Zotenberg, *Catal.*, p. 28, No. 54.

[26] Brit. Mus. Add. 14727, f. 110a (Wright, *Catal.*, p. 887).

[27] *B.O.*, ii. 117.

[28] See *B.O.*, iii. 1, 88 *sq.*, 472; Hoffmann, *Auszüge*, pp. 121, 161, 172.

was ruled by Bābhai with a firm and skilful hand. The bishops of Nisībis, Ḥĕdhaiyabh, and Karkhā dhĕ-Bēth Sĕlōkh (or Bēth Garmai) entrusted him with the duties of inspector of convents, with the express object of rooting out all who held the doctrines of the *Mĕṣallĕyānē*,[1] as well as the followers of Ḥannānā of Ḥĕdhaiyabh and Joseph of Ḥazzā.[2] So well did he acquit himself in this post[3] that, after the murder of Khosrau II. in 628, when his successor Ḳawādh II. Shērōē permitted a synod to be held, he would have been unanimously elected to the dignity of catholicus, had he only given his consent, in default of which the choice fell upon Īshō‘-yabh of Gĕdhālā (628–644). As a writer Bābhai would seem to have been very prolific, for no less than eighty-three or eighty-four works are set down to his account.[4] The principal of these, as enumerated by ‘Abhd-īshō‘, are a commentary on the whole text of Scripture; on the commemorations of the Blessed Virgin Mary and St. John, and other commemorations and feasts throughout the year; on the reasons of the celebration of Palm Sunday and of the festival of the holy cross;[5] a discourse on the union (of the two natures in our Lord, against the Monophysites);[6] exposition of the *Centuries* of Evagrius;[7] exposition of the discourses of Mark the monk (on the spiritual law);[8] rules for novices; canons for monks; (controversial) letters to Joseph Ḥazzāyā; history of Diodore of Tarsus and his followers; on Matthew the wanderer, Abraham of Nisībis, and Gabriel Ḳaṭrāyā.[9] To these must be added an account of the life and martyrdom of his contemporary George, a convert from Zoroastrianism, whose heathen name was Mihrāmgushnasp,[10] and a few hymns, contained in Nestorian psalters.[11]

Īshō‘-yabh II. of Gĕdhālā.

The successor of Bābhai was, as we have just mentioned, Īshō‘-yabh II. of Gĕdhālā,[12] who was elected in 628 and sat till 644.[13] He studied at Nisībis, and was bishop of Balad at the time of his elevation to the patriarchate. He was sent in 630 by Bōrān, the daughter of Khosrau II., on an embassy to Heraclius, the emperor of Constantinople, whom he met at Aleppo, and to whom, we are told, he restored the holy cross, which had been carried off by the Persians when they captured Jerusalem in 614.[14] Foreseeing the downfall of the enfeebled Persian monarchy, Īshō‘-yabh prudently made conditions on behalf of his flock with the Muḥammadan ruler, it is said through the intervention of a Christian chief at Najrān and of Yēshū‘ (or Īshō‘), bishop of that place.[15] The deed or ordinance containing the terms of agreement was renewed and confirmed by ‘Omar ibn al-Khaṭṭāb.[16] According to ‘Abhd-īshō‘, the principal writings of Īshō‘-yabh were a commentary on the Psalms and sundry epistles, histories, and homilies. A hymn of his occurs in the Nestorian psalter, Brit. Mus. Add. 14675.[17]

Sāhdōnā of Halamūn.

Sāhdōnā of Halamūn, a village in Bēth Nuhādhrē,[18] was educated at Nisībis, and became a monk under Mār Jacob, the founder of the famous convent of Bēth ‘Ābhē.[19] Here he composed a treatise in two volumes on the monastic life, besides a history of his master, and a funeral sermon on him.[20] He became bishop of Māḥōzē dh'Arēwān in Bēth Garmai,[21] and was one of the Nestorian clergy who accompanied Īshō‘-yabh of Gĕdhālā on his embassy to Heraclius. Whilst halting at Apamea, Īshō‘-yabh, John the Nestorian bishop of Damascus, and Sāhdōnā tried their hand at converting the monks of a neighboring (Jacobite) convent, the result of which was that Sāhdōnā himself was converted,[22] and afterwards wrote several heterodox works. This incident caused much scandal in the East, as may be seen from the numerous letters which Īshō‘-yabh of Ḥĕdhaiyabh, another member of the embassy, found it necessary to write upon the subject.[23]

Īshō‘-yabh III. of Ḥĕdhaiyabh.

This Īshō‘-yabh was the son of a wealthy Persian Christian named Bas-ṭuhmag, of Kuphlānā in Ḥĕdhaiyabh or Adiabēnē, who used often to visit the convent of Bēth ‘Ābhē.[24] He was educated at the school of Nisībis, became bishop of Mosul, and afterwards metropolitan of Ḥazzā (Arbēl or Irbil) and Mosul. The chief event of his rule at Mosul seems to have been that he hindered the Jacobites from building a church in that city,[25] notwithstanding that they were supported by all the weight and influence of the Taghrītans.[26] Bar-Hebræus declares that he bribed right and left to effect this.[27] He was one of those who accompanied Īshō‘-yabh of Gĕdhālā on his embassy to Heraclius,[28] and stole a very costly and beautiful casket, containing relics of the Apostles, from a church at Antioch, the which he conveyed (apparently quite openly and shamelessly) to the convent of Bēth ‘Ābhē.[29] On the death of Mār-emmĕh[30] (who sat 644–647)[31] he was elevated to the dignity of catholicus,[32] which he held till 657–658.[33] In his desire to do something for the promotion of learning he wished to found a school in the convent of Bēth ‘Ābhē, where he had built a magnificent church, but the abbot Ḳām-īshō‘ and the rest of the lazy brotherhood would have none of this, and preferred to quit the convent and withdraw to the neighboring village of Ḥerpā in Saphsāphā.[34] Hereupon the catholicus gave up this part of his plan and built his college in his father's village of Kuphlānā (or Kulpānā.)[35] Soon afterwards he found himself involved in another and more serious dispute with Simeon, the metropolitan of Rēv-Ardashēr[36] in Persis and of the Ḳaṭrāyē,[37] who refused obedience to him as his diocesan; and this led to a lengthy correspondence, regarding which see *B O.*, iii. 1, 127–136. His works, as enumerated by ‘Abhd-īshō‘, are—*Ḥuppākh Ḥushshābhē* or "Refutation of (Heretical) Opinions,"[38] written for John, metropolitan of Bēth Lāpāt,[39] and other controversial tracts, consolatory and other discourses, various hymns,[40] and an exhortation to certain novices. He arranged the Ḥudhrā[41] or service-book for the Sundays of the whole year, for Lent, and for the fast of Nineveh,[42] and drew up offices of baptism,[43] absolution,[44] and consecration.[45] He also wrote a history of the monk Īshō‘-sabhran, a convert from the religion of Zoroaster and a Christian martyr.[46] A large collection of his letters is extant in Cod. Vat. clvii. (*Catal.*, iii. 299), a judicious selection from which would be worth printing.[47]

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[1] See *B.O.*, iii. 1, 101; Bar-Hebræus, *Chron. Eccles.*, i. 578.

[2] See above, p. 879.

[3] See *B.O.*, iii. 1, 88, 89, 473.

[4] *B.O.*, iii. 1, 94, and note 1.

[5] See next paragraph.

[6] See *Catal. Vat.*, iii. 372.

[7] *Ibid.*, iii. 367 *sq.*

[8] Brit. Mus. Add. 17270 (Wright, *Catal.*, p. 482).

[9] That is, of Ḳaṭar, on the coast of al-Baḥrein.

[10] Brit. Mus. Add. 7200, f. 14; Hoffmann, *Auszüge*, pp. 91 *sq.*, 178.

[11] *E.g.*, Brit. Mus. Add. 7156, 17219; see Bickell, *Conspectus*, pp. 37, 38.

[12] Judāl, near Mosul.

[13] *B.O.*, ii. 416–418, iii. 1, 105, 475; Bar-Hebræus, *Chron. Eccles.*, iii. 113 and note 1, 127 and note 3; Baethgen, *Fragmente*, pp. 13, 19, 108, 111.

[14] This, however, seems to have been given back by Ardashēr III. in 628–629, as the festival to celebrate its restoration took place at Jerusalem in 629; see Bar-Hebræus, *Chron. Eccles.*, ii. 113; *B.O.*, iii. 1, 96 note 3, 105–106; Nöldeke, *Gesch. d. Perser u. Araber*, pp. 391–392.

[15] *B.O.*, ii. 418, iii. 1, 108, col. 1; Bar-Hebræus, *Chron. Eccles.*, ii. 115. Bar-Hebræus names Muḥammad himself, but it was more likely Abū Bakr (632–633).

[16] See *B.O.*, iii., 1, 108, col. 1.

[17] Wright, *Catal.*, p. 130, col. 2.

[18] Hoffmann, *Auszüge*, p. 215.

[19] *Ibid.*, p. 226.

[20] *B.O.*, iii. 1, 453, 462.

[21] See *B.O.*, iii. 1, 116, col. 1, at the foot. Assemani pronounces the name Aryūn, but Arēwān is more likely to be correct. See Hoffmann, *Auszüge*, p. 277.

[22] We cannot see that Assemani has any grounds for asserting that Sāhdōnā was converted "ab erroribus Nestorianis ad Catholicam veritatem" (*B.O.*, iii. 1, 107, col. 1; comp. col. 2, ll. 10–12, and p. 120, col. 2, ll. 11–13).

[23] *B.O.*, iii. 1, 116–123. Bar-Hebræus (*Chron. Eccles.*, ii. 113) spitefully improves the occasion by making out that the catholicus Īshō‘-yabh of Gĕdhālā himself was the pervert.

[24] *B.O.*, iii. 1, 472; Hoffmann, *Auszüge*, p. 226.

[25] *B.O.*, iii. 1, 114–115.

[26] Taghrīth was always strongly Jacobite, and the Nestorians had no church there till 767 (see *B.O.*, iii. 1, 111, note 4; Hoffmann, *Auszüge*, pp. 190–191; Bar-Hebræus, *Chron. Eccles.*, ii. 155–157).

[27] *Chron. Eccles.*, ii. 127.

[28] *B.O.*, iii. 1, 106, col. 1.

[29] There is no reason to doubt the circumstantial recital of a Nestorian writer, *B.O.*, iii. 1, 106, col. 2, 475. Strange to say, Assemani does not improve this occasion.

[30] Properly Mār(i)-emmĕh (see *B.O.*, ii. 389, col. 2, No. 29).

[31] According to others, 647–650; *B.O.*, ii. 420, iii. 1, 113, 615.

[32] In 647 or 648.

[33] Or, according to the other reckoning, till 660, *B.O.*, *locc. citt.* He predeceased the maphriān Denḥā, who died in 660 (Bar-Hebræus, *Chron. Eccles.*, ii. 129, 131).

[34] See Hoffmann, *Auszüge*, pp. 228, 227.

[35] *B.O*, iii. 1, 124–125.

[36] Or Rēshahr (Yāḳūt); see Nöldeke, *Gesch. d. Perser u. Araber*, p. 19, note 4.

[37] Or Arabs of Ḳaṭar, on the Persian Gulf, and the adjacent districts. See *B.O.*, iii. 1, 136.

[38] *B.O.*, iii. 1, 137, note 1.

[39] *B.O.*, iii. 1, 138, col. 1; Nöldeke, *Gesch. d. Perser u. Araber*, p. 41, note 2; Hoffmann, *Auszüge*, p. 41, note 351.

[40] The composition on the martyr George quoted by Cardāhi (*Liber Thes.*, pp. 124–125) is probably of much later date. At least we should not expect such artificial riming in the 7th century.

[41] *B.O.*, iii. 1, 139, 144, col. 2.

[42] See Badger, *The Nestorians*, ii. p. 22.

[43] Brit. Mus. Add. 7181 (Rosen, *Catal.*, p. 59).

[44] *E.g.*, of apostates and heretics, *Catal. Vat.*, ii. 307, 367; of public penitents, *ibid.*, 291, Brit. Mus. Add. 7181 (Rosen, *Catal.*, p. 59).

[45] *E.g.*, the consecration of an altar with the chrism, *Catal. Vat.*, ii. 302, 368; see also *ibid.*, 294, where canons of his are given, and Cod. Vat. ccxci., in Mai, *Scriptt. Vett. Nova Coll.*, v.

[46] *Catal. Vat.*, iii. 328; *B.O.*, iii. 1, 285, note 2, and p. 633.

[47] *B.O.*, iii. 1, 140–143.

'Ânân-îshō'

'Ânân-îshō'[1] of Ḥĕdhaiyabh and his brother Īshō'yabh were fellow-students at Nisîbis with Îshō'-yabh III., and afterwards entered the great convent on Mount Îzlâ. Îshō'-yabh subsequently became bishop of Ḳârdâliyâbhâdh;[2] but 'Ânân-îshō' was seized with a fit of wandering, and visited Jerusalem, whence he went on to the desert of Skete in Egypt, and made himself thoroughly acquainted with the lives and habits of its monks, regarding whom he had read so much in the *Paradise* of Palladius. On his return he soon forsook the great convent, because of dissensions that had arisen in it, and betook himself with his brother to the convent at Bēth 'Âbhē, where he devoted himself to study, and so distinguished himself that he was employed by Îshō'-yabh III. to assist in arranging the Ḥudhrâ (see above). 'Ânân-îshō' wrote a volume of philosophical divisions and definitions, with a copious commentary, dedicated to his brother,[3] and compiled a work on the correct reading and pronunciation of difficult words in the writings of the fathers,[4] thus following in the footsteps of Joseph Hûzâyâ (see above, p. 878), and anticipating Jacob of Edessa and the monks of the convent of Ḳarḳaphĕthâ (see above, p. 866). He was also the author of a treatise entitled *Liber Canonum de Æquilitteris, i.e.*, on the different pronunciation and signification of words that are spelt with the same letters. This has been published, with the additions of Ḥonain ibn Isḥâḳ of al-Ḥîrah (died in 873) and another compiler, by Hoffmann, *Opuscula Nestoriānā*, pp. 2–49.[5] His greatest work, however, was a new recension or redaction, in two volumes, of the *Paradise* of Palladius and Jerome, with additions collected by himself from other sources and from his own experience.[6] This he compiled at the request of the patriarch George, and it became the standard work on the subject in the Nestorian convents.[7]

John of Bēth Garmai.

John of Bēth Garmai (Garmĕḳâyâ), called John the Elder, was a disciple of Jacob of Bēth 'Âbhē, and his successor as abbot of that convent. After a few months, however, he secretly fled from Bēth 'Âbhē and betook himself to a hill near Dâḳûḳâ[8] in Bēth Garmai, where the monastery of Ezekiel[9] was soon afterwards built, in which he ended his days.[10] His works, according to 'Abhd-îshō',[11] are—a collection of heads of knowledge or maxims, rules for novices, a brief chronicle, histories of Abraham, abbot of the great convent on Mount Îzlâ, of the monk Bar-'idtâ,[12] and of Mâr Khodhâhwai, the founder of the convent of Bēth Ḥâlē (near al-Ḥadîthah, by Mosul), with a discourse and hymns on the last named.

Sabhr-îshō' Rusṭam.

Sabhr-îshō' Rusṭam[13] was a native of a village called Hĕrem in Ḥĕdhaiyabh, and entered the great convent on Mount Îzlâ under the abbot Narsai, the successor of Bâbhai. Here, at the request of the monks he wrote a tract on the occasion of the celebration of Golden Friday, and also a large volume of disputations against heresies and other theological questions. He migrated thence, perhaps along with Narsai, to Bēth 'Âbhē, where, however, he resided only for a short time, being invited by the monks of Bēth Ḳûḳâ[14] to become their prior. Here he composed eight discourses on the dispensation of our Lord, the conversion of the various countries by the Apostles, and on continence and the monastic life. Further, at the request of Mâr Ḳardagh, the syncellus of Îshō'-yabh III., he wrote lives of Îshō'-Zĕkhâ (of the convent of Gaṣṣâ), of Îshō'-yabh III., of Abraham abbot of Bēth 'Âbhē, who came thither from the convent of Zĕkhâ-îshō'[15] of Ḳâm-îshō' abbot of Bēth 'Âbhē,[16] of Abraham of Nethpar, of rabban Îyôbh (or Job) the Persian, and of the elder Sabhr-îshō', the founder of the convent of Bēth Ḳûḳâ,[17] to which may be added the lives of the brothers Joseph and Abraham.[18]

George of Kaphrâ.

George, the pupil and successor of Îshō'-yabh III., was a native of Kaphrâ in Bēth Gĕwâyâ, a district of Bēth Garmai.[19] His parents were wealthy, and owned two farms in the neighborhood of the convent of Bēth 'Âbhē. Being sent to take charge of these, he got acquainted with the monks and ultimately joined their body. When Îshō'-yabh was promoted to the patriarchate, he appointed George to be metropolitan of Ḥĕdhaiyabh in his stead;[20] and, on the death of his friend, George succeeded to the patriarchate in 661, and sat till 680. As an author he is not of much account, having written merely a few homilies, with hymns and prayers for certain occasions, and published nineteen canons.[21] His too in all probability is the "epistola dogmatica" contained in Cod. Vat. cccclvii., p. 360.[22]

Elias of Merv.

Elias, bishop of Marû or Merv, was one of those who were present at the death of Îshō'-yabh III. and elected George as his successor.[23] He compiled a *Catena patrum* (*Mallĕphânûthâ dhĕ-Ḳadhmâyē*) on the four Gospels, and wrote commentaries on Genesis, Psalms, Proverbs, Ecclesiastes, the Song of Songs, Ecclesiasticus, Isaiah, the twelve minor Prophets, and the epistles of St. Paul. His letters would probably be of some interest to us, and the loss of his ecclesiastical history, to which 'Abhd-îshō' applies the epithet of "trustworthy," is to be regretted.[24]

Daniel bar Maryam.

Of Daniel bar Maryam we can only say that he flourished under Îshō'-yabh III. of Ḥĕdhaiyabh, about 650.[25] He wrote an ecclesiastical history in four volumes, and an explanation of the calendar. The history is cited by George of Arbēl in the 10th century for the date of the destruction of Jerusalem.[26]

Gabriel Taurĕthâ.

Gabriel, surnamed Taurĕthâ, was a native of the province of Siarzûr or Shahrazûr.[27] He studied at Nisîbis, and then entered the great convent on Mount Îzlâ, where he took part in a controversy with the Monophysite monks of the convent of Ḳartamîn (near Mârdîn) and against Sâhdônâ. He afterwards migrated to Bēth 'Âbhē, where he wrote a life of Mâr Narsai the abbot, an account of the martyrs of Ṭûr Bĕrâ'în or Ṭûr Bĕrēn (Âdhurparwâ, Mihrnarsai, and their sister Mâhdokht, in the ninth year of Sapor II.), a homily for the washing of the feet, etc.[28] He became abbot of Bēth 'Âbhē under the catholicus Ḥĕnân-îshō' I. (686–701).[29]

Ḥĕnân-îshō' I.

Ḥĕnân-îshō' I., called the Elder or the Lame (*ḥĕghîrâ*), was appointed catholicus in 686,[30] in succession to John bar Mârtâ,[31] the follower of George. He was opposed by Îshō'-yabh of al-Baṣrah, whom he threw into prison, but afterwards released on his making his submission. A more serious rival was John of Dâsen, bishop of Nisîbis, surnamed the Leper, who curried favor with the caliph 'Abd al-Malik ibn Marwân and procured the deposition of Ḥĕnân-îshō', whose place he occupied for nearly two years.[32] Bar-Hebræus adds[33] that John put him for some days into prison, and then sent him off to a convent among the mountains in charge of two of his disciples, who threw the luckless catholicus down a precipice and left him there for dead. Luckily he was found by some shepherds, who took good care of him, though he seems to have been lame ever after. On his recovery he withdrew to the convent of Yaunân (or Jonah)[34] near Mosul, where he stayed till the death of his rival. He continued to rule the Nestorian Church till 701,[1] and was buried in the convent of Jonah.[2] Besides composing homilies, sermons, and epistles, he was the author of a life of Sergius Dĕwādhā[3] of Daraukarah or Daukarah, near Kashkar, who was a contemporary of his. He also wrote a treatise *On the Twofold Use of the School* or university, as a place of moral and religious training as well as of instruction in letters, and a commentary on the *Analytics* of Aristotle.[4]

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[1] Properly 'Anâ-n(î)-shō'; see *B.O.*, iii. 1, 144–146; Hoffmann, *Opusc. Nestor.*, p. iv.

[2] The older name of Shennâ dhē-Bhēth Remmân, in Arabic Sinn Bâ-rimmâ, or simply as-Sinn; see Hoffmann, *Auszüge*, pp. 189, 258.

[3] *B.O.*, iii. 1, 144,, col. 2, near the foot.

[4] *Ibid.*, iii. 1, 144.

[5] From a MS. in the India Office library, London. There is another copy in the collection of the S.P.C.K., now at Cambridge.

[6] See *B.O.*, ii. 493; iii. 1, 49, 145 col. 2, 151 col. 1, middle.

[7] The *The Illustrations of the Book of the Paradise* in Brit. Mus. Add. 17263, 17264 (Wright, *Catal.*, pp. 1078–80) and Orient. 2311 seems to be a different work. The author of it is said to have been a Ḳaṭrâyâ, "a native of Ḳaṭar," which 'Ânân îshō' was not.

[8] Hoffmann, *Auszüge*, p. 273.

[9] So called from its founder; see Hoffmann, *op. cit.*, p. 274, note 2154.

[10] *B.O.*, iii. 1, 203–204, 474. But he must have lived till after 661, for Mâr Khodhâhwai was still alive in that year (*B.O.*, iii. 1, 151, near the top).

[11] *B.O.*, iii. 1, 204.

[12] *Ibid.*, iii. 1, 467, col. 2, ch. 4.

[13] *Ibid.*, iii. 1, 454–455.

[14] On the Great Zâb, in Ḥĕdhaiyabh; see Hoffmann, *Auszüge*, p. 215, note 1715.

[15] *B.O.*, iii. 1, 468, col. 1, at the top.

[16] Who died in 652; see Baethgen, *Fragmente*, pp. 21, 112.

[17] *B.O.*, ii. 418, col. 2.

[18] *Ibid.*, iii. 1, 228, col. 1, near the foot.

[19] *B.O.*, ii. 421, iii. 1, 149; Bar-Hebræus, *Chron. Eccles.*, ii. 131, 133; Hoffmann, *Auszüge*, p. 277.

[20] He must be distinguished from two other Georges, Persians by race, also disciples of Îshō'-yabh, viz., George, bishop of Pĕrath dĕ-Maishân or al-Baṣrah, and George, bishop of Nisîbis, the latter of whom is the author of a well-known hymn (see *B.O.*, iii. 1, 456; Bickell, *Conspectus*, p. 38), often found in Nestorian psalters, *e.g.*, Rosen, *Catal.*, p. 14, w; Wright, *Catal.*, p. 131, col. 1; Munich *Catal.*, Cod. Syr. 4, p. 112.

[21] *B.O.*, iii. 1, 153.

[22] Mai, *Scriptt. Vett. Nova Coll.*, v.

[23] *B.O.*, ii. 420.

[24] *Ibid.*, iii. 1, 148.

[25] *Ibid.*, ii. 420; iii. 1, 231.

[26] *Ibid.*, iii. 1, 521.

[27] See Hoffmann, *Auszüge*, p. 43, notes 364, 365, p. 254 *sq.*

[28] *B.O.*, iii. 1, 456–458; Hoffmann, *Auszüge*, pp. 9–16, from Brit. Mus. Add. 12174 (Wright, *Catal.*, p. 1188).

[29] Bar-Ṣaumâ was abbot at the beginning of Ḥĕnân-îshō''s patriarchate; see *B.O.*, iii. 1, 457, col. 1.

[30] Bar-Hebræus, *Chron. Eccles.*, ii. 135; Baethgen, *Fragmente*, pp. 82, 117; *B.O.*, ii. 423.

[31] He sat 680–682; *B.O.*, ii. 422, iii. 1, 615; Bar-Hebræus, *Chron. Eccles.*, ii. 133.

[32] Baethgen, *Fragmente*, pp. 34, 85, 118, 119.

[33] *Chron. Eccles.*, ii. 135 *sq.*; *B.O.*, ii. 423.

[34] *B.O.*, ii. 424, note 3. Bar-Hebræus calls it "the convent of John."

Alāhā-zĕkhā.

Presumably to this century belong two ecclesiastical historians who are known to us only from the *Chronicle* of Elias bar Shīnāyā. Alāhā-zĕkhā is quoted by him in regard to events that took place in 594–596 and 606.[5] Perhaps he is identical with that Alāhā-zĕkhā to whom we find Īshō'-yabh III. writing a letter while he was yet bishop, consequently in the earlier part of the century.[6]

Mīkhā.

Mīkhā or Micah is cited by Elias as an authority for the years 594–596 and 605.[7]

David of Bēth Rabban.

Passing over into the 8th century, we may mention David of Bēth Rabhan, that is, of the convent of Zĕkhā-īshō', afterwards of Bēth 'Ābhē, who was the author of a monastic history, called *The Little Paradise*, which is frequently cited by Thomas of Margā. Its first chapter contained anecdotes relative to George Neshrāyā, Nathaniel, and other monks of Bēth 'Ābhē, who lived under Ḥĕnān-īshō' I., towards the end ef the 7th century.[8] David attained episcopal dignity, though we do not know the name of his see. He wrote also a geographical treatise *Upon the Limits of Climates or Countries, and the Variations of the Days and Nights.*[9]

Bābhai bar Nĕṣībh-nāyē.

Bābhai bar Nĕṣībhnāyē (so called because his parents were of Nisībis) flourished under the catholicus Ṣĕlībhā-zĕkhā (713–729), the successor of Ḥĕnān-īshō'.[10] He was a native of Gĕbhīltā or Jabiltā in Ṭirhān,[11] and is described by Thomas of Margā as being a tall, powerful man, with a magnificent voice, gentle and modest, and learned withal. He devoted himself to the reformation of the musical services of the Nestorian Church, which had fallen into sad confusion, and founded many schools, more particularly in the dioceses of Ḥĕdhaiyabh and Margā, with the special object of promoting the study of church music. The most important of these were at Kĕphar-'Uzzēl[12] in Ḥĕdhaiyabh and Bāshūsh in the district of Saphsāphā in Margā.[13] At the former he took up his residence, but used to visit and inspect the others once a year. In his latter years he returned to Gĕbhīltā and died there. He wrote discourses and homilies of different kinds, numerous hymns for various occasions, histories (of holy men), and letters.[14]

Bar-Sāhdē.

Bar-Sāhdē of Karkhā dhĕ-Bhēth Sĕlōkh flourished, according to Assemani, under the catholicus Pethiōn (731–740).[15] 'Abhd-īshō' states that he wrote an ecclesiastical history[16] and a treatise against the Zoroastrian religion.

Abraham bar Dāshandādh.

When Bābhia the Nisibene was residing at Kĕphar-'Uzzēl (see above), a woman from the village of Bēth Ṣaiyādhē brought to him her crippled son, whom she called "only half a man," and begged him to bless him. "This is no half man," was the gentle monk's reply; "this shall be a father of fathers and a chief of teachers; his name and his teachings shall be famous throughout the whole East."[17] This was Abraham bar Dāshandādh "the Lame," whose works are enumerated by 'Abhd-īshō' as follows[18]—a book of exhortation, discourses on repentance,"[19] letters, the book of the king's way, a disputation with the Jews, and a commentary on the discourse of Mark the monk.[20] He was teacher at the school of Bāshūsh in Saphsāphā, where the future catholicus Timothy I. received his early education, as well as his successor Īshō' bar Nōn and Abū Nūḥ al-Anbārī.[21]

Mār-abhā II.

Mār-abhā, the son of Bĕrīkh-ṣebhyānēh, was a native of Kashkar,[22] and became bishop of that town. From this see he was promoted in 741 to the dignity of catholicus.[23] At first he had some difficulties with the emir Yūsuf ibn 'Omar ath-Thaḳafī, but these were settled by a visit to al-Kūfah, which gave him an opportunity of going also to al-Ḥīrah, where he was received with great honor by the aged bishop John Azraḳ. He shortened his name to Abhā, the better to distinguish himself from his predecessor Mār-abhā I. (see above, p. 878). In the sixth year of his patriarchate he got into a dispute with his clergy about the management of the school at Seleucia, and withdrew to Kashkar, but returned to Seleucia before his death, which took place in 751, at the age, it is said, of 110 years. According to Bar-Hebræus, "he was learned in ecclesiastical works and in dialects, and composed a commentary on Theologus (*i.e.*, Gregory Nazianzen),[24] and all his time he was occupied in reading books." 'Abhd-īshō' mentions him in two places, as Abhā of Kashkar[25] in *B. O.*, iii. 1, 154, and as Abhā bar Bĕrīkh-ṣebhyānēh at p. 157. In the former place he ascribes to him expositions, letters, and a commentary on the whole *Dialectics* of Aristotle,[26] and in the latter, *The Book of the Generals*, or *Military Governors*,[27] and other works.

Simeon bar Ṭabbākhē.

Simeon bar Ṭabbākhē (the Butcher) of Kashkar held the important post of chief officer of the treasury under the caliph al-Mansūr,[28] about the same time that his co-religionist George bar Bōkht-īshō' of Gundē-Shābhōr or Bēth Lāpāṭ,[29] in Khūzistān, was court physician.[30] The only work of his mentioned by 'Abhd-īshō' is an ecclesiastical history, which from his position at Baghdādh doubtless contained much valuable information.

Sūrēn.

Sūrēn or Sūrīn,[31] bishop of Nisībis and afterwards of Ḥalaḥ or Ḥolwān in Bēth Mādhāyē,[32] was raised to the patriarchate in 754, by the orders of Abān, the Muḥammadan emīr of al-Madāīn (Seleucia). The bishops appealed to the caliph 'Abdallāh as-Saffāḥ,[33] and not in vain. The election was cancelled, and Jacob, bishop of Gundē-Shābhōr, was chosen in his place (who sat till 773). Their continued squabbles, however, so irritated al-Manṣūr that he gave orders to throw them both into prison. Sūrēn made his escape in time, but Jacob was caught and spent the next nine years under strict ward, during which time "the second Judas," 'Īsā ibn Shahlāthā or Shahlāfā,[34] deacon and physician, trampled the rights of the bishops under foot. On his release, he sent Sūrēn as bishop to al-Baṣrah, at the request of some of the Christian citizens, but others would not receive him, and their quarrels once more attracted the caliph's attention. Sūrēn, warned by 'Īsā, again made his escape, but was captured by the emīr of al-Madāīn and died in prison.[35] The epithet of *Mĕphashshĕḳānā*, given to him by 'Abhd-īshō',[1] implies that he was either a commentator on Scripture or a translator of Greek works into Syriac. He composed a treatise against heretics, but the remainder of 'Abhd-īshō''s text is not clear in Assemani's edition.[2]

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[1] According to Elias bar Shīnāyā in Baethgen, *Fragmente*, pp. 88, 120. Others say 699.

[2] His Arab biographer and co-religionist adds that his grave was opened 650 years afterwards, and his body found undecayed and looking as if he slept.

[3] Not Dūdhā. The word means "liable to fits," "epileptic," "crazy."

[4] *B.O.*, iii. 1, 154.

[5] See Bar-Hebræus, *Chron. Eccles.*, ii. 106 note 3, 107 note 3.

[6] *B.O.*, iii. 1, 141, No. 35.

[7] See Bar-Hebræus, *Chron. Eccles.*, ii. 106 note 3, 107 note 2.

[8] *B.O.*, iii. 1, 217 col. 2, 218 col. 1; see also pp. 49 note 1, 184 col., 1, l., 1.

[9] *B. O.*, iii. 1, 255. The poems referred to by Assemani in note 1 are no doubt of much later date. The first of them is edited by Cardāhī in his *Liber Thasauri*, pp. 41–46. Cardāhī places David's death "in the year 800." Twenty-two very artificial poems "on the love of wisdom," ascribed to him, are printed in the *Directorium Spirituale* of John of Mosul, edited by the bishop Elias John Millos, 1868, pp. 172–214.

[10] According to Elias bar Shīnāyā, in Baethgen, *Fragmente*, pp. 42, 47, 122, 124. Assemani (*B. O.*, ii. 430) gives 714–728.

[11] Hoffmann, *Auszüge*, p. 188.

[12] *Ibid.*, p. 236 *sq.*

[13] *Ibid.*, p. 223.

[14] See *B. O.*, iii. 1, 177–181. Of his hymns a few are still extant; see Bickell, *Conspectus*, p. 38; Brit. Mus. Add. 7156 (Rosen, *Catal.*, p. 14, v, x, y, z), Add. 14675 (Wright, *Catal.*, p. 181, col. 1); 17219 (*ibid.*, p. 186, col. 1); Paris, Suppl. 56 (Zotenberg. *Catal.*, p. 9, col. 1, t); Munich, Cod. Syr. 4 (Orient. 147).

[15] *B.O.*, ii. 430; Baethgen, *Fragmente*, pp. 49, 125.

[16] Cited by Elias bar Shīnāyā; see Bar-Hebræus, *Chron. Eccles.*, ii. 65, note 1.

[17] *B.O.*, iii. 1, 179.

[18] *Ibid.*, iii. 1, 194.

[19] According to another reading *on desire* or *cupidity*.

[20] See Brit. Mus. Add. 17270 (Wright, *Catal.*, p. 482).

[21] Assemani (*B.O.*, iii. 1, 196, note 4) says that Timothy I. was a pupil of Abraham bar Līphah, but Īshō' bar Nōn and Abū Nūḥ are expressly stated to have been pupils of Abraham "the Lame," *ibid.*, p. 165, note 4, and p. 212, note 2; see also p. 486, col. 1.

[22] Others say of Daukarah, in the neighborhood of Kashkar, *B. O.*, ii. 431.

[23] Baethgen, *Fragmente*, pp. 50, 125; Bar-Hebræus, *Chron. Eccles.*, ii. 158; *B. O.*, ii. 431, iii. 1, 157.

[24] See *B.O.*, iii. 1, 157, col. 2.

[25] Whom Assemani takes for Abraham of Kashkar (see above p. 878); for what reason we cannot see.

[26] See *B.O.*, iii, 1, 157, col. 2.

[27] Perhaps a chronicle of the Muḥammadan governors of al-'Irāḳ.

[28] *B.O.*, iii. 1, 206, col. 1, ll. 4, 5.

[29] Nöldeke, *Gesch. d. Perser u. Araber*, p. 41, note 2.

[30] *B.O.*, iii. 1, 205, col. 2, note 4; Baethgen, *Fragmente*, pp. 59, 60, 129; Bar-Hebræus, *Hist. Dynast.*, 221; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 26.

[31] On the name see Nöldeke, *Gesch. d. Perser u. Araber*, p. 488, note 4.

[32] See Hoffmann, *Auszüge*, p. 120.

[33] He died in June of this same year.

[34] See Bar-Hebræus, *Hist. Dynast.*, p. 221; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 26.

[35] *B.O.*, ii. 431; iii. 1, 168, 205–206.

Cyprian of Nisibis.

Cyprian, bishop of Nisībis, was appointed to that see in 741.[3]. The great event of his life was the building of the first Nestorian church in the Jacobite city of Taghrīth, just outside of the walls, on the banks of the Tigris. The idea originated with Ṣĕlībhāzĕkhā, bishop of Ṭirhān, but would never have been realized, had not Cyprian allowed the Jacobites to resume possession of the church of Mār Domitius at Nisībis. The building of the church at Taghrīth was commenced in 767.[4] Cyprian also erected a magnificent church at Nisībis, on which he expended the sum of 56,000 dīnārs, in 758–759.[5] After this time it so happened that the patriarchs of the three Christian sects, Theodoret the Malkite, George the Jacobite, and Jacob the Nestorian, were all in prison at once at Baghdādh. 'Isā the physician, thinking to improve the occasion to his own advantage, wrote to Cyprian that the caliph al-Manṣūr coveted some of the golden and silver vessels of the church of Nisībis, hinting at the same time in pretty plain language that a handsome present to himself might be of some avail at this juncture. Cyprian had the courage to go straight to Baghdādh with the letter and show it to the caliph, who disgraced 'Īsā and confiscated his property,[6] releasing the three patriarchs at the same time.[7] Cyprian died in 767.[8] According to 'Abhd-īshō', he wrote a commentary on the theological discourses of Gregory Nazianzen and various forms of ordination.[9]

Timothy I.

Timothy I. was a native of Ḥazzā in Ḥĕdhaiyabh, and had been a pupil of Abraham bar Dāshandādh (see above p. 887 at the the school of Bāshūsh in Saphsāphā. He became bishop of Bēth Bāghēsh,[10] and stood well with the Muḥammadan governor of Mosul, Abū Mūsā ibn Mus'ab, and his Christian secretary Abū Nūḥ al-Anbārī.[11] On the death of Ḥĕnān-īshō' II. in 779,[12] several persons presented themselves as candidates for the dignity of catholicus. Timothy got rid of Īshō'-yabh, abbot of Bēth 'Abhē, by pointing out to him that he was an old man, unfit to withstand his younger rivals, and by promising, if he himself were successful, to make him metropolitan of Ḥĕdhaiyabh, which he afterwards did. Meantime Thomas of Kashkar and other bishops held a synod at the convent of Mār Pethiōn in Baghdādh, and elected the monk George, who had the support of 'Īsā the court physician; but this formidable opponent died suddenly. Having by a mean trick obtained the support of the archdeacon Bēṛōē and the heads of the various colleges, Timothy managed at last to get himself appointed catholicus, about eight months after the death of his predecessor. He still, however, encountered strong opposition. Ephraim metropolitan of Gundē-Shābhōr, Solomon bishop of al-Ḥadīthah, Joseph metropolitan of Marū or Merv, Sergius bishop of Ma'allĕthāyā, and others held a synod at the convent of Bēth Ḥālē, in which they made Rusṭam, bishop of Ḥĕnāithā,[13] metropolitan of Hĕdhaiyabh in place of Ishō'-yabh,[14] and excommunicated Timothy, who retorted with the same weapon and deposed Joseph of Merv. Joseph brough the matter before the caliph al-Mahdī, but, failing to gain any redress, in an evil hour for himself became a Muḥammadan.[15] Once more Ephraim summoned his bishops to Baghdādh and excommunicated Timothy for the second time, with no other result than a counter-excommunication and some disgraceful rioting, which led to the interference of 'Īsā and the restoration of peace.[16] Timothy was duly installed in May, 780.[17] He made the bishops of Persia subject to the see of Seleucia, and appointed over them one Simeon as metropolitan with orders to enforce a stricter rule than heretofore.[18] In his days Christianity spread among the Turks, and the khāḳān himself is said to have become a convert.[19] Timothy's disgraceful response to the caliph ar-Rashīd in the matter of the divorce of Zubaidah may be seen in *B.O.*, iii. 1, 161. He is said to have died in 204 A.H. = 819–820 A.D., or 205 = 820–821; but, if he really was catholicus for forty-three years, his death cannot have taken place till 823.[20] 'Abhd-īshō' informs us that Timothy wrote synodical epistles, a volume on questions of ecclesiastical law, another on questions of various sorts, a third containing disputations with a heretic, viz., the Jacobite patriarch George, about 200 letters in two volumes, a disputation with the caliph al-Mahdī or his successor al-Hādī (on matters of religion) and an astronomical work on the stars[21]. Bar-Hebræus adds hymns for the dominical feasts of the whole year and a commentary on Theologus (Gregory Nazianzen).[22]

Anonymous historians.

In this century too we may place the two following historical writers, whose names and works are unfortunately known to us only through the mention made of them by a later annalist. (1) An anonymous author, the abbot of the great convent (of Abraham on Mount Īzlā), cited by Elias bar Shīnāyā in his *Chronicle* under the year 740–741.[23] (2) An ecclesiastical historian called Pethiōn, identified by Baethgen (*Fragmente*, p. 2, No. 6) with the catholicus of that name. This is, however, impossible, because the catholicus died in 740, whereas the *Ecclesiastical History of Pethiōn* is cited by Elias bar Shīnāyā under the years 765 and 768.

Pethiōn.

Ishō'-dĕnaḥ.

We conclude our enumeration of the Nestorian writers of this century with the name of another historian. In the *Bibl. Orient.*, iii. 1, 195, the text of 'Abhd-īshō', as edited by Assemani, speaks of a writer named Īshō-dĕnaḥ, bishop of Ḳaṣrā. Other MSS., however, read Baṣrā (al-Baṣrah), which is confirmed by Elias bar Shīnāyā in Baethgen's *Fragmente*, p. 2. The variation Dĕnaḥ-īshō' Bar-Hebræus (*Chron. Eccles.*, i. 334) is of no consequence, and even there the MSS. differ. Besides the usual homilies of sorts and some metrical discourses, he wrote an introduction to logic, a work entitled *The Book of Chastity*, in which he collected lives and anecdotes of holy men and founders of monasteries, and an ecclesiastical history in three volumes.[24] This valuable work is known to us only by a few citations in Bar-Hebræus and Elias bar Shīnāyā. Those in Bar Shīnāyā[25] range from 624 to 714, but the extract in Bar-Hebræus[26] brings us down to 793.

Reverting now to the Jacobite Church, we shall find that the number of its literary men in the 9th century is not large, though some of them are of real importance as theologians and historians.

Dionysius of Tell-Maḥrē.

Dionysius Tell-Maḥrāyā was, as his surname implies, a native of Tell-Maḥrē, a village situated between ar-Raḳḳah and Ḥiṣn Maslamah, near the river Balīkh.[27] He was a student in the convent of Ḳen-neshrē,[28] and on its destruction by fire[29] and the consequent dispersion of the monks, he went to the convent of Mār Jacob at Kaisūm, in the district of Samosāta.[30] He devoted himself entirely to historical studies,[31] which he seems to have carried on in peace and quiet till

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[1] *Ibid.*, iii. 1, 168.

[2] *Ibid.*, iii. 1, 169.

[3] Baethgen, *Fragmente*, pp. 50, 125; Bar-Hebræus, *Chron. Eccles.*, ii. 154, note 1.

[4] Bar-Hebræus, *Chron. Eccles.*, ii. 155–157.

[5] Baethgen, *Fragmente*, pp. 57, 128.

[6] Bar-Hebræus, *Hist. Dynast.*, p. 224.

[7] Bar-Hebræus, *Chron. Eccles.*, ii. 161-163; *B.O.*, iii. 1, 111–112.

[8] Baethgen, *Fragmente*, pp. 60, 129.

[9] *B.O.*, iii. 1, 111–113. By the "theology" of Gregory Nazianzen are probably meant the discourses bearing the title *Theologica Prima*, etc.; see, for example, Wright, *Catal.*, p. 425, Nos. 22–25.

[10] Hoffmann, *Auszüge*, p. 227 *sq.*

[11] Also a pupil of Abraham bar Dāshandādh (*B.O.*, iii. 1, 212 note 2, 159, col. 1). He is mentioned in commendatory terms by Timothy in his encyclical letters of 790 and 805 (*B.O.*, iii. 1, 82 col. 1, 164 col. 1; 'Abhd-īshō', *Collectio Canonum Synodicorum*, ix. 6, in Mai, *Scriptt. Vett. Nova Coll.*, x. pp. 167 col. 1, 329 col. 1). He was the author of a refutation of the Kor'ān, a disputation against heretics, and other useful works (*B.O.*, iii. 1, 212), among which may be mentioned a life of the missionary John of Dailam (*B.O.*, iii. 1, 183, col. 2).

[12] Or, according to others, 777.

[13] Hoffmann, *Auszüge*, p. 216 *sq.*

[14] *B.O.*, iii. 1, 207.

[15] We need not believe all the evil that Bar-Hebræus tell us of this unhappy man, *Chron. Eccles.*, ii. 171 *sq.*

[16] See the whole miserable story told in full in *B.O.*, ii. 433, iii. 1, 156-160; Bar-Hebræus, *Chron. Eccles.*, ii. 165-169.

[17] Baethgen, *Fragmente*, pp. 64, 131.

[18] Bar-Hebræus, *Chron. Eccles.*, ii. 169; *B.O.*, ii. 433.

[19] *B.O.*, iii. 1, 160. Compare Chwolson's interesting memoir "Syrische Grabinschriften aus Semirjetschie" (west of the Chinese province of Kuldja, more correctly Kuldja), in *Mém de l'Acad. Imp. des Sc. de St. Pétersb.*, 7th ser., vol. xxxiv., No. 4. The oldest of these tombstones is dated A. Gr. 1169 = 858 A.D., and marked "the grave of Mengkū-ṭenesh the believer" (p. 7); but most of them belong to the 13th and 14th centuries.

[20] See *B.O.*, ii. 434; iii. 1, 160.

[21] *B.O.*, iii. 1, 162-163.

[22] *Chron. Eccles.*, ii. 179. He is probably the author of the hymn in Brit. Mus. Add. 7156 (Rosen *Catal.*, p. 18, col. 1, l) and Paris, Suppl. 56) Zotenberg, *Catal.*. p. 9, col. 1, i).

[23] See Baethgen, *Fragmente*, p. 2, No. 3; Bar-Hebræus *Chron. Eccles.*, ii. 152 note 2, 154 note 1 (Abbeloos writes "the abbots of the great convent").

[24] *B.O.*, iii. 195.

[25] Baethgen, *Fragmente*, p. 2.

[26] *Chron. Eccles.*, i. 333; *B.O.*, iii. 1, 195 note 4 (where 695 is a mistake for 793). See also Bar-Hebræus *Chron. Eccles.*, ii. 42 note 2, 114 note 1, 122 note 1, 127 note 3, 138 notes 1, 2, 140 note 1.

[27] See Hoffmann in *Z.D.M.G.*, xxxii. (1878), p. 742, note 2.

[28] Bar-Hebræus, *Chron. Eccles.*, i. 347–349.

[29] *B.O.*, ii. 345, col. 1, where the rebuilding of it by Dionysius is mentioned; Bar-Hebræus, *Chron. Eccles.*, i. 355, at the top.

[30] Bar-Hebræus, *Chron. Eccles.*, i. 347–349. A previous residence at the convent of Zuḳnīn near Āmid (*B.O.*, ii. 98, col. 2) is uncertain, as the words *dairā dhīlan* probably mean no more than "the convent of us Jacobites."

[31] Bar-Hebræus, *Chron. Eccles.*, i. 347, last line.

818. The patriarch Cyriacus (see above, p. 884) had got entangled in a controversy with the monks of Cyrrhus and Gubbā Barrāyā about the words *laḥmā shĕmaiyānā* ("the heavenly bread"), etc., in the Eucharistic service, which ended in the malcontents setting up as anti-patriarch Abraham, a monk of the convent of Ḳartamin. After the death of Cyriacus in 817, a synod was held in June, 818, at Callinīcus (ar-Raḳḳah), in which, after considerable discussion, Theodore, bishop of Kaisūm, proposed the election of Dionysius, which was approved by most of those present, including Basil I., maphriān of Taghrīth.[1] The poor monk was accordingly fetched to Callinīcus, received deacon's orders on Friday in the convent of Estūnā or the Pillar, priest's orders on Saturday in the convent of Mār Zakkāi or Zacchæus, and was raised to the patriarchate in the cathedral on Sunday the first of Âbh, 818, the officiating bishop being Theodosius of Callinīcus. Abraham and his partisans, seeing their hopes disappointed, maintained their hostile attitude, which led afterwards to the usual scandalous scenes before the Muslim authorities.[2] Immediately after his installation, Dionysius commenced a visitation of his vast diocese, going first northwards to Cyrrhus, thence to Antioch, Kirkēsion (Ḳirḳisiyā), the district of the Khābhūr, Nisībis, Dārā and Kĕphar-tūthā, and so back to Callinīcus, where he enjoyed the protection of 'Abdallāh ibn Ṭāhir against his rival Abraham. He did not on this occasion visit Mosul and Taghrīth because the maphriān Basil thought the times unfavorable.[3] In 825 'Abdallāh ibn Ṭāhir was sent to Egypt to put down the rebellion of 'Obaidallāh ibn as-Sarī, where he remained as governor till 827.[4] His brother Muḥammad ibn Ṭāhir was by no means so well disposed towards the Christians, and destroyed all that they had been allowed to build in Edessa.[5] Wherefore the patriarch went down into Egypt to beg the emīr 'Abdallāh to write to his brother and bid him moderate his zeal against the church, which he accordingly did.[6] On his return from Egypt the patriarch had troubles with Philoxenus, bishop of Nisībus, who espoused the cause of the anti-patriarch Abraham;[7] and he then went to Baghdādh in 829 to confer with the caliph al-Ma'mūn as to an edict that he had issued on the occasion of dissensions between the Palestinian and Babylonian Jews regarding the appointment of an exiliarch.[8] During his stay in the capital disputes took place among the Christians, which ended in a reference to the caliph and in the deposition of the bishop Lazarus bar Sābhĕtha.[9] From Baghdādh Dionysius proceeded to Taghrīth and Mosul, and nominated Daniel as maphriān in place of the deceased Basil. In 830 al-Ma'mūn made an attack on the Greek territory, and the patriarch tried to see him on his return at Kaisūm, but the caliph had hurried on to Damascus, whither Dionysius followed him and accompanied him to Egypt on a mission to the Bashmuric Copts, who were then in rebellion. Any efforts of his and of the Egyptian patriarch were, however, of no avail, and the unfortunate rebels suffered the last horrors of war at the hands of al-Ma'mūn and his general Afshīn.[10] On this journey Dionysius saw and examined the obelisks of Heliopolis, the pyramids, and the Nilometer.[11] In 835 he revisited Taghrīth to settle some disputes between the Taghritans and the monks of Mār Matthew at Mosul, and to ordain Thomas as maphriān in place of the deceased Daniel.[12] In the same year he went once more to Baghdādh to salute al-Ma'mūn's successor al-Mu'taṣim, and met there the son of the king of Nubia, who had come on the same errand.[13] The latter years of Dionysius were embittered by the oppressions and afflictions which the Christians had to endure at the hands of the Muḥammadans. He died on 22d August, 845, and was buried in the convent of Ḳen-neshrē.[14] He left behind him one great work, his *Annals*, covering the whole period of the world's history from the creation down to his own time. Of this there were two recensions, a longer and a shorter. The longer redaction was dedicated to John, bishop of Dārā, and came down at all events to the year 837, or perhaps a little later.[15] Assemani has published an extract from it, which he was fortunate enough to find in Cod. Vat. cxliv., f. 89, in the *B. O.*, ii. 72–77.[16] It would seem to have been written, after the manner of John of Asia, in a series of chapters dealing with particular topics. The shorter redaction is extant in a single imperfect MS. Cod. Vat. clxii.,[17] and is dedicated to George, chorepiscopus of Âmid, Euthalius the abbot (of Zuḳnīn?), Lazarus the periodeutes, the monk Anastasius, and the rest of the brotherhood. It is arranged by successive years, and ended with the year of the Greeks 1087 = 776 A.D.[18] The author has adopted a division into four parts. Part first extends from the creation to the reign of Constantine. Here the chief authority is the *Chronicorum Canonum Liber* of Eusebius, supplemented by some extracts from other Greek sources, such as Eusebius's *Ecclesiastical History* and the *Chronographia* of Julius Africanus. With these Dionysius has incorporated matter derived from sundry other works, *e.g.*, the *Chronicle of Edessa* (see above, p. 886), the *Mĕ'arrath Gazzē* or "Cave of Treasures,"[19] Pseudo-Callisthenes's *Life of Alexander the Great* the story of the seven sleepers,[20] and Josephus's *Jewish War* (see above, p. 862).[21] The second part of Dionysius's *Chronicle* reaches from Constantine to Theodosius II., and here he principally followed the *Ecclesiastical History* of Socratés (compare Cod. Vat. clxv.). The third part extends from Theodosius II. to Justin II. Here Dionysius acknowledges himself chiefly indebted to his countryman John of Asia (see above, p. 886), but has also incorporated the short *Chronicle* of Joshua the Stylite (see above, p. 873) and the epistle of Simeon of Bēth Arshām on the Himyarite Christians (see above, p. 873). The fourth part, coming down to 158 A.H. = 774–775 A.D., is his own compilation, partly from such written documents as he could find, partly from the oral statements of aged men, and partly from his own observation. Assemani has given an account of the whole work, with an abridgment or excerpt of the fourth part, in the *Bibl. Orient.*, ii. 98–116; but the labors of Dionysius of Tell-Maḥrē will never be appreciated as they deserve till the appearance of the edition which is now being prepared by Guidi.

Under Dionysius flourished his brother Theodosius, bishop of Edessa, also a student of Greek at Ḳen-neshrē. Bar-Hebræus makes mention of him as accompanying Dionysius to Egypt in 825–826 to complain to 'Abdallāh ibn Ṭāhir of the wrongs of the Christians.[22] At an earlier period (802–803), when only a priest, he translated the homily of Gregory Nazianzen on the miracles[23] of the prophet Elijah, and Bar-Hebræus says that he also rendered into Syriac the poems of the same author.[24]

Theodosius of Edessa.

A friend of his was Antonius, a monk of Taghrīth, surnamed "the Rhetorician."[25] He was the author of a treatise on rhetoric in seven chapters,[26] of a work on the good providence of God in four discourses,[27] and of various encomia, thanksgivings, consolatory epistles,[28] and prayers,[29] in many of which he makes use not merely of metre but also of rime.[30]

Antonius the Rhetorician.

Lazarus bar Sābhĕthā, called as bishop Philoxenus and Basil,[31] ruled the see of Baghdādh in the earlier part of the 9th century. As mentioned above, he was deposed by Dionysius in 829. He compiled an anaphora or liturgy,[32] and wrote an exposition of the office of baptism.[33] The latter may be

Lazarus bar Sābhĕthā.

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[1] *Ibid.*, i. 347.

[2] *Ibid.*, i. 355–357; *B.O.*, ii. 345. Abraham died in 837, and was succeeded by his brother Simeon as anti-patriarch.

[3] Bar-Hebræus, *Chron. Eccles.*, i. 358.

[4] Wüstenfeld, *Die Statthalter von Aegypten*, 1te Abth., p. 32 *sq.*; De Sacy *Relation de l'Egypte par Abd-allatif*, pp. 501–508 and 552–557.

[5] Bar-Hebræus, *Chron. Eccles.*, i. 359.

[6] *Ibid.*, i. 369.

[7] *Ibid.*, i. 368.

[8] *Ibid.*, i. 365.

[9] *Ibid.*, i. 365–371.

[10] Bar-Hebræus, *Chron. Eccles.*, i. 373; Weil, *Gesch. d. Khalifen*, ii. 246; Wüstenfeld, *Die Statthalter von Aegypten*, 1te Abth., pp. 40–43.

[11] Bar-Hebræus, *Chron. Eccles.*, i. 377–381.

[12] *Ibid.*, 381.

[13] *Ibid.*, 381.

[14] *Ibid.*, 385.

[15] *Ibid.*, 383–385.

[16] See *Catal. Vat.*, iii. 253.

[17] See *Catal. Vat.*, iii. 328. Assemani's account of this MS. is not so clear as could have been wished. In the *Catal Vat.*, iii. 329, he says that it is "unus ex iis codicibus, quos Moses Nisibenus cœnobiarcha e Mesopotamia in Scetense S. Mariæ Syrorum monasterium intulit" (viz., in 932); but there is now no note whatever in the MS. to show that this was the case.

[18] *B.O.*, ii. 99. At present the MS. ends in the year 775, a few leaves being wanting at the end.

[19] Translated into German by Besold, *Die Schatzhöhle* (1883). The Syriac text is not yet published.

[20] Guidi, *Testi Orientali inediti sopra i Sette Dormienti di Efeso* (Reale Accad. dei Lincei), 1885; see in particular p. 34, note 3.

[21] The Syriac text of this first part was edited by Tullberg, *Dionysii Telmaharensis Chronici liber primus*, 1850 (compare Land, *Johannes Bischof von Ephesos*, pp. 39–41). The Eusebian extracts have been translated and compared with the Greek original (so far as possible), the Latin version of Jerome, and the Armenian version, by Siegfried and Gelzer, *Eusebii Canonum Epitome ex Dionysii Telmaharensis Chronico petita* (1884). On this work see Gutschmid, *Untersuchungen über d. syrische Epitome der Eusebischen Canones* (1886). The editors have not always correctly rendered the text of their "blatero Syrius"; see a flagrant example on p. 79, last paragraph.

[22] Bar-Hebræus, *Chron. Eccles.*, i. 361; *B.O.*, ii. 345.

[23] Cod. Vat. xcvi., *Catal. Vat.*, ii. 521; *B.O.*, ii. p. cxlix, No. 17.

[24] Bar-Hebræus, *Chron. Eccles.*, i. 363; *B.O.*, ii. 345. To this version perhaps belong the poems contained in Brit. Mus. Add. 14547 (Wright, *Catal.*, p. 433) and 18821 (*ibid.*, p. 775).

[25] Bar-Hebræus, *Chron. Eccles.*, i. 363; *B.O.*, ii. cl. and 345.

[26] Brit. Mus. Add. 17208 (Wright, *Catal.*, p. 614).

[27] Brit. Mus. Add. 14726 (Wright, *Catal.*, p. 617).

[28] Brit. Mus. Add. 17208.

[29] Brit. Mus. Add. 14726.

[30] See a specimen in Rödiger's *Chrestom Syr.*, 2d ed., pp. 110–111.

[31] See Wright, *Catal.* p. 496, col. 2.

[32] See Renaudot, ii. 399.

[33] Cod. Vat. cxlvii., *Catal.*, iii., 276.

only part of a larger work on the offices of the church, from which Bar-Hebræus may have derived the information regarding the musical services quoted by Assemani, *B.O.*, i. 166.

John of Dārā.

Contemporary with these was John, bishop of Dārā, to whom Dionysius dedicated the larger recension of his history (see above). He compiled a liturgy,[1] and was the author of the following works—a commentary on the two books of Pseudo-Dionysius Areopagita *De Hierarchia Cœlesti et Ecclesiastica*,[2] four books on the priesthood,[3] four books on the resurrection of the dead,[4] and a treatise on the soul.[5]

Nonnus of Nisībis.

Nonnus was an archdeacon of the Jacobite church at Nisībis during the first half of this century, the Nestorian bishop Cyprian having allowed the Monophysites to resume possession of the church of St. Domitius in 767 (see above, page 887). He is mentioned by Bar-Hebræus as bringing charges against the bishop Philoxenus, who had sided with the anti-patriarch Abraham, and was therefore deposed by a synod held at Rās'ain in 827 or 828.[6] We know also that he was in prison at Nisībis when he wrote his work against Thomas bishop of Margā and metropolitan of Bēth Garmai, who flourished under the Nestorian catholics Abraham (837–850) and Theodosius (852–858). Besides this controversial treatise in four discourses, Nonnus was the writer of sundry letters of a similar character.[7]

Romanus the physician or Theodosius.

Romanus the physician, a monk of the convent of Ķartamīn, was elected patriarch at Āmid in 887, and took the name of Theodosius.[8] He died in 896. He was the author of a medical syntagma (*kunnāshā*) of some repute.[9] He wrote a commentary on Pseudo-Hierotheus, *On the Hidden Mysteries of the House of God*,[10] and dedicated it to Lazarus, bishop of Cyrrhus.[11] The work is divided into five books, the first and second of which he finished at Āmid before going down to the East, and the third at Samosāta. He also compiled a collection of 112 Pythagorean maxims and proverbs, with brief explanations in Syraic and Arabic, addressed to one George.[12] A synodical epistle of his is extant in Arabic, written to the Egyptian patriarch Michael III.,[13] and a Lenten homily in Arabic.[14]

Moses bar Kēphā.

Moses bar Kēphā was the son of Simeon Kēphā (or Peter) and his wife Maryam. The father was from the village of Mashhad al-Koḥail, on the Tigris opposite al-Ḥadīthah,[15] the mother a native of Balad, in which town their son was born somewhere about 813. He was taught from his early youth by Rabban Cyriacus, abbot of the convent of Mār Sergius on the Ṭārā Ṣahyā, or Dry Mountain, near Balad, and there assumed the monastic garb. He was elected bishop of Bēth Remmān (Bārimmā),[16] Bēth Kiyōnāyā,[17] and Mosul,[18] about 863, and took the name of Severus. He was also for ten years periodeutes or visitor of the diocese of Taghrīth. He died A. Gr. 1214 = 903 A.D.,[19] "aged about ninety years, of which he had been bishop for forty," and was buried in the convent of Mār Sergius. His works are numerous. He wrote commentaries on the whole Old and New Testaments,[20] which are often cited by Bar-Hebræus in the *Auṣar Rāzē*. Of these, that on the book of Genesis survives, though imperfect, in Brit. Mus. 17274,[21] and there are extracts from them in Paris, Ancien fonds 3.5 (Zotenberg, *Catal.*, p. 156), and Bodl. Marsh. 101 (P. Smith, *Catal.*, p. 462). The Gospels and Pauline epistles (imperfect) are contained in Brit. Mus. Add. 17274 (Wright, *Catal.*, p. 620), the latter only in Bodl. Or. 703 (P. Smith, *Catal.*, p. 410) and Bodl. Marsh. 86 (*ibid.*, p. 418). His treatise on the *Hexaēmeron* in five books[22] is preserved to us in the Paris MS. Anc fonds 120 (Zotenberg, *Catal.*, p. 197), and there are extracts from it in two other MSS. (*ibid.*, pp. 157, 159). The work *de Paradiso*, in three parts, dedicated to his friend Ignatius of ܡܪܘܢܠܐ (?),[23] is known to us only through the Latin translation of Andreas Masius, 1569.[24] The treatise on the soul[25] survives in Cod. Vat. cxlvii. (*Catal.*, iii. 273-274); it consists of 40 chapters, with a supplementary chapter to show that the dead are profited by offerings made on their behalf. That on predestination and freewill, in four discourses, is extant in Brit. Mus Add. 14731 (Wright, *Catal.*, p. 853). The *Disputations against Heresies*, spoken of by Moses's biographer in *B.O.*, ii. 218, col. 2, is probably identical with the work *On Sects* mentioned by Assemani at p. 131, No. 7. The *Festal Homilies* for the whole year[26] is extant in several MSS., *e.g.*, Brit. Mus. Add. 21210 (Wright, *Catal.*, p. 877) and 17188 (*ibid.*, p. 621), Paris, Anc. fonds 35 and 123 (Zotenberg, *Catal.*, pp. 156, 159).[27] Besides these we have four funeral sermons,[28] an admonitory discourse to the children of the holy orthodox church,[29] and a discourse showing why the Messiah is called by various epithets and names.[30] Moses also wrote expositions of the sacraments of the church, such as on the holy chrism, in 50 chapters, Cod. Vat. cxlvii. (*Catal.*, iii. 274) and Paris, Anc. fonds 123 (Zotenberg, *Catal.*, p. 159),[31] with which is connected the discourse on the consecration of the chrism in Brit. Mus. Add. 21210 (Wright, *Catal.*, p. 879); on baptism, addressed to his friend Ignatius, in 24 chapters, Cod. Vat. cxlvii. (*Catal.*, iii. 276), in connection with which we may take the discourse on the mysteries of baptism in Brit. Mus. Add. 21210 (Wright, *loc. cit.*) and on baptism in Cod. Nat. xcvi. (*Catal.*, ii. 522);[32] exposition of the liturgy, Brit. Mus. Add. 21210 (Wright, *Catal.*, p. 879) and Berlin, Sachau 62 (?); further, expositions of the mysteries in the various ordinations, Cod. Vat. li. (*Catal.*, ii. 320);[33] on the ordination of Bishops, priests, and deacons, Brit. Mus. Add. 21210 (Wright, *Catal.*, p. 879); on the tonsure of monks,[34] Cod. Vat. li. (*Catal.*, ii. 322).[35] He also compiled two anaphoræ,[36] one of which has been translated by Renaudot, ii. 391. Lastly, Moses bar Kēphā was the author of a commentary on the dialectics of Aristotle, mentioned by Bar-Hebræus in *Chron. Eccles.*, ii. 215, and of a commentary on the works of Gregory Nazianzen, and an ecclesiastical history, mentioned by his biographer in *B. O.*, ii. 218, col. 2. The loss of this last book is to be regretted.

The contemporary Nestorian writers of mark are hardly more numerous.

Honain ibn Isḥāķ.

In this century the foundations of Syriac lexicography were laid by the famous physician Abū Zaid Ḥonain ibn Isḥāķ al-'Ibādī of Ḥērtā (al-Ḥīrah).[37] He applied himself to medicine at Baghdādh, under Yaḥyā, or Yuḥannā, ibn Māsawaihi (Māsūyah or Mesue); but an ill-feeling soon sprang up between teacher and pupil, and Ḥonain took his departure for the Grecian territory, where he spent a couple of years in acquainting himself with the Greek language and its scientific literature. He afterwards became physician to the caliph al-Mutawakkil. His downfall and excommunication were meanly brought about by a fellow-Christian of the same profession, Isrā'īl ibn aṭ Ṭaifūrī, and Ḥonain died soon after, 260 A.H. = 873 A.D.[1] Ḥonain composed most of his original works in Arabic, and likewise many of his translations from the Greek. ‘Abhd-īsho‘ mentions but three books of his,[2] viz., a book on the fear of God (which he wrote as a deacon of the church), a Syriac grammar, and a compendious Syriac lexicon. The lexicon has no doubt been in great part absorbed into the later works of Bar ‘Alī and Bar Bahlūl.[3] The grammar seems to have been entitled *Kĕthābhā-dhĕ-Nuḳzē*, or the "Book of (Diacritical) Points." It is cited by Bar-Hebræus in the *Ausār Rāzē*[4] and by Elias of Ṭīrhān, in his grammar.[5] Ḥonain also wrote a treatise *On Synonyms*, whether they be "voces æquilitteræ" (as *rĕghīz* and *raggīz*) or not (as *‘āḳĕthā* and *karyūthā*). Extracts from this work have been preserved to us by a later compiler, who made use also of the canons of Ānanīshō‘ of Ḥĕdhaiyabh[6] (see above, p. 885). In Cod. Vat. ccxvii. (*Catal.*, iii. 504) there are excerpts from a medical treatise of Ḥonain, but no title is given.[7] Ḥonain, his son Isḥāḳ, and his nephew Ḥobaish ibn al-Ḥasan al-A‘sam ("Stiff-wrist") were among the earliest and ablest of those Christians, chiefly Nestorians, who, during the 9th and 10th centuries, making Baghdādh their headquarters, supplied Muḥammadan scholars with nearly everything that they knew of Greek science, whether medicine, mathematics, or philosophy. As a rule, they translated the Greek first into Syriac and afterwards into Arabic; but their Syriac versions have unfortunately, as it would appear, perished, without exception.[8]

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[1] *B.O.*, ii. 128.

[2] *B.O.*, ii. 120–121; Cod. Vat. c. (*Catal.*, ii. 539), ccclxiii. (Mai *Scriptt. Vett. Nova Coll.*, v.); Bodl. Or. 264 (Payne Smith, *Catal.*, pp, 487–492). There is an extract in Cod. Vat. ccccxl. p. 1 (Mai, *op. cit.*).

[3] *B.O.*, ii. 121; Cod. Vat. c. (*Catal.*, ii. 542), ccclxiii. (Mai, *op. cit.*); Bodl. Or. 264 (P. Smith, pp. 492–496). Extracts from bks. ii. and iv. in Zingerle, *Monum. Syr.*, i. 105–110; from bk. iv. in Overbeck, *S. Ephraemi*, etc., *Opp. Sel.*, pp. 409-418; see Bar Hebræus, *Chron. Eccles.*, ii. 394, note 1, No. 18.

[4] *B.O.*, ii. 119; Cod. Vat. c. (*Catal.*, ii. 531), ccclxii. (Mai, *op. cit.*).

[5] *B.O.*, ii. 219, note 1. From it there are extracts in Cod. Vat. cxlvii. (*Catal.*, iii. 276).

[6] Bar-Hebræus, *Chron. Eccles.*, i. 363; *B.O.*, ii. 346, col. 1.

[7] These writings are all contained in Brit. Mus. Add. 14594 (Wright (*Catal.*, pp. 618–620).

[8] Bar-Hebræus, *Chron. Eccles.*, i. 391; ii. 213.

[9] *Ibid.*, i. 391. Assemani suggests that it may be the work contained in Cod. Vat. cxcii, (*Catal.*, iii. 409). Compare Frothingham, *Stephen bar Sudaili the Syrian Mystic and the Book of Hierotheos*, 1886, p. 84 *sq.*

[10] A forgery of Stephen bar Ṣūdh-ailē; see above p. 878.

[11] Brit. Mus. Add. 7189 (Rosen, *Catal.*, p. 74). This is the very copy which was procured with some difficulty for the use of Gregory Bar-Hebræus (Wright, *Catal.*, p. 1205).

[12] Paris, Ancien fonds 118, 157 (Zotenberg, *Catal.*, p. 147 col. 1, 166 col. 1); Bodl. Marsh. 201, f. 58 (Payne Smith, *Catal.*, p. 507); *B. O.*, ii. 125. It is admirably edited by Zotenberg in the *Journ. Asiat.*, 1876, pp. 426–476.

[13] *B. O.*, ii. 124.

[14] Brit. Mus. Add. 7206, f. 73 (Rosen, *Catal.*, p. 108).

[15] See Hoffmann, *Auszüge*, p. 190.

[16] *Ibid.*, p. 190.

[17] *B.O.*, ii. 218, note 1, col 2; Hoffmann, *Auszüge*, p. 30, note 343. In Wright's *Catal.*, p. 620, col. 2, the name is written Bēth Kiyōnā; in *B. O*., ii. 127, Bēth Kēnā.

[18] In Wright's *Catal.*, p. 621, he is called bishop of Bēth Remmān and Bēth 'Arbāyē (Bā-'arbāyā).

[19] As correctly given in *B. O.*, ii. 218; Bar-Hebræus, *Chron. Eccles.*, ii. 217 (and by MS. C. also in i. 395).

[20] *B.O.*, ii. 130, note 3; 218, col. 2.

[21] Wright *Catal.*, p. 620.

[22] *B.O.*, ii. 128, No. 1.

[23] *Ibid.*, ii. 218, col. 2.

[24] *Ibid.*, ii. 128, No. 2.

[25] *Ibid.*, ii. 131, No. 6.

[26] *Ibid.*, ii. 131, No. 9.

[27] See also Cod. Vat. clix. (*Catal.*, iii. 316–317); on the Ascension, Cod. Vat. cxlvii. (*Catal.*, iii. 276).

[28] Brit. Mus. Add. 17188 (Wright, *Catal.*, p. 622).

[29] Brit. Mus. Add. 21210 (Wright, *Catal.*, p. 879).

[30] Brit. Mus. Add. 17188 (Wright, *Catal.*, p. 622).

[31] The Paris MS. Ancien fonds 35 contains another redaction in 36 chapters (Zotenberg, *Catal.*, p. 157).

[32] See also Cod. Vat. ccccxl., in Mai. *Scriptt. Vett. Nova Coll.*, v.

[33] See also Cod. Vat. ccciv., in Mai, *op. cit.*

[34] *B.O.*, ii. 131, No. 8.

[35] Compare Cod. Vat. cccv., in Mai, *op. cit.*

[36] *B.O.*, ii. 130, No. 4.

[37] Al-'Ibādī was the *nisbah* of an Arab Christian of Al-Ḥīrah. See Ibn Khallikān, ed. Wüstenfeld, No. 87. Latin writers generally call him Joannitius.

Gabriel bar Bōkht-īshō‘.

An elder contemporary of Ḥonain was Gabriel bar Bōkht-īshō‘, in Arabic Jabra’īl ibn Bakhtīshū‘ (or rather Bokhtīshū‘), a member of a family of renowned physicians, beginning with George bar Bōkht-īshō‘ of Gundē-Shăbhōr, whom we have mentioned above (p. 887). He was in practice at Baghdādh in 791, and attended on Ja‘far ibn Yaḥyā al-Barmakī, became court physician to ar-Rashīd, and maintained this position, with various vicissitudes, till his death in 828.[9] ‘Abhd-īshō‘ says that he was the author of a Syriac lexicon,[10] which is our reason for giving him a place here, but no such work is mentioned by the other authorities to whom we have referred.[11]

Īshō‘ Marūzāyā.

Of Īshō‘ Marūzāyā, in Arabic ‘Īsā al-Marwazī, from the city of Marū or Merv, little is known to us beyond the fact that he compiled a Syriac lexicon, which was one of the two principal authorities made use of by Bar ‘Alī.[12] That he should be identical with the physician al-Marwazī, who lived about 567,[13] seems wholly unlikely. We might rather venture to identify him with Abū Yaḥyā al-Marwazī, who was an eminent Syrian physician at Baghdādh, wrote in Syriac upon logic and other subjects, and was one of the teachers of Mattā ibn Yaunān or Yūnus (who died in 940).[14] In any case, ‘Īsā al-Marwazī seems to have flourished during the latter part of the 9th century, and therefore to have been a contemporary of Bar ‘Alī.

Bar ‘Alī.

Īshō‘, or ‘Īsā, bar ‘Alī is stated in Cod. Vat. ccxvii. (*Catal.*, iii. 504, No. xv,) to have been a pupil of Ḥonain. His father ‘Alī and his uncle ‘Īsā, the sons of Dā-ūd or David, were appointed by the catholicus Sabhr-īshō‘ II. (832–836) to the charge of the college founded by him in the convent of Mār Pethiōn at Baghdādh.[15] Bar ‘Alī's lexicon is dedicated to a deacon named Abraham,[16] who made certain additions to it after the death of the author.[17]

Īshō‘bar Nōn.

Īshō‘ bar Nōn was a native of the village of Bēth-Gabbarē near Mosul. He was a pupil of Abraham bar Dāshandādh (see above, p. 887) at the same time with Abū Nūḥ al-Anbārī (see above, p. 888), note 11, and Timothy, his predecessor in the dignity of catholicus (see above, p. 888). He retired first to the convent of Mār Abraham on Mount Īzlā, where he devoted himself to study and to refuting the views and writings of his schoolfellow and subsequent diocesan Timothy, whom he spitefully called *Ṭālĕm-otheos* ("the wronger of God") instead of *Timotheos*. In consequence of a dispute with the monks he left Mount Īzlā and went for some months to Baghdādh, where he stayed at the house of George Māsawaihi (Māsūyah or Mesue) and taught his son Yaḥyā.[18] He then returned to Mosul, where he took up his residence in the convent of Mār Elias, and lived there for thirty years, till the death of Timothy.[19] Through the influence of Gabriel bar Bōkht-īshō‘ (see above) and his son-in-law Michael bar Māsawaihi (Māsūyaḥ or Mesue), the physician of the caliph al-Ma’mūn, he was appointed catholicus A.Gr. 1135 = 823–824 A.D.[20] He sat for only four years, and was buried, like his predecessor, in the convent of Kĕlīl-īshō‘ at Baghdādh. Of his ill-feeling towards Timothy I. we have already made mention; how he kept it up after Timothy's death, and what troubles he got into in consequence, may be read in the pages of Assemani (*B.O.*, iii. 1, 165). Bar-Hebræus has preserved some account of a disputation between him and a Monophysite priest named Pāpā.[21] ‘Abhd-īshō‘ gives the following list of his works[22]—a treatise on theology, questions on the whole text of Scripture, in two volumes, a collection of ecclesiastical canons and decisions,[23] consolatory discourses, epistles, a treatise on the division of the services, *turgāmē* or "interpretations,"[24] and a tract on the efficacy of hymns and anthems. Of the questions on Scripture there is a copy in the collections of the S.P.C.K., and of the consolatory discourses a mutilated MS. in the British Museum, Add. 17217 (Wright, *Catal.*, p. 613).[25] The replies to the questions of Macarius the monk seem to belong to the treatise on the division of the services (*purrāsh teshmĕshāthā*), if one may judge by the first and only one quoted.[26]

Denḥā.

A disciple of Īshō‘ bar Nōn was Denḥā, or, as he is otherwise called in some MSS. of ‘Abhd-īshō‘'s *Catalogue*, Īhībhā (or rather Hībhā, Ibas).[27] Assemani places him under the catholicus Pethiōn (died in 740), but we prefer to follow the authority of John bar Zō‘bī in his *Grammar*.[28] Denḥā was the author of sermons and tracts on points of ecclesiastical law, and of commentaries on the Psalms, on the works of Gregory Nazianzen (as contained in two vols. in the translation of the abbot Paul), and on the dialectics of Aristotle.

Thomas of Margā.

In 217 A.H. = 832 A.D., the same year in which Sabhr-īshō‘ II. succeeded to the patriarchate,[29] a young man named Thomas, the son of one Jacob of Bēth Sherwānāyē, in the district of Salakh,[30] entered the convent of Bēth ‘Ābhē, which seems at this time to have fallen off sadly in respect of the learning of its inmates.[1] A few years afterwards (222 A.H. = 837 A.D.) we find him acting as secretary to the patriarch Abraham (also a monk of Bēth ‘Ābhē, who sat from 837 to 850).[2] By him he was promoted to be bishop of Margā, and afterwards metropolitan of Bēth Garmai, in which capacity he was present at the ordination of his own brother Theodosius bishop of al-Anbār, afterwards metropolitan of Gundēshābhōr) as catholicus in 852.[3] Thomas of Margā (as he is commonly called), having been very fond from his youth of the legends and histories of holy men, more especially of those connected with his own convent of Bēth ‘Ābhē, undertook to commit them to writing at the urgent request of the monk ‘Abhd-īshō‘, to whom he dedicates the *Monastic History*. Assemani has given a tolerably full analysis of this work, with a few extracts, in the *B.O.*, iii. 1, 464–501, throughout which volume it is one of his chief authorities. The publication of it in a complete form is much to be desired. The MSS. available in Europe are—Cod. Vat. clxv. (*Catal.*, iii. 331), of which Codd. Vatt. ccclxxxi.–ii. are a copy (Mai, *Scriptt. Vett. Nova Coll.*, v.); Paris, No. 286 in Zotenberg's *Catal.*, p. 216 (also copied from Vat. clxv.); Brit. Mus. Orient. 2316 (ff. 182, 17th century, imperfect); Berlin, Sachau 179 (copied in 1882). Thomas also wrote a poem in twelve-syllable metre on the life and deeds of Māran-‘ammēh, metropolitan of Ḥĕdhaiyabh, which he introduced into his *History*, bk. iii. ch. 10; see *B.O.*, iii. 1, 485.

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[1] See the *Fihrist*, pp. ٢٩٤ and 140; Ibn Abī Uṣaibi‘ah, ed. Müller, i. 184; Ibn Khallikān, ed. Wüstenfeld, No. 208; al-Mas‘ūdī *Murūj adh-Dhahab*, ix. 173 *sq.*; Bar-Hebræus, *Chron. Syr.*, p. 170 (transl., p. 178; *B.O.*, ii. 270, note 3; *Chron. Eccles.*, ii. 197–199 (*B.O.*, ii. 438; *Hist. Dynast.*, p. 263 *sq.* (transl. p. 171 *sq.*); Wenrich, *De Auctt. Gr. Versionibus*, Index, p. xxxi.; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 69.

[2] *B.O.*, iii. 1, 165.

[3] See Gesenius, *De Bar Alio et Bar Bahlulo Commentatio*, 1834, p. 7.

[4] See Hoffman, *Z.D.M.G.*, xxxii., 1878, p. 741.

[5] Edit. Baethgen, p. 32; see Hoffmann, *Opusc. Nestor.*, p. xvii.

[6] Hoffmann, *Opusc. Nest.*, pp. 2–49; see *B.O.*, ii. 308, col. 2, and Cod. Berlin, Sachau 72, No. 14. There is also a MS. in the collection of the S.P.C.K.

[7] Cod. Vat. cxcii. (*Catal.*, iii. 409). *Syntagma Medicum Syr. et Arab.*, is not likely to be his, but requires closer examination.

[8] This is a large subject, into which we cannot here enter, the more so as it pertains rather to a history of Arabic than of Syriac literature. We would refer the reader to Wüstenfeld, *Geschichte d. arab. Aerzte u. Naturforscher*, 1840; Flügel, *Dissert. de Arabicis Scriptorum Græcorum Interpretibus*, 1841; Wenrich, *De Auctorum Græcorum Versionibus et Commentariis*, 1842; Renan, *De Philosophia Peripatetica apud Syros*, 1852, sect. viii. p. 51; *Al-Farabi (Alpharabius) des Arab. Philosophen Leben u. Schriften*, by M. Steinschneider, 1869; A. Müller, *Die Griechischen Philosophen in der arabischen Ueberlieferung*, 1873. Of Muhammadan authorities two of the most important are the *Fihrist* of Abu ‘l-Faraj Muhammad ibn Isḥāḳ al-Warrāḳ al-Baghdādhī, commonly called Ibn Abī Ya‘ḳūb an-Nadīm (died early in the 11th century), and the ‘*Uyūn al-Anbā fī Ṭabaḳāt al-Aṭibbā* of Muwaffaḳ ad-Dīn Abū ‘l-‘Abbās Aḥmad ibn al-Ḳāsim as-Sa‘dī al-Khazrajī, generally known by the name of Ibn Abī Uṣaibi‘ah (died in 1269). The former work has been edited by Flügel J. Rödiger, and A. Müller, 1871–72, the latter by A. Müller, 1884.

[9] See Ibn Abī Usaibi‘ah, ed. Müller, i. 127; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 28; Bar-Hebræus, *Chron. Syr.*, pp. 139–140, 170 (*B.O.*, ii. 271, note, col. 1), and *Hist. Dynast.*, 235, 264.

[10] *B.O.*, iii. 1, 258.

[11] Compare Gesenius, *De B A et BB*, p. 7.

[12] See Gesenius, *op. cit.*, p. 8; *B.O*, iii. 1, 258.

[13] *B.O.*, iii. 1, 437, 438, note 2.

[14] See the *Fihrist*, p. 263; Ibn Abī Uṣaibi‘ah. ed. Müller, i. 234–235.

[15] *B.O.*, iii. 1 257; Gesenius, *op. cit.*, cap. ii.

[16] Gesenius, *op. cit.*, p. 14.

[17] *Ibid.*, p. 21; see Hoffmann, *Syrisch-arabische Glossen*, 1874, and Payne Smith, *Thes. Syr.*, passim.

[18] See *B.O.*, iii. 1. 501 *sq.*

[19] So Assemani, *B.O.*, ii. 435. Bar-Hebræus (*Chron. Eccles.*, ii. 181) says that he resided for thirty-eight years in the convent of Sa‘īd near Mosul.

[20] Bar-Hebræus (*loc. cit.*) says 205 A.H. = 821 A.D.; see above, p. 888.

[21] *Chron. Eccles.*, ii. 183–187.

[22] *B.O.*, iii. 1, 165–166. ‘Amr ibn Mattā says that he wrote a commentary on Theologus, *i.e.*, Gregory Nazianzen, *B.O.*, iii. 1, 262, note 1.

[23] Compare *B.O.*, iii. 1. 279.

[24] See Badger, *The Nestorians*, ii. 19.

[25] The pious Monophysites of St. Mary Deipara cut up this volume for binding, etc., as they did some other Nestorian books of value in their library.

[26] Cod. Vat. lxxxviii. 5 (*Catal.*, ii. 483). cl. 9 (*Catal.*, iii. 281); clxxxvii. 5 (*Catal.*, iii. 405). Assemani supposes that the next article in clxxxvii. does not belong to Theodore of Mopsuestia, but is taken from Īshō‘bar Nōn's questions on Scripture.

[27] *B.O.*, iii. 1, 175.

[28] Wright, *Catal.*, p. 1176, col. 1.

[29] *B.O.*, ii. 435; iii. 1. 505 *sq.*

[30] *Ibid.*, iii. 1, 479; Hoffmann, *Auszüge*, pp. 244–245.

Īshō‘-dādh of Merv.

Īshō‘-dādh of Marū or Merv, bishop of Ḥĕdhattā or al-Hadīthah, was a competitor with Theodosius for the patriarchate in 852.[4] According to ‘Abhd-īshō‘, his principal work was a commentary on the New Testament, of which there are MSS. in Berlin, Sachau 311, and in the collection of the S.P.C.K. It extended, however, to the Old Testament as well, for in Cod. Vat. cccclvii. we find the portions relating to Genesis and Exodus.[5]

Kendī.

In the *B.O.*, iii. 1, 213, ‘Abhd-īshō‘ names a certain Kendī as the author of a lengthy disputation on the faith.[6] Assemani places this "Candius" or "Ebn Canda" under the catholicus John IV., apparently on the authority of ‘Amr ibn Mattā. We suspect, however, that the person meant is ‘Abd al-Masīḥ (Ya‘ḳūb) ibn Isḥāḳ al-Kindī, the author of a well known apology for the Christian religion, which has been published by the Society for Promoting Christian Knowledge.[7] The work dates from the time of the caliph al-Ma'mūn (813–833), and, therefore, synchronizes with the disputations of Theodore Abū Ḳorrah, bishop of Ḥarrān.[8] Being written in Arabic, it hardly belongs to this place, but is mentioned to avoid misapprehension.

Theodore bar Khōnī.

Theodore bar Khōnī is stated to have been promoted by his uncle John IV. to the bishopric of Lāshōm in 893.[9] He was the author of scholia (on the Scriptures), an ecclesiastical history, and some minor works.

Ahrōn.

To about this period probably belongs another historian, the loss of whose work we have to regret. This is a writer named Ahrōn or Aaron, who is mentioned by Elias bar Shīnāyā under 273 A.H. = 886–887 A.D.[10]

Jacobite authors of 10th century.

Simeon the deacon.

In the 10th century the tale of Jacobite authors dwindles away to almost nothing. Most of the dignitaries of the church composed their synodical epistles and other official writings in Arabic, and the same may be said of the men of science, such as Abū ‘Alī ‘Isā ibn Isḥāḳ ibn Zur‘ah (943–1008) and Abū Zakarīyā Yaḥyā ibn ‘Adī, who died in 974 at the age of eighty-one. About the middle of the century we may venture to place the deacon Simeon, whose *Chronicle* is cited by Elias bar Shīnāyā under 6 A.H. = 627–628 A.D. and 310 = 922–923.[11] The 11th century is somewhat more prolific.

John of Mārōn.

A Persian Christian named Gīsā,[12] leaving his native city of Ushnūkh or Ushnū in Ādharbāigān, settled, after several removals, in the district of Gūbōs or Gūbās,[13] one of the seven dioceses of the province of Melitēne (Malaṭiah), and built there a humble church, in which he deposited sundry relics of St. Sergius and St. Bacchus, and cells for himself and his three companions. This happened in 958.[14] As the place grew in importance, other monks gradually resorted to it, and among them "Mār (ī) Yōḥannān dĕ-Mārōn," or John (the son) of Mārōn,[15] a man of learning in both sacred and profane literature, who had studied under Mār Mĕḳīm at Edessa. Gīsā, the founder of the convent, died at the end of twelve years, and was succeeded as abbot by his disciple Elias, who beautified the church. Meantime its fame increased as a seat of learning under the direction of John of Mārōn, and many scribes found employment there. The patriarch John VII., *da-sĕrīghtā*, "He of the Mat" (his only article of furniture),[16] was one of its visitors. Elias, on his retirement, nominated John of Mārōn as his successor, who, aided by the munificence of Emmanuel, a monk of Ḥarrān and a disciple of the maphriān Cyriacus,[17] rebuilt the church on a larger and finer scale, whilst a constant supply of fresh water was provided at the cost of a Taghritan merchant named Mārūthā. This was in 1001. About this time Elias bar Gāghai, a monk of Taghrīth, founded a monastery near Melitēne, but died before it was finished. His work was taken up by one Eutychus or Kulaib, who persuaded John of Mārōn to join him. Here again his teaching attracted numbers of pupils. At last, after the lapse of twelve years, when there were 120 priests in the convent, he suddenly withdrew by night from the scene of his labors and retired to the monastery of Mār Aaron near Edessa, where he died at the end of four years, about 1017. His commentary on the book of Wisdom is cited by Bar-Hebræus in the *Auṣar Rāzē*.[18]

Mark bar Ḳīkī.

Mark bar Ḳīkī was archdeacon of the Taghritan church at Mosul, and was raised to the dignity of maphriān by the name of Ignatius in 991.[19] After holding this office for twenty-five years, he became a Muḥammadan in 1016,[20] but recanted before his death, which took place at an advanced age[21] in great poverty. He composed a poem on his own fall, misery, and subsequent repentance, of which Bar-Hebræus has preserved a few lines.[22]

Joseph of Melitēne.

According to Assemani, *B.O.*, ii. 317 and cl., Bar-Hebræus mentioned in his *Chronicle* that a monk named Joseph wrote three discourses on the cruel murder of Peter the deacon by the Turks at Melitēne in 1058. The anecdote may be found in the edition of Bruns and Kirsch, p. 252 (transl., p. 258), but the discourses would seem rather to have dealt with the retribution that overtook the retiring Turks at the hands of the Armenians and the wintry weather.

Yĕshū‘ bar Shūshan.

Yĕshū‘ bar Shūshan (or Susanna), syncellus of Theodore or John IX., was chosen patriarch by the eastern bishops, under the name of John X., in opposition to Ḥāyē or Athanasius VI., on whom the choice of their western brethren had fallen in 1058.[23] He soon abdicated, however, retired to a convent, and devoted himself to study. On the death of Athanasius he was re-elected patriarch in 1064, and sat till 1073.[24] He carried on a controversy with the patriarch of Alexandria, Christodūlus, regarding the mixing of salt and oil with the Eucharistic bread according to the Syrian practice.[25] He compiled an anaphora, issued a collection of twenty-four canons,[26] and wrote many epistles,[27] chiefly controversial. Such are the letters in Arabic to Christodūlus on the oil and salt[28] and the letter to the catholicus of the Armenians.[29] The tract on the oil and salt is extant in Paris, Anc. fonds 54 (Zotenberg, *Catal.*, p. 71), and there is an extract from it in Suppl. 32 (Zotenberg, *Catal.*, p. 54). Bar-Shūshan also wrote four poems on the sack of Melitēne by the Turks in 1058,[30] and collected and arranged the works of Ephraim and Isaac of Antioch, which he had begun to write out with his own hand when he was interrupted by death.[1]

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[1] *B.O.*, iii. 1, 488; comp. the ordinance of Sabhr-īshō‘, pp. 505–506.

[2] *B.O.*, iii. 1, 204 col. 1, 488 col. 2, 490 col. 2.

[3] *Ibid.*, iii. 1, 210, 510 col. 2.

[4] *Ibid.*, iii. 1, 210–212.

[5] Mai, *Scriptt. Vett. Nova Coll.*, v. The name of the author is there given as Iesciuaad, doubtless a misprint for *dad*. We are, therefore, surprised to find Martin writing "Ichou-had évêque d'Hadeth," *Introd. à la Critique Textuelle du Nouveau Test.*, p. 99.

[6] The correct reading is *dhĕ-hāimānūthā*.

[7] *The Apology of El-Kindi*, 1885. An English translation appeared in 1882, *The Apology of Al-Kindy*, etc., by Sir W. Muir.

[8] See Zotenberg, *Catal.*, No. 204, 1 and 8, and No. 205.

[9] *B.O.*, ii. 440; iii. 1, 198.

[10] See Baethgen, *Fragmente*, p. 3.

[11] *Ibid.*, p. 2; Bar-Hebræus, *Chron. Eccles.*, ii. 126, note 1.

[12] Others write Galyāsā.

[13] Bar-Hebræus, *Chron. Eccles.*, i. 401 *sq.*; *B.O.*, ii. 283, 350.

[14] *B.O.*, ii. 260. Gūbōs was on the right bank of the Euphrates, between the plain of Melitēne and Claudia.

[15] Abbeloos, in a note on Bar-Hebræus, *Chron. Eccles.*, i. 404, raises the question what connection there may be between this historical personage and the somewhat shadowy "Joannes Maro," to whom Assemani has devoted a large space, *B.O.*, i. 496–520.

[16] *B.O.*, ii. 132–351.

[17] *Ibid.*, ii. 442.

[18] *B.O.*, ii. 283: see also p. cl.

[19] Bar-Hebræus, *Chron. Eccles.*, ii. 257; *B.O.*, ii. 443.

[20] See Baethgen, *Fragmente*, pp. 105, 153; *B.O.*, iii. 289, note 1.

[21] According to Cardāhī, *Liber Thesauri*, p. 140, in 1030 or 1040.

[22] *Chron. Eccles.*, ii. 289; *B.O.*, ii. 443, and also p. cl.

[23] Bar-Hebræus, *Chron. Eccles.*, i. 437 *sq.*; *B.O.*, ii. 141 (where there are errors, see Add., p. 475), 354.

[24] Bar-Hebræus, *Chron. Eccles.*, i. 445; *B.O.*, ii. 143 (where there are again many errors, see Add., p. 475), 355.

[25] *B.O.*, ii. 144, 356.

[26] Bar-Hebræus, *Chron. Eccles.*, i. 446; *B.O.*, ii. 355.

[27] Bar-Hebræus, *Chron. Eccles.*, i. 447; *B.O.*, ii. 355.

[28] *B.O.*, ii. 508, col. 2.

[29] *Ibid.*, ii. 211, 383; Berlin, Sachau, 60, 1.

[30] Bar-Hebræus, *Chron. Syr.*, p. 252 (transl., p. 258); *B.O.*, ii. 317.

Sa'īd bar Ṣābūnī. Sa'īd bar Ṣābūnī lived during the latter part of the 11th century. He was versed in Greek as well as Syriac, and well known as a literary man,[2] especially as a writer of hymns.[3] The patriarch Athanasius VII. Abu 'l-Faraj bar Khammārā (1091–1129) raised him to the office of bishop of Melitēne (Malaṭiah) in October, 1094. His consecration took place at Ḳanḳĕrath, near Āmid, by the name of John, and he set out for Malatiah, which he entered on the very day that the gates were closed to keep out the Turks, who laid siege to it under Ḳilij Arslān (Dā'ūd ibn Sulaimān), sultān of Iconium. He was murdered during the course of the siege, in July, 1095, by the Greek commandant Gabriel.[4]

The Nestorian writers of these two centuries are both more numerous and more important than the Jacobite.

Bar Sarōshwai. We may place at the head of our list the name of Ḥĕnān-īshō' bar Sarōshwai, who must have lived quite early in the 10th century, as he is cited by Elias of Anbār, who wrote about 922.[5] He was bishop of Ḥērtā (al-Ḥīrah), and published questions on the text of Scripture and a vocabulary with glosses of explanations,[6] which is constantly cited by his successor in this department of scholarship, Bar Bahlūl.[7]

Bar Bahlūl. With Bar Sarōshwai we naturally connect Īshō' bar Bahlūl, in Arabic Abu 'l-Ḥasan 'Īsā ibn al-Bahlūl, the fullest and most valuable of Syriac lexicographers. His date is fixed by that of the election of the catholicus 'Abhd-īshō' I., in which he bore a part, in 963.[8]

Abhzūdh. 'Abhd-īshō' in his *Catalogue*, *B.O.*, iii. 1, 261, mentions an author Abhzūdh, a teacher in some school or college (*eskōālyā*), who composed a treatise containing demonstrations on various topics, alphabetically arranged and dedicated to his friend Ḳurtā.[9] In note 5 Assemani makes the very circumstantial statement, but without giving his authority, that Abhzūdh was head of the college founded at Baghdādh about 832 by Sabhr-īshō' II.,[10] under Sergius (860–872). But, if this writer be identical, as seems probable, with the Bazūdh who was the author of a *Book of Definitions* described at some length by Hoffmann, *De Hermeneuticis apud Syros Aristoteleis*, pp. 151–153, we must place him nearly a century later, because he cites the "scholia" of Theodore bar Khōnī, who was appointed bishop of Lāshōm in 893.[11] The whole matter is, however, very obscure, and Hoffmann has subsequently (*Opusc. Nestor.*, p. xxii.) sought to identify Bazūdh, who was also called Michael (*ibid.*, p. xxi.), with the Michael who is mentioned as a commentator on the Scriptures by 'Abhd-īshō', *B. O.*, iii. 1, 147, and whom Assemani supposed to be the same as Michael bishop of al-Ahwāz (died in 852 or 854).[12] All then that appears to be certain is that the Persian Bazūdh also bore the Christian name of Michael, and that, besides the alphabetically arranged demonstrations and the *Book of Definitions*, he composed a tract on man as the microcosm.[13]

Elias of al-Anbār. Elias, bishop of Pērōz-Shābhōr or al-Anbār, flourished about 922, as appears from his disputes with the catholicus Abraham (905–937),[14] and his account of the miserable bishop Theodore of Bēth Garmai, who, after his deposition by John bar Ḥĕghīrē (900–905) and subsequent absolution by Abraham, became a Muhammadan.[15] He was the author of a collection of metrical discourses in three volumes,[16] an apology, epistles, and homilies.[17]

George of Mosul and Arbēl. George, metropolitan of Mosul and Arbēl, was promoted to this dignity by the catholicus Emmanuel about 945, and died after 987. He contested the patriarchate three times but in vain, viz.,—in 961, when Isrā'ēl was elected,[18] in 963, when 'Abdh-īshō' I. was the successful candidate,[19] and in 987, when the choice of the synod fell on Mārī bar Ṭōbī.[20] His chief work was an exposition of the ecclesiastical offices for the whole year, in seven sections, of which Assemani has given a full analysis in *B.O.*, iii. 1, 518–540.[21] Some specimens of his *turgāmē* or hymns may be found in Codd. Vatt. xc. and xci. (*Catal.*, ii. 487, No. 27, and 490, No. 24), and Berlin, Sachau 167, 2.

Emmanuel bar Shahhārē. The date of Emmanuel bar Shahhārē[22] is fixed by his presence at the consecration of 'Abhd-īshō' I. in 963.[23] He was teacher in the school of Mār Gabriel in the convent called the Dairā' Ellāitā at Mosul. Cardāḥī places his death in 980.[24] Besides some minor expository treatises, he wrote a huge work on the *Hexaēmeron* or six days of creation.[25] The Vatican MS.[26] contains twenty-eight discourses, of which the second is wanting, and a twenty-ninth is added *On Baptism*. It is dated 1707. The MS. in the Brit. Mus., Orient. 1300, dated 1685, also contains twenty-eight discourses, of which the second is wanting.[27] Some of them are in seven-syllable, others in twelve-syllable metre.[28] Cardāḥī has published a specimen in his *Liber Thesauri*, pp. 68–71. Emmanuel's brother, 'Abhd-īshō' bar Shahhārē, is mentioned by Assemani, *B.O.*, iii. 540, and by Cardāḥī. The latter has printed part of one of his poems, on Michael of Āmid, a companion of Mār Eugenius, in *Liber Thesauri*, pp. 136–137. It is taken from Cod. Vat. clxxxiv. (*Catal.*, iii. 395). But there the author is called Bar Shi'ārah, ܒܪܫܝܥܪܗ, and is said to have been a monk of the convent of Michael (at Mosul).

Andreas or Andrew. Somewhere about the end of this century we may venture to place a writer named Andrew, to whom 'Abhd-īshō' has given a place in his *Catalogue*, and whom Assemani has chosen to identify with the well-known Andrew, bishop of Samosāta, the opponent of Cyril of Alexandria.[29] The words of 'Abhd-īshō', if we understand them rightly, mean that this Andrew wrote *turgāmē* (or hymns of a particular kind) and a work on *puḥḥām sĕyāmē*, the placing of the diacritical and vowel points and marks of interpunction.[30] He was therefore an inoffensive grammarian.

Elias I., Nestorian catholicus. Elias, the first Nestorian catholicus of the name, was a native of Karkhā dhĕ-Gheddān,[31] was trained in Baghdādh and al-Madāïn, and became bishop of Ṭīrhān, whence he was advanced to the primacy in 1028, and sat till 1049.[32] According to 'Abhd-īshō', he compiled canons and ecclesiastical decisions, and composed grammatical tracts.[33] According to Mārī ibn Sulaimān,[34] he was the author of a work on the principles of religion in twenty-two chapters, which may be identical with the second of the above, and of a form of consecration of the altar (*ḳuddās al-madhbaḥ*). His *Grammar* was composed in his younger days, before he became bishop. It has been edited and translated from a MS. at Berlin[35] by Baethgen.[36] A tract of his on the diacritical points and marks of interpunction is cited and used by John bar Zō'bī.[37]

'Abhd-īshō' bar Bahrīz. Abū Sa'īd 'Abhd-īshō' bar Bahrīz was abbot of the convent of Elias or Sa'īd at Mosul, and a candidate for the patriarchate when Elias I. was elected in 1028. He was subsequently promoted to be metropolitan of Āthōr or Mosul.[38] He collected ecclesiastical canons and decisions,[1] wrote on the law of inheritance,[2] and an exposition of the offices of the church.

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[1] Bar-Hebræus, *Chron. Eccles.*, i. 447; *B.O.*, ii. 355.

[2] Bar-Hebræus, *Chron. Eccles.*, i. 463; *B. O.*, ii. 211–212.

[3] See one of these, an acrostic canon, used in the service of the assumption of the monastic garb, in Cod. Vat. li. (*Catal.*, ii. 321, No. 31), Brit. Mus. 17232 (Wright, *Catal.*, p. 372, No. 22), Paris, Suppl. 88 (Zotenberg, *Catal.*, p. 74, No. 34), Bodl. Hunt. 444 (P. Smith, *Catal.*, p. 243, No. 9).

[4] Bar-Hebræus, *Chron. Syr.*, pp. 278–279 (transl., pp. 284–285).

[5] *B.O.*, iii. 1, 260, col. 2, at foot.

[6] *Ḥashḥāthā* are χρήσεις and λέξεις; see Hoffmann, *Opusc. Nestor.*, p. xiii.

[7] *B.O.*, iii. 1, 261; see Payne Smith, *Thes. Syr.*, passim.

[8] Bar-Hebræus, *Chron. Eccles.*, iii. 251; *B.O.*, ii. 442, iii. 1, 200 col. 2; Gesenius, *De BA et BB*, p. 26; see Payne Smith, *Thes. Syr.*, passim. An edition of his *Lexicon*, by M. R. Duval, is now (1887) being printed in Paris at the expense of the French Government.

[9] *B.O.*, iii. 1, 261.

[10] *Ibid.*, ii. 435.

[11] See above, p. 892.

[12] *B.O.*, iii. 1, 210, note 2, col. 2. Michael's *Book of Questions* is quoted by Solomon of al-Baṣrah in *The Bee*, ed. Budge, p. 135.

[13] Hoffmann, *op. cit.*, p. xxi.

[14] *B.O.*, iii. 1, 258, note 3; Baethgen, *Fragmente*, pp. 84, 141.

[15] *B.O.*, iii. 1, 234, col. 1, at foot.

[16] *B.O.*, iii. 1, 258–260; Cod. Vat. clxxxiii. (*Catal.*, iii. 383); Berlin, Sachau 132; collection of the S.P.C.K.; Cardāḥī, *Liber Thesauri*, pp. 72–76.

[17] In Cod. Vat. xci. (*Catal.*, ii. 491, No. 35) there is a homily ascribed to Elias of Anbār, but the Syriac text has Paul.

[18] *B.O.*, ii. 442.

[19] *Ibid.*, ii. 442; iii. 1, 200, col. 2.

[20] *Ibid.*, ii. 448.

[21] See also Codd. Vatt. cxlviii., cxlix., and cliii., in *Catal.*, iii. 277 *sq.* In Cod. Vat. cl. (*Catal.*, iii. 280) there are questions regarding various services, baptism, and communion at Easter.

[22] See *B.O.*, iii. 1, 540. In Arabic ash-Shahhār or, according to another reading, ash-Sha''ār (see end of this paragraph).

[23] *B.O.*, iii. 1, 200, col. 2.

[24] *Liber Thesauri*, p. 71.

[25] *B.O.*, iii. 1, 277.

[26] No. clxxxii., *Catal.*, iii. 380.

[27] There are two MSS. in Berlin, Sachau 169–170 and 309–310 (see Sachau, *Reise*, pp. 364–365), and one in the collection of the S.P.C.K.

[28] In MS. Br. Mus. it is said this is only the 4th vol. of the *Hexaēmeron*, [illegible].

[29] *B.O.*, iii. 1, 202.

[30] See Hoffmann, *Opusc. Nestor.*, pp. vii., viii. And so Abraham Ecchellensis rendered the words, *librum de ratione punctandi*.

[31] In Arabic Karkh Juddan, in Bēth Garmai; see Hoffmann, *Auszüge*, pp. 254, 275.

[32] *B.O.*, iii. 262–263; Bar-Hebræus, *Chron. Eccles.*, ii. 285–287.

[33] *B.O.*, iii. 1, 265.

[34] *Ibid.*, p. 263, col. 1.

[35] Alter Bestand 86, 15, in *Kurzes Verzeichniss*, etc., p. 31.

[36] *Syrische Grammatik des Mar Elias von Tirhan*, 1880.

[37] See *B.O.*, iii. 1, 265, note 7; *Catal. Vat.*, iii. 411 (under No. ii.); Wright, *Catal.*, p. 1176, col. 2.

[38] *B.O.*, iii. 1, 263–264.

Daniel of Tahal.

Assemani has assigned the same date to Daniel (the son) of Ṭūbhānīthā, bishop of Taḥal in Bēth Garmai, but without any sufficient reason.[3] If he be really identical with the Daniel to whom George, metropolitan of Mosul and Arbēl, dedicated his exposition of the offices of the church, he must have lived about the middle of the previous century. He wrote funeral sermons, metrical homilies, answers to Scriptural questions and enigmas, and other stuff of the same sort. More important probably were his "Book of Flowers," *Kĕthābhā dhĕ-Habbābhē*, which may have been a poetical florilegium; his *Solution of the Questions in the Fifth Volume of Isaac of Nineveh's Works;* and his commentary on the *Heads of Knowledge* or maxims (of Evagrius).[4]

Elias bar Shīnāyā.

Conspicuous among the writers of this century is Elias bar Shīnāyā, who was born in 975,[5] adopted the monastic life in the convent of Michael at Mosul under the abbot John the Lame,[6] and was ordained priest by Nathaniel, bishop of Shennā (as-Sinn), who afterwards became catholicus under the name of John V. (1001-12).[7] Elias was subsequently in the convent of Simeon on the Tigris opposite Shennā, and was made bishop of Bēth Nuhādhrē in 1002.[8] At the end of 1008 he was advanced to the dignity of metropolitan of Nisībis.[9] With the next patriarch, John VI. bar Nāzōl (1012–20),[10] previously bishop of Ḥērtā, he was on good terms; but he set his face against Īshō‘-yabh bar Ezekiel (1020–25).[11] Under Elias I. (1028–49) all seems to have been quiet again. That our author survived this patriarch is clear from his own words in *B. O.*, iii. 1, 268, col. 2, ll. 19, 20.[12] His greatest work is the *Annals* or *Chronicle*, of which unfortunately only one imperfect copy exists.[13] Baethgen has published extracts from it under the title of *Fragmente syr. u. arab. Historiker*, 1884, which have enabled scholars to recognize its real importance.[14] The exact date of the *Annals*, and probably of the writing of the unique copy, is fixed by the statement of the author, f. 15b, that John, bishop of Ḥērtā, was ordained catholicus on Wednesday, 19th of the latter Teshrīn, A. Gr. 1324 (19th November, 1012 A.D.), and that he still ruled the Nestorian Church "down to this year in which this work was composed, namely, A. Gr. 1330" (1018–1019).[15] After the *Annals* we may mention Elias's Syriac grammar, one of the best of the Nestorian writings on the subject,[16] and his Arabic-Syriac vocabulary, *Kitāb at-Tarjumān fī ta'līm lughat as-Suryān* or "the Interpreter, to teach the Syriac Language." It has been edited by De Lagarde in his *Prætermissorum Libri Duo*, 1879, and was the storehouse from which Thomas a Novaria derived his *Thesaurus Arabico Syro-Latinus*, 1636. Elias was also a composer of hymns, some of which occur in the Nestorian service-books,[17] and of metrical homilies, apparently of an artificial character.[18] He edited four volumes of decisions in ecclesiastical law, which are often cited by 'Abhd-īshō‘ of Nisībis in his *Collectio Canonum Synodicorum*;[19] indeed the third section, "On the Division of Inheritances," is entirely borrowed from the work of Elias.[20] Of his epistles that to the bishops and people of Baghdādh on the illegal ordination of Īshō‘-yabh bar Ezekiel is preserved in Cod. Vat. cxxix. (*Catal.*, iii. 191).[21] Six of his Arabic dissertations have been described by Assemani in the *B. O.*, iii. 1, 270–272. The most important of them appears to be No. 5, a disputation, in seven sessions or chapters, with the vizīr Abu 'l Ḳāsim al-Ḥusain ibn 'Alī al-Maghribī, preceded by a letter to the secretary Abu 'l-'Alā Ṣā'id ibn Sahl. These meetings took place in 1026, and the work was committed to writing in 1027, after the death of the vizīr at Maiyāfāriḳīn in October, and published with the approbation of the celebrated commentator, philosopher, and lawyer Abu 'l-Faraj 'Abdallāh ibn aṭ-Ṭaiyib,[22] who was secretary to the patriarch Elias I. The anonymous work described in full by Assemani (*B. O.*, iii. 1, 303–306) under the title of *Kitābu 'l-Burhān 'alā ṣaḥīḥi* (or rather *fī taṣḥīḥi*) *'l-īmān*, "The Demonstration of the Truth of the Faith," also by him.[23]

Anonymous translations.

Here we may pause in our enumeration to cast an eye upon some anonymous translations, which we are inclined to ascribe to the 10th and 11th centuries, and which are interesting as showing what the popular literature of the Syrians was, compared with that of their theologians and men of science.

Kalīlah wa-Dimnah.

We have already spoken of the older translation of *Ḳalīlagh wĕ-Damnagh*, made by the periodeutes Bōdh in the 6th century of our era (see above, p. 879). About the middle of the 8th century there appeared an independent Arabic translation from the Pāhlavī by 'Abdallāh ibn al-Muḳaffa', which, under the name of *Kalīlah wa-Dimnah*, has been the parent of secondary versions in the Syriac, Persian, Greek, Hebrew, and Spanish languages.[24] The Syriac version was discovered by the present writer in a unique MS. in the library of Trinity College, Dublin, and published by him in 1884.[25] It is evidently the work of a Christian priest, living at a time when the condition of the Syrian Church was one of great degradation, and the power of the caliphate on the wane, so that the state of society was that of complete disorder and licentiousness,[26] a description which would very well apply to the 10th or 11th century. Indeed we could not place it much later, because part of the unique MS. goes back to the 13th century, and even its text is very corrupt, showing that it had passed through the hands of several generations of scribes. "The chief value of this later Syriac version is that it sheds light on the original text of the Arabic *K. w. D.* The Arabic text which the Syriac translator had before him must have been a better one than De Sacy's, because numbers of Guidi's extracts,[27] which are not found at all in De Sacy's text, appear in their proper places in the later Syriac."[28]

Sindbān.

To about the same period, judging by the similarity of style and language, we would assign the Syriac version of the book of *Sindibādh*. This work was translated, probably in the latter half of the 8th century, from Pahlavī into Arabic by Mūsā, a Muḥammadan Persian. It is, as Nöldeke has shown,[29] the smaller of the two recensions known to the Arabs, the larger, entitled *Aslam* (?) *and Sindibādh*, being the work of al-Aṣbagh ibn 'Abd al-'Azīz as-Sijistānī. The smaller *Sindibādh* was in its turn done into Syriac, and thence into Greek by Michael Andreopūlus for Gabriel, prince of Melitēne (1086–1100), as discovered by Comparetti,[30] under the name of Συντίπας (Sindipas), just as *Kalīlah wa-Dimnah* was translated by Symeon (the son of) Seth for the emperor Alexius Comnenus, who ascended the throne in 1081. The Syriac version, which bears the title of the *Story of Sindbān and the Philosophers who were with him*, has been edited by Baethgen, with a German translation and notes, from the unique MS. in the Royal Library at Berlin.[31]

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[1] *B.O.*, iii. 1, 279.

[2] *Ibid.*, p. 267, col. 2, lin. penult.

[3] That he follows 'Abhd-īshō‘ bar Bahrīz in the *Catalogue* of 'Abhd-īshō‘ is no evidence whatever as to his date; and the work mentioned in *B.O.*, iii. 1, 174, notes 3 and 4, is not by Bar Bahrīz, but by George of Mosul and Arbēl (see Cod. Vat. cliii.).

[4] *B.O.*, iii. 1, 174.

[5] Rosen, *Catal.*, p. 89, col. 2.

[6] *B.O.*, iii. 1, 266 note 3, 271 col. 1.

[7] Baethgen, *Fragmente*, pp. 101, 151; 104, 153; compare Bar-Hebræus, *Chron. Eccles.*, ii. 261, 281; *B.O.*, ii. 444.

[8] Baethgen, *Fragmente*, pp. 101, 152.

[9] *Ibid.*, pp. 103, 152.

[10] *Ibid.*, pp. 104, 153; Bar-Hebræus, *Chron. Eccles.*, ii. 283; *B.O.*, ii. 446.

[11] *B.O.*, iii. 1, 272.

[12] Consequently the statement in *B. O.*, ii. 447, is inaccurate. Cardāḥī (*Liber Thesauri*, p. 84) names 1056.

[13] Brit. Mus. Add. 7197 (Rosen, *Catal.*, pp. 86–90; Wright, *Catal.*, p. 1206).

[14] Baethgen has overlooked Wright's *Catal.*, p. 1206, and the plate in the *Oriental Series of the Palæographical Society*, No. lxxvi. The Syriac text was evidently written by an amanuensis, whereas the older Arabic text was probably written by Elias himself.

[15] There are some extracts from the *Annals* in Berlin, Sachau 108, 2.

[16] There are MSS. in the Brit. Mus. Add. 25876, Or. 2314 (frag.); Vat. Cod. cxciv. (*Catal.*, iii. 410), Codd. ccccx. ccccl. (Mai, *Scriptt. Vett. Nova Coll.*, v.); Palat. Medic. cclxi. (*Catal.*, p. 419); Berlin, Sachau 5, 2, also 216, 1, and 306, 1; and in the collection of the S. P.C.K. Part of the work (sections 1–4) has been edited by Dr. R. Gottheil, Leipsic, 1886.

[17] *E.g.*, Cod. Vat. xc. (*Catal.*, ii. 487), Nos. 13, 15, 17, 18: Cod. Vat. xci. (*Catal.*, ii. 491), Nos. 12, 14, 16, 17; Berlin, Sachau 64, 10.

[18] See Cod. Vat. clxxxiv. (*Catal.*, iii. 390), a poem on the love of learning, in which the letter Ālaph does not occur. It is printed by Cardāḥī in the *Liber Thesauri*, pp. 83–84.

[19] Mai, *Scriptt. Vett. Nova Coll.*, x.

[20] *B.O.*, iii. 1, 267–269; Mai, *op. cit.*, v. pp. 54, 220.

[21] *B.O.*, iii. 1, 272–273.

[22] He died in 1043; see *B. O.*, iii. 1, 544; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 132; Ibn Abī Oṣaibi'ah, ed. Müller, i. 239; Bar-Hebræus, *Hist. Dynast.*, p. 355 (transl., p. 233); *Chron. Syr.*, p. 239 (transl., p. 244); *Chron. Eccles.*, ii. 283.

[23] See the German translation by L. Horst, *Des Metropoliten Elias von Nisibis Buch vom Beweis der Wahrheit d. Glaubens*, Colmar, 1886.

[24] See Keith-Falconer, *Kalīlah and Dimnah or the Fables of Bidpai*, 1885, Introduction.

[25] Wright, *The Book of Kalīlah and Dimnah, translated from Arabic into Syriac.*

[26] See Wright's Preface, p. xi. *sq.*

[27] See Guidi, *Studii sul Testo Arabo del Libro di Kalila e Dimna*, 1873.

[28] Keith-Falconer, *op. cit.*, p. lx.

[29] *Z.D.M.G.*, xxxiii. (1879), pp. 521–522.

[30] *Ricerche intorno al Libro di Sindibād*, 1869, p. 28 *sq.*; *The Folk-lore Society*, vol. ix. 1, p. 57 *sq.*

[31] Alt. Bestand 57, ff. 60–87. A small specimen had already been published by Rödiger, *Chrestom. Syr.*, 2d ed., pp. 100–101.

Life of Alexander the Great.

A third product of the same age we believe to be the Syriac translation of Pseudo-Callisthenes's *Life of Alexander the Great*, made from an Arabic version of a Greek original. Of this, however, we shall be better able to judge when the Syriac text lies before us in print.[1]

Æsop's Fables.

Lastly we would place somewhere between the 9th and 11th centuries the Syriac translation of Esop's (Æsop's) *Fables*, which has been edited under a somewhat Jewish garb by Landsberger,[2] who imagined himself to have found the Syriac original of the fables of Syntipas (Sindipas), whereas Geiger[3] clearly showed that we have here to do with a Syriac rendering of one of the forms of the fables of Esop. In fact, as Geiger pointed out, דסופוס is only a clerical error for דאסופוס. In Syriac MSS. of this collection the title is written ܕܝܘܣܦܘܣ, "of Josephus."[4] In some close relation to these stands the story of Josephus and king Nebuchadnezzar in the Berlin MS. Alt. Bestand 57, ff. 16–57, with which are interwoven a number of Esopic fables. They have been edited (with the exception of two) by Rödiger in his *Chrestom. Syr.*, 2d ed., pp. 97–100.

Resuming our enumeration of Syrian writers, we find that in the 12th century the number of them, whether Jacobite or Nestorian, is small, but two of the former sect are men of real mark.

Abū Ghālib bar Ṣābūnī.

Abū Ghālib bar Ṣābūnī, the younger brother of Sa'īd bar Ṣābūnī (see above, p. 893), was almost as unfortunate as his brother. He was raised to the episcopate of Edessa after his brother's death by Athanasius VII., but speedily deposed on account of a quarrel, although many of the Edessenes, among them the governor Baldwin, brother of Godfrey of Bouillon, took his part. He died of a fall from his horse, shortly after the death of the patriarch in 1129.[5] Though a good scholar and linguist, he does not appear to have written anything that has come down to our times. Assemani, it is true, ascribes to him three poems in twelve-syllable metre on the capture of Edessa by Zengī ibn Āḳ-sunḳur; but as this took place in 1144,[6] the writer must have been his successor, Basil bar Shumnā (1143–69).[7]

John of Ḥarrān and Mārdīn.

John,[8] bishop of Ḥarrān and Mardē or Mārdīn, had charge of the Jacobite churches in the East, his diocese including Tell-Besmē, Kĕphar-tūthā, Dārā, Nisībis, Rās'ain, and the Khābhōrā or Khābūr. He was originally a monk of Edessa, was appointed bishop by Athanasius VII. in 1125, and was killed by a fall from his horse in 1165, at the age of seventy-eight.[9] He devoted himself chiefly to the restoration of the decayed churches and monasteries of his diocese, as may be seen from the autobiographical fragment in *B.O.*, ii. 217 *sq.* From the same document, pp. 224–225, it appears that he was fond of MSS., which he collected, repaired, and bound, and that he wrote with his own hand four small copies of the Gospels in gold and silver. He enjoyed a well-earned reputation as a land-surveyor and practical engineer.[10] Bar-Hebræus notes his great liberality in redeeming the captive Edessenes who had been carried off by Zengī's troops.[11] The fall of Edessa (1144), however, was an event that got him into a great deal of trouble. He was ill-advised enough to write a treatise on the Providence of God, in which he maintained that chastisements of that kind were *not* sent upon men by God, and that, if the troops of the Franks (Crusaders) had been there, Edessa would not have been taken by Zengī. Such rank heresy of course brought down upon him the whole bench of bishops. He was attacked by the priest Ṣalībhā of Ḳarīgārah (?),[12] by John bishop of Kaisūm,[13] John bar Andreas bishop of Mabbōgh,[14] and Dionysius bar Ṣalībī.[15] He was also the compiler of an anaphora.[16]

Jacob or Dionysius bar Ṣalībī.

The star of this century among the Jacobites is undeniably Jacob bar Ṣalībī of Melitēne (Malaṭiah). He was created bishop of Mar'ash, under the name of Dionysius, by Athanasius VIII. (Yēshū' bar Ḳeṭrah, 1138–66), in 1145, and the diocese of Mabbōgh was also placed under his charge.[17] Michael I. (1166–99) transferred him to Āmid, where he died in 1171.[18] The list of his works, as quoted by Assemani from a Syriac MS., is very considerable,[19] and he has dealt with them at great length.[20] We may mention the following. (1) Commentary on the Old Testament, of which only one complete MS. exists in Europe.[21] The order of the books is—the Pentateuch, Job, Joshua, Judges, Samuel and Kings, Psalms, Proverbs, Ecclesiastes, the Song of Songs, Isaiah, Jeremiah and Lamentations, Ezekiel, Daniel, the twelve minor Prophets, and Ecclesiasticus. Each book has a material or literal and a spiritual or mystical commentary. Several of the books have two commentaries, one on the Pĕshīṭtā, the other on the Hexaplar text; Jeremiah has actually three, one on the Hexaplar, and two, a shorter and a longer, on the Pĕshīṭtā. (2) Commentary on the New Testament, from which Assemani has given many extracts.[22] The order of the books is—the four Gospels, the Revelation of St. John, the Acts of the Apostles, the seven apostolic epistles, and the fourteen epistles of St. Paul.[23] (3) A compendium of theology, of which we do not seem to have any MS. in Europe; see *B.O.*, ii. 163, col. 1, ll. 13–15, and p. 170. (4) A copious treatise against heresies, dealing with the Muḥammadans, the Jews, the Nestorians, the Dyophysites or supporters of the council of Chalcedon, and the Armenians.[24] (5) A treatise on the Providence of God, against John, bishop of Mārdīn,[25] apparently no longer extant. (6) Expositions of the Eucharistic service,[26] of the Nicene creed,[27] of the consecration of the chrism,[28] of the services of consecration,[29] and of the Jacobite confession of faith.[30] (7) Canons on confession and absolution.[31] (8) Two anaphoræ or liturgies.[32] (9) Various prayers, prooemia, and sedrās.[33] (10) Homilies, *e.g.*, encomium on the patriarch Michael the Elder,[34] on the Passion of our Lord,[35] and on withholding the sacrament from those who abstain from communicating for a period of more than forty days.[36] (11) A commentary on the six *Centuries* of Evagrius.[37] (12) Two poems on the fall of Edessa (1144),[38] three on the fall of Mar'ash (1156),[39] and two on another incident (1159).[40] Among the works mentioned in the list in *B.O.*, ii. 210–211, we cannot find any traces of the *Commentarius in Scripta Doctorum*, the *Compendium Historiarum Patrum et Sanctorum et Martyrum*, and the *Compendiam Canonum Apostolicorum*, nor of the commentaries on the books of *Dialectics*, *ibid.*, col. 1. Of the epistles two are extant in Arabic, Berlin, Sachau 61, 1, 2. From a treatise *On the Structure of Man* there are two short extracts in Bodl. Marsh. 361, f. 39. Dionysius appears also to have revised the Jacobite order of baptism,[1] and to have drawn up a volume of services for the days of the week.[2]

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[1] An edition of it is in preparation by Mr. E. A. W. Budge, of the British Museum, from five MSS. See Rödiger, *Chrestom. Syr.*, 2d ed., pp. 112–120, and Perkins in the *Journal of the American Oriental Society*, iv. p. 359 *sq.*

[2] מתליא דסופוס, *Die Fabeln des Sophos, Syrisches Original der Griechischen Fabeln des Syntipas*, 1859. Compare his earlier dissertation, *Fabulæ aliquot Aramææ*, 1846.

[3] *Z.D.M.G.*, xiv. (1860), p. 586 *sq.*

[4] *B.O.*, iii. 1, 7, with note 2. So, for example, MS. Trin. Coll. Dublin, B. 5, 32 (Wright, *Kalilah and Dimnah*, pp. ix., x.).

[5] See *B. O.*, ii. 212, 358–359; Bar-Hebræus, *Chron. Eccles.*, i. 467–479.

[6] *B.O.*, ii. cli. (comp. p. 317).

[7] See Bar-Hebræus, *Chron. Syr.*, p. 328 (transl., p. 335); *Chron. Eccles.*, i. 497, 547.

[8] His baptismal name was probably Jacob; see *B.O.*, ii. 230, col. 1, at the foot.

[9] *B.O.*, ii. 216, 226; Bar-Hebræus, *Chron. Eccles.*, i. 531.

[10] *B.O.*, ii. 226; Bar-Hebræus, *Chron. Eccles.*, i. 525–527.

[11] *Chron. Eccles.*, i. 501.

[12] Died in 1164, *B.O.*, ii. 362.

[13] *B.O.*, ii. 364; Bar-Hebræus, *Chron. Eccles.*, i. 501, 554, 559. Died in 1171.

[14] Afterwards of Ṭūr-'Abhdīn; Bar-Hebræus, *Chron. Eccles.*, i. 515. He composed both in Armenian and Syriac, *B.O.*, ii. 360 coll. 1, 2, 362 col. 1; Bar-Hebræus, *Chron. Eccles.*, i. 487. Died in 1156; *B.O.*, ii. 362; Bar-Hebræus, *Chron. Eccles.*, i. 517; see Brit. Mus. Orient. 1017 (Wright, *Catal.*, pp. 897–898).

[15] *B.O.*, ii. 207; Bar-Hebræus, *Chron. Eccles.*, i. 503.

[16] *B.O.*, ii. 230.

[17] *B.O.*, ii. 362; Bar-Hebræus, *Chron. Eccles.*, i. 513–515.

[18] *B.O.*, ii. 363, 365; Bar-Hebræus, *Chron. Eccles.*, i. 559.

[19] *B.O.*, ii. 210; comp. *Catal. Bibl. Laur. et Palat. Medic.*, p. 79.

[20] *B.O.*, ii. 157–208.

[21] At Paris, Supl. 92, in Zotenberg's *Catal.*, No. 66. There are fragments in Anc. fonds 3 (Zotenberg, *Catal.*, No. 9); see also Cod. Vat. xcvi. 29, 42, 43 (Psalms), 30 (on the Prophets).

[22] *B.O.*, ii. 157–170.

[23] The Gospels are in Brit. Mus. Add. 7184; Cod. Vat. clv. 19–24, clvi., cclxxv.–ix.; Paris, Anc. fonds 33, 34 (Zotenberg, *Catal.*, Nos. 67-68); Bodl. Or. 703, 2. St. Matthew, Bodl. Hunt. 247. Revelation, etc., Brit. Mus. Add. 7185; Bodl. Or. 560. Dudley Loftus was the first to make use of these commentaries in his two works, *The Exposition of Dionysius Syrus, written above* 900 *years since, on the Evangelist St. Mark, translated by D. L.* (Dublin, 1672), and *A Clear and Learned Explication of the History of our Blessed Saviour J. C., . . by Dionysius Syrus, translated by D. L.* (Dublin, 1695); see Payne Smith, *Catal.*, p. 411, notes d and f. Loftus's manuscript translations are in the Bodleian Library, Fell 6 and 7.

[24] *B.O.*, ii. 170, 211. The section against the Muḥammadans is contained in Cod. Vat. xcvi. 19, and that against the Nestorians in Paris, Anc. fonds 125 (Zotenberg, *Catal.*, No. 209, 2). There is an extract from the latter in Bodl. Or. 467 (P. Smith, *Catal.*, p. 561). From it is extracted the list of the Jacobite patriarchs in *B.O.*, ii. 323, note 1.

[25] *B.O.*, ii. 207; see above.

[26] *B.O.*, ii. 176-208; Cod. Vat. cii., ccclxi.; Brit. Mus. Or. 2307 (partly Arabic); Paris, Anc. fonds 35, 69, 126.

[27] Cod. Vat. clix. 4; Bodl. Marsh. 101.

[28] Cod. Vat. clix. 30 (in Arabic).

[29] *B.O.*, ii. 171; comp. Cod. Vat. clv. 10, clix. 31.

[30] Bodl. Marsh. 101, f. 31.

[31] *B.O.*, ii. 171.

[32] *Ibid.*, ii. 175.

[33] *Ibid.*, ii. 175.

[34] *Ibid.*, ii. 170. Read, with slight alterations, on the installation of a bishop or patriarch. Cod. Vat. ii. 26, ccciv.; Paris, Suppl. 23.

[35] Cod. Palat. Medic. xl. (*Catal.*, p. 78).

[36] Cod. Palat. Medic. lxii. (*Catal.*, p. 107).

[37] Berlin, Alt. Bestand 37, 1.

[38] *B.O.*, ii. 317; Bar-Hebræus, *Chron. Syr.*, 328 (transl., p. 335).

[39] *B.O.*, ii. 317; Bar-Hebræus, *Chron. Syr.*, 346–347.

[40] *B.O.*, ii. 451–452; Bar-Hebræus, *Chron. Eccles.*, ii. 351.

Michael I.

Michael the Elder,[3] the son of Elias, a priest of Melitēne, of the family of Kindasī,[4] was abbot of the convent of Bar-ṣaumā, near Melitēne,[5] which we find him supplying with water, with the help of John, bishop of Mārdīn, in 1163.[6] He was elected patriarch in 1166, and held office till 1199.[7] He revised the Jacobite pontifical and ritual, arranging its contents under forty-six heads, as exhibited in Cod. Vat. li.,[8] drew up an anaphora,[9] wrote a tract setting forth the Jacobite confession of faith,[10] a treatise against a Coptic schismatic, Mark the son of Ḳonbar, on the question of confession,[11] and a poem on a case of persecution in 1159.[12] He also revised in 1185 the life of Abhḥai, bishop of Nicæa, having found most copies of it in a very disordered state.[13] His most important work was a *Chronicle*, from the creation to 1196 A.D., which was translated, with other works of his, into Armenian, and apparently exists in that language alone.[14] Some extracts from it were published by Dulaurier in the *Journal Asiatique* for 1848, p. 281 *sq.*, and 1849, p. 315 *sq.*, and the whole has been edited in a French translation by V. Langlois,[*] *Chronique de Michel le Grand*, 1868. According to him the translator of the first part of the work was the vartabed David, and it was finished by the priest Isaac, who completed his task in 1248, continuing it down to his own day. A third person engaged in translating the works of Michael into Armenian was the vartabed Vartan.[15] Appended to the *Chronicle* is an extract from a treatise of his "On the Sacerdotal Order and its Origin," or "On the Origin of Sacerdotal Institutions," with a continuation by Isaac and Vartan,[16] which is followed in the MSS. by the Jacobite "confession of faith."[17] Michael appears also to have written an ecclesiastical history, which is entirely lost to us. At least Bar-Hebræus[18] speaks of his recording certain matters in his "Ekklēsiastikē," which do not appear in the *Chronicle*.

Theodore bar Wahbōn.

A thorn in the side of Michael was his disciple Theodore bar Wahbōn. He first appears on the stage in 1170,[19] when the emperor Manuel sent Theorianus to the Armenian catholicus and the Jacobite patriarch with letters. Michael declined an interview, but sent John of Kaisūm to see Theorianus at Ḳal‘at ar-Rūm, and on his coming a second time to the same place selected Theodore bar Wahbōn as his representative.[20] Ten years afterwards, in 1180, when Michael was at Antioch, Ibn Wahbōn was made anti-patriarch at Āmid by certain malcontent bishops, under the name of John.[21] Michael, however, at once took energetic measures,[22] got hold of the anti-patriarch, formally deposed him, and shut him up in the convent of Bar-ṣaumā, whence he was afterwards allowed to make his escape by some of the monks. He fled to Damascus, where he tried in vain to bring his case before Ṣalāḥ ad-dīn, and thence to Jerusalem, after the fall of which city in 1187 he joined Gregorius Degha, the Armenian catholicus, at Ḳal‘at ar-Rūm and went with him to Cilicia, where the king, Leo, made him patriarch of the Jacobites in his territories. He died in 1193. According to Bar-Hebræus, Theodore bar Wahbōn was a good scholar, and could speak and write three foreign languages, Greek, Armenian, and Arabic.[23] He compiled an anaphora,[24] wrote an exposition of the Eucharistic service,[25] and a statement of his case against Michael in Arabic.[26]

Elias III.

Of Nestorian writers there are scarcely any worth naming in this century, for the historian and controversialist Mārē bar Shĕlēmōn, otherwise Mārī ibn Sulaimān, wrote in Arabic;[27] and Elias III.,[28] Abū Ḥalīm ibn al-Ḥadīthī, of Maiperḳaṭ, metropolitan of Nisībis and catholicus from 1175 to 1190, chiefly used the same language in his homilies and letters.[29] He is best remembered for having compiled and arranged the prayers in one of the service books, which is still called by his name, "the Abū Ḥalīm."[30]

Īshō‘-yabh bar Malkōn.

Īshō‘-yabh bar Malkōn was ordained bishop of Nisībis in 1190 by the catholicus Yabh-alāhā II. (1190–1222), was present at the consecration of his successor Sabhr-īshō‘ IV. (1222–25), and died under Sabhr-īshō‘ V. (1226–56), his follower at Nisībis being Makkīkhā, who was afterwards catholicus

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[1] Brit. Mus. Arund. Or. 11 (Rosen, *Catal.*, p. 62, col. 2).

[2] Cod. Vat. ccccxxv., in Mai, *Scriptt. Vett. Nova Coll.*, v.

[3] So called to distinguish him from his nephew Michael the Younger, Yēshū‘ Sephĕthānā or "Big-lips," who became patriarch at Melitēne (1199–1215), in opposition to Athanasius IX., Ṣalībhā Ḳĕrāḥā (the Bald), at Mārdīn (1199–1207), and John XIV., Yēshū‘ the scribe (1208–20).

[4] Bar-Hebræus, *Chron. Eccles.*, i. 537.

[5] Assemani expressly says "at Shennā" (read ܕܫܢܐ), *B.O.*, ii. 154, but the list of patriarchs at p. 323 does not give the word ܕܫܢܐ, though he repeats it in the translation (No. 100). In the *Dissert. de Monophysitis*, p. xcviii., he makes Michael belong to the convent near Melitēne, and merely mentions another convent of Bar-ṣaumā at "Sena" (see also the Index, p. 532). Langlois, in the preface to the *Chronique de Michel le Grand*, p. 3, thinks of a convent near Mārdīn, such as that restored by John, bishop of Mārdīn (*B.O.*, ii. 222, l. 19). We believe, however, that the convent near Melitēne is meant, as John of Mārdīn had acquired a certain reputation in what Abbeloos calls the "ars gromatica" (Bar-Hebræus, *Chron. Eccles.*, i. 526, note 1), wherefore it is said that Michael sent for him (*shaddar bāthrēh*), and that John "returned to his diocese because the winter was at hand, meaning to come back in April" (p. 527).

[6] Bar-Hebræus, *Chron. Eccles.*, i. 525.

[7] *B.O.*, ii. 363–369; Bar-Hebræus, *Chron. Eccles.*, i. 535–605.

[8] Assemani's *Catal.*, ii. 314 *sq.*; *B.O.*, ii. 155.

[9] Cod. Vat. xxv. 8; Paris, Anc. fonds 68 (Zotenberg, *Catal.*, p. 49); Leyden, Cod. 1572 (*Catal.*, v. 73).

[10] Bar-Hebræus, *Chron. Eccles.*, i. 549; Langlois, p. 331.

[11] Bar-Hebræus, *Chron. Eccles.*, i. 573–575; *B.O.*, ii. 155, No. iii.

[12] Bar-Hebræus, *Chron. Eccles.*, ii. 351.

[13] See Brit. Mus. Add. 12174, No. 8 (Wright, *Catal.*, p. 1124); Cod. Vat. xxxvii. 12 (*Catal.*, ii. 247); *B.O.*, ii. 505, col. 2. But the account of the death of the emperor Constantius, and the lives of Jacob of Sĕrūgh and of Mār Aḥā, appear to be wrongly ascribed to him in *Catal. Vat.*, ii. 248–249.

[14] The present writer has been recently informed that a copy of the original Syriac exists in the library of the convent of az-Za‘farān near Mārdīn.

[15] Langlois, Préface, p. 10, and note 2. [16] Langlois, p. 363 *sq.*

[17] Langlois, Préface, p. 8, at the top; Bar-Hebræus, *Chron. Eccles.*, i. 606, note 1, 6.

[18] *Chron. Eccles.*, i. 589.

[19] *Ibid.*, i. 549, 551, where 1172 is an error, as remarked by Abbeloos in note 1. John of Kaisūm, who was present on the occasion, died in 1171 (p. 559).

[20] The disputations held on these occasions were of course utterly fruitless. See Leunclavius, *Legatio Imp. Cæsaris Manuelis Comneni Aug. ad Armenios, sive Theoriani cum Catholico disputatio*, etc., 1578, and in Galanus, *Conciliationis Ecclesiæ Armenæ cum Romana* . . . . pars i., 1690, p. 242 *sq.*; *Disp. Theoriani secunda*, in Mai, *Scriptt. Vett. Nova Coll.*, vi. pp. xxiii. and 314 *sq.*, and in Migne, *Patrol. Gr.*, cxxxiii. 114 *sq.*; also Bar-Hebræus, *Chron. Eccles.*, i. 549–557; Langlois, *Chronique*, pp. 329–331; comp. Abbeloos's notes on Bar-Hebræus, pp. 550–552, and *B.O.*, ii. 364–365.

[21] Bar-Hebræus, *Chron. Eccles.*, i. 575 *sq.*; *B.O.*, ii. 213.

[22] Bar-Hebræus, *Chron. Eccles.*, i. 579; *B.O.*, ii. 214.

[23] *Chron. Eccles.*, i. 581.

[24] See Renaudot, ii. 409; *B.O.*, ii. 216; Payne Smith, *Catal.*, p. 241, note c. [25] *B.O.*, ii. 216.

[26] Bar-Hebræus, *Chron. Eccles.*, i. 581, at the foot.

[27] He flourished in the first half of this century (*B.O.*, iii. 1, 554–555, 582). His work is extant in the Vatican Library in 2 vols., cviii. and cix. (Mai, *Scriptt. Vett. Nova Coll.*, iv. 219–223), with the title *Kitāb al-Majdal* or "the Tower," wrongly ascribed to ‘Amr ibn Mattā of Ṭirhān. The first volume, transcribed in 1401, is theological and dogmatical; it comprises the first four sections. The second volume is theological and historical. The series of patriarchs ended with "71," ‘Abhd-īshō‘ bar Muḳī of Mosul (1138–47), but is continued down to Yabh-alāhā bar Ḳāyōmā of Mosul (1190) "qui nunc sedem tenet," *i.e.*, in 1214, when this volume was written. His epitomizer ‘Amr ibn Mattā of Ṭirhān lived in the first half of the 14th century (*B.O.*, iii. 1, 580, 586). To him is ascribed Cod. Vat. cx., which "autographus esse videtur" (Mai, *Scriptt. Vett. Nova Coll.*, iv. 224–227). It consists of five parts, of which the first is wanting in this MS., which has therefore no title. The series of catholics in pt. v., fundam. 2, is continued down to Yabh-alāhā (1281–1317). In pt. v., fundam. 3, sect. 6, we find the confession of faith of Michael, bishop of Āmid and Maiyāfāriḳīn (*B.O.*, iii. 1, 557), translated into Arabic by the priest Ṣalībā ibn Yoḥannā, whom G. E. Khayyath, archbishop of ‘Amādia, asserts to be the real author of the whole work (see his *Syri Orientales seu Chaldæi Nestoriani et Romanorum Pontificum Primatus*, 1870, and comp. Hoffmann, *Auszüge*, p. 6). Cod. Vat. dclxxxvii. (Mai, *op. cit.*, v. 594) contains part of the same work as Cod. Vat. cx. (though the *Catalogue* calls it the *Majdal*, and ascribes it to Mārī), viz., pt. v., fundam. 1 and 2 ("usque ad Ebediesum Barsaumæ successorem, qui obiit die 25 novembris an. Christi 1147. Continuat eandem historiam Amrus Matthæi filius, a Jesuiabo baladensi, Ebediesu successore, usque ad Iaballahum III. Timothei secundi successorem, qui obiit die 31 ianuarii an. Christi 1222"!). Cod. Vat. dclxxxviii. is also said to contain "Historia Patriarcharum Chaldæorum sive Nestorianorum," from Addai and Mārī down to Yabh-alāhā bar Ḳāyōmā, by ‘Amr ibn Mattā. "Hæc autem historia longe fusior est atque emendatior illa, quam Mares f. Salomonis conscripsit, de qua in præcedente codice"! And to add to the perplexity, Sachau describes his Cod. 12 (Arab.) as "Theil einer grossen Kirchengeschichte der Nestorianer. أسفار الأسرار Bücher der Geheimnisse. Alte Papierhandschrift (14 Jh.). Es ist das كتاب المجدل von ‘Amr b. Mattā aus Ṭirhān. Possibly the MS. in the collection of the S.P.C.K. may give some light.

[28] *B.O.*, ii. 450, iii. 1, 287; Bar-Hebræus, *Chron. Eccles.*, ii. 367–369.

[29] *B.O.*, iii. 1, 290.

[30] Badger, *The Nestorians*, ii. 23: "The Aboo Haleem contains a collection of collects appointed to be read at the conclusion of the Nocturns of all the Sundays throughout the year, of the festivals, and the three days of the *Baootha d'Ninwàyé*, before the commencement of the Matins." See *B.O.*, iii. 1, 291–295.

[*] [French Orientalist and historian of Armenia (1829–1869).—AM. ED.]

(1257–65).[1] He wrote on questions of grammar, besides homilies, letters, and hymns, in which, however, he chiefly, if not exclusively, employed the Arabic language.[2] He is the same as Joseph bar Malkōn, bishop of Mārdīn, whose metrical tract on the points, entitled *Mĕsīdhtā-dhĕ-Nuḳzē*, or "the Net of the Points," is found in MSS., along with the grammatical writings of Elias bar Shīnāyā and John bar Zō'bi.[3] This tract must therefore have been composed before 1190.

Simeon Shanḳĕlāwī.

Simeon Shanḳĕlabhādhī or Shanḳĕlāwī, of Shanḳĕlābhādh or Shanḳĕlāwah,[4] near Irbil, must have been a contemporary of Bar Malkōn, and perhaps somewhat senior to him. He was the teacher of John bar Zō'bī, for whom he wrote a *Chronikon* or chronological treatise in the form of questions and answers, explanatory of the various eras, the calendar, etc. There is a MS. in the British Museum, Add. 25875,[5] and several at Berlin.[6] He was also the author of a moral poem in enigmatical language, of which 'Abhd-īshō' thought it worth his while to write an explanation for his disciple Abraham.[7] To him is likewise ascribed "the questions of Simon Kēphā concerning the Eucharist and Baptism," which he appears to have introduced to the notice of his pupil John bar Zō'bī.[8]

John bar Zō'bī.

John bar Zō'bī flourished about the end of the 12th and the beginning of the 13th century. He was a monk of Bēth Ḳūḳā (or Ḳūḳē) in Ḥĕdhaiyabh, and numbered among his pupils Jacob bar Shakkō, or Severus, bishop of Mār Matthew (see below).[9] He wrote metrical homilies, partly in seven-syllable, partly in twelve-syllable verse, on the chief points of the Nestorian faith.[10] One of these is mentioned by Assemani, *B.O.*, iii. 1, 309, note 1;[11] another, on the four problems of philosophy, is in Berlin, Sachau 72, 15. Bar Zō'bī is, however, better known as a grammarian.[12] The larger of his two grammars is based on the works of previous writers, such as Severus Sēbōkht and Denḥā, commentators on Aristotle, and the grammarians Elias I., the catholicus, and Elias bar Shīnāyā, bishop of Nisībis.[13] The smaller grammar is an epitome in verse, accompanied by a metrical tract on the four chief marks of interpunction.[14] He seems also to have continued the treatise of Ḥonain *De Synonymis*,[15] so that he may perhaps be Hoffmann's "analecta anonymus."[16]

As the lamp flares up before it expires, so the 13th century witnessed a revival of Syriac literature before its extinction.

David bar Paul.

David bar Paul is cited by Bar-Hebræus in the *Auṣar Rāzē*,[17] and may therefore be supposed to have lived early in the 13th century. He was evidently a man of considerable culture, and a versifier. We have from his pen a poem on the letters of the Syriac alphabet,[18] a note on the mutable letters,[19] and a brief enumeration of the categories of Aristotle,[20] a moral poem in twelve-syllable verse,[21] another on repentance in an Arabic translation,[22] and specimens of a third in Cardāḥī's *Liber Thesauri*, p. 138. Theological are a dialogue between a Malkite and a Jacobite on the hymn Trisagion,[23] and a tract in Arabic on matters in dispute between the Jacobites and Malkites.[24]

Jacob or Severus bar Shakkō.

Jacob bar Shakkō (Shakkākō?),[25] or 'Īsā, bar Mark, of Barṭellāi or Barṭullā, near Mosul, was a monk of the famous convent of Mār Matthew, of which he afterwards became bishop by the name of Severus.[26] He was trained in grammar by John bar Zō'bī (see above) in the convent of Bēth Ḳūḳā (or Ḳūḳē) in Ḥĕdhaiyabh,[27] and in dialectics and philosophy by Kamāl ad-Dīn Mūsā ibn Yūnus at Mosul.[28] He composed one of his works, the *Book of Treasures*, in 1231 and died in 1241,[29] on his way to visit the aged patriarch Ignatius II. (maphriān 1215–22, patriarch 1222–53). He possessed a great many books, which were all conveyed to the *dĕmosion*[30] of the ruler of Mosul. His works are as follows. (1) The *Book of Treasures*, a theological treatise in four parts, viz., part i., of the three-one God; part ii., of the incarnation of the Son of God; part iii., of the Divine Providence; part iv., of the creation of the universe, the angels, the different kinds of life, the soul of man, the resurrection, and the last judgment.[31] (2) The *Dialogues*, in two books. Book i., dial. 1, on grammar, followed by a discourse on the same in twelve-syllable metre; dial. 2, on rhetoric; dial. 3, on the art of poetry and metres; dial. 4, on the eloquence and copiousness of the Syriac language. Book ii., dial. 1, on logic and the syllogism; dial. 2, on philosophy, its kinds, divisions, and subdivisions, in five sections, viz., (*a*) on the definitions of philosophy, its divisions, etc.; (*b*) on the philosophic life and conduct; (*c*) on physics or physiology; (*d*) on the four disciplines,—arithmetic, music, geometry, and mathematics; (*e*) on metaphysics and theology.[32] Of his letters two are extant, in verse, addressed to Fakhr ad-Daulah Mark bar Thomas and his brother Ṭāj ad-Daulah Abū Ṭāhir Ṣā'id.[33] He also wrote a confession of faith regarding the Trinity and the incarnation, which he himself cites in the *Book of Treasures*, part ii., chap. 14, and an exposition of the services and prayers of the church, which is referred to in the same work, part ii., chap. 31 (on the addition of the words "who was crucified for us" to the Trisagion).[34] Under the name of Jacob of Maiperḳaṭ we have an admonition addressed to persons seeking ordination as priests, which is found in many service books.[35]

Aaron bar Ma'danī.

Aaron bar Ma'danī (or Ma'dānī?) had been recently appointed bishop of Mārdīn, under the name of John, when he was promoted by the patriarch Ignatius II. to the dignity of maphriān in 1232.[36] His bodily presence seems to have been somewhat insignificant, and he was no orator, for which reasons he was unpopular.[37] In 1237 he went to Baghdādh, where in the following year he composed his panegyric on the holy Mār Aaron, and ingratiated himself with the three brothers Shams ad-Daulah, Fakhr ad-Daulah, and Ṭāj ad-Daulah, the sons of the archiater Thomas, who were in high favor at the court of al-Mustansir bi'llāh. He learned to speak and write Arabic thoroughly.[1] In 1244 he was recalled to Mosul and received with every mark of respect.[2] On the death of Ignatius in 1252, Dionysius (Aaron 'Angūr) was created patriarch,[3] but a rival faction set up John bar Ma'danī;[4] and so the two ruled in a divided church till Dionysius was murdered in the convent of Bar-ṣaumā near Melitenē in 1261,[5] after which time his rival sat alone till 1263.[6] John bar Ma'danī compiled an anaphora[7] and wrote a great many poems, of which Bodl. Hunt. 1 contains no less than 60.[8] Some of the more important of these are the poem on the soul, entitled "the Bird" (*Pārāḥĕthā*),[9] on the high origin of the soul and its degradation by sin,[10] on the excellent path of the perfect,[11] and on the capture of Edessa and other places by the Seljūḳ sultān 'Alā 'u 'd-din Kaiḳobadh in 1235.[12] Of his homilies Cod. Vat. xcvii. contains eighteen for various feasts in Arabic.[13]

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[1] *B.O.*, iii. 1, 295, note 1.

[2] *Ibid.*, iii. 1, 295–306.

[3] *E.g.*, Cod. Vat. cxciv. (copied from a MS. written in 1246), and Brit. Mus. Add. 25876, f. 276b (note the colophon, f. 290b, Wright, *Catal.*, p. 1178); see *B.O.*, iii. 1, 308, col. 1, No. viii., and the Abbé Martin, *De la Métrique chez les Syriens*, 1879, p. 70 (at p. 68, l. 14, read ܕܢܨܝ̈ܒܝܢܐ, "the bishop of Nisibis").

[4] See Hoffmann, *Auszüge*, p. 231, and note 1847.

[5] Wright, *Catal.*, p. 1067.

[6] Sachau 108, 1, 121, and 153, 1, 3.

[7] Cod. Vat. clxxxvii. (*Catal.*, iii. 404); MS. Ind. Off. No. 9, "Tracts in Syriac," f. 204. It has been published by Cardāḥī, *Liber Thesauri*, p. 89. Cardāḥī calls the author *as-Sanḳalabārī*, blindly copying Assemani's *Sancalabarensis*, and places his death in 780 (see *B.O.*, iii. 1, 225, note 5, p. 226, note 7; and *Catal. Vat.*, iii. 405).

[8] *B.O.*, iii. 1, 562.

[9] Bar-Hebræus, *Chron. Eccles.*, ii. 409.

[10] Brit. Mus. Or. 2305; and apparently Berlin, Sachau 8.

[11] It has been translated by Badger, *The Nestorians*, ii. 151–153.

[12] *B.O.*, iii. 1, 307.

[13] Part of this work, namely, the portion that deals with the marks of interpunction, has been edited and translated by Martin, *Traité sur l'Accentuation chez les Syriens Orientaux*, 1877.

[14] MSS. of these grammars,—Cod. Vat. cxciv., ccccl.; Brit. Mus. Add. 25876; Or. 2314; Berlin, Alt. Best. 36, 16, and Sachau 216, 2, and 306, 2.

[15] Berlin, Sachau 72, 14.

[16] *Opusc. Nestor.*, p. iv.

[17] *B.O.*, ii. 243.

[18] Cod. Vat. ccxvii. (*Catal.*, iii. 505); Paris, Anc. fonds 118 (Zotenberg, *Catal.*, p. 166), 157 (*Ibid.*, p. 147).

[19] Paris, Anc. fonds 164 (Zotenberg, *Catal.*, p. 213).

[20] Berlin, Alt. Best. 36, 13.

[21] Cod. Vat. xcvi. (*Catal.*, ii. 522).

[22] Cod. Vat. lviii. (*Catal.*, ii. 851).

[23] Cod. Vat. cxlvi. (*Catal.*, iii. 268), ccviii. (*Catal.*, iii. 496); Paris, Anc. fonds 134A (Zotenberg, *Catal.*, p. 154), with an Arabic translation.

[24] Bodl. Hunt. 199 (P. Smith, *Catal.*, p. 449), Poc. 79 (*ib.*, p. 459).

[25] Written ܫܟܘ and ܫܟܟܘ.

[26] Bar-Hebræus, *Chron. Eccles.*, ii. 409 (a contemporary). In Cod. Vat. ccccxi. (Mai, *Scriptt. Vett. Nova Coll.*, v.) he bears the name of Jacob bar Talia, a corruption of Barṭellāyā. In MS. Berlin, Alt. Best. 38, 1 (if the *Catal.* be correct), he is called "metropolitan of the convent of St. Matthew near Arbela," confusing Mār Matthew at Mosul with Bēth Ḳūḳā, where he was trained. Assemani and others have identified him with Jacob, bishop of Maiperḳaṭ (Mĕdhīnath Sāhdē). With Taghrith he never had anything to do.

[27] Hoffmann, *Auszüge*, p. 215, note 1715.

[28] Born 1156, died 1224; Bar-Hebræus, *Chron. Eccles.*, ii. 411; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 229; Ibn Khallikān, ed. Wüstenfeld, No. 757; Ibn Abī Oṣaibi'ah, ed. Müller, i. 306.

[29] Assemani (*B.O.*, ii. 455) is mistaken; see also pp. 237 and 477.

[30] According to Abbeloos Bar-Hebræus, *Chron. Eccles.*, ii. 412, "in ærarium publicum principis Mossulæ assumpti fuerunt." We suspect that the Christian bishop's library went to light the fires of the public bath.

[31] Cod. Vat. clix. (*Catal.*, iii. 307); Brit. Mus. Add. 7193 (Rosen, *Catal.*, p. 84); and in the collection of the S.P.C.K. An extract in Cod. Vat. ccccxi. (Mai, *Scriptt. Vett. Nova Coll.* v.); see *B.O.*, ii. 237–240.

[32] Brit. Mus. Add. 21454 (Wright, *Catal.*, p. 1165); Göttingen, Cod. Orient. 18c; Bodl. Marsh. 528 (apparently imperfect, P. Smith, *Catal.*, p. 642). Excerpts in Berlin, Alt. Best. 38, 1. Book i., dial. 3, has been edited by Martin, "De la Métrique chez les Syriens," in *Abhandlungen für d. Kunde d. Morgenlandes*, Bd. vii., No. 2, 1879.

[33] Brit. Mus. Add. 7193 (Rosen, *Catal.*, p. 84); see Bar-Hebræus, *Chron. Eccles.*, ii. 407, where the third brother Shams ad-Daulah is also mentioned.

[34] *B.O.*, ii. 240.

[35] *E.g.*, Cod. Vat. li 9 (*Catal.*, i. 318); ccciv. (Mai, *Scriptt. Vett. Nova Coll.*, v.); Paris, Suppl. 22, 23, 38, 94 (the last in Arabic), see Zotenberg, *Catal.*, pp. 68, 72, 76; comp. *B.O.*, ii. 241.

[36] *B.O.*, ii. 454.

[37] Bar-Hebræus, *Chron. Eccles.*, ii. 407.

Bar-Hebræus.

These writers are, however, all cast into the shade by the imposing figure of Bar-Hebræus, as we are accustomed to call him, one of the most learned and versatile men that Syria ever produced.[14] Abu 'l-Faraj Gregory[15] was the child of a physician at Melitēne (Malaṭiah') named Aaron, a convert from Judaism or of Jewish descent, whence his son got the name of Bar 'Ebhrāyā or Ibn al-'Ibri, "the son of the Hebrew." He was born in 1226,[16] and devoted himself from his boyhood to the acquisition of Greek and Arabic. A little later he applied himself also to theology and philosophy, besides practicing medicine under his father and other distinguished physicians. His lot was cast, however, in evil days. In 1243 many of the inhabitants of Malaṭiah fled to Aleppo before the advancing hordes of Hulāgū and his Tatars, and his father would have been among the fugitives, had it not been for a lucky accident.[17] In the following year his father had actually to attend as physician upon one of the Tatar generals, whom he accompanied to Ḳhartabirt, and on his return retired almost immediately from Malaṭiah to the safer city of Antioch.[18] Here Bar-Hebræus completed his studies and commenced his monastic life.[19] Thence he went to Tripolis, where he and Ṣalībhā bar Jacob Wagīh, of Edessa, were studying medicine and rhetoric with a Nestorian teacher named Jacob, when they were summoned before the patriarch Ignatius II., on 14th September, 1246, and ordained bishops, the former of Gūbōs (Gūbās) near Malatiah, the latter of 'Akkō.[20] Bar-Hebræus was then just twenty years of age. In the following year he was transferred to Laḳabhīn, another diocese adjacent to Malaṭiah,[21] by the patriarch Ignatius.[22] After the death of Ignatius, Bar-Hebræus took the part of Dionysius (Aaron 'Angūr) against John bar Ma'danī, and was transferred by him in 1253 to Aleppo,[23] but quickly deposed by his old friend Ṣalībhā (who sided with John bar Ma'danī);[24] nor did he recover this see till 1258.[25] The next patriarch, Ignatius III. (Yēshū), abbot of Gĕvīkāth near Mopsuestia,[26] advanced him to the dignity of maphriān in 1264.[27] Henceforth his life was an active and busy one, and it seems almost marvellous that he should have studied and written so much, while in no way neglectful of the vast diocese committed to his charge. The story is told by himself in simple language in his *Ecclesiastical History*,[28] with a continuation by his surviving brother Bar-ṣaumā Ṣafī, giving a nearly complete list of his works.[29] He died at Marāghah in Adhurbāigān on 30th July, 1286, and the greatest respect was shown to his memory by Greeks, Arminians, and Nestorians alike, the shops being closed and no business transacted.[30] His body was conveyed to the convent of Mār Matthew at Mosul,[31] where his grave was seen by Badger in October, 1843.[32] Bar-Hebræus cultivated nearly every branch of science that was in vogue in his time, his object being on the one hand to reinvigorate and keep alive the Syriac language and literature, and on the other to make available to his co-religionists the learning of the Muhammadans in a suitable form. Hence his treatment of the Aristotelian philosophy, following in the footsteps of Ibn Sīnā (Avicenna) and other Arabian writers.[33] The *Kĕthābhā dhĕ-Bhābhātha*, or "Book of the Pupils of the Eyes," is a compendium of the art of logic or dialectics, comprising an introduction on the utility of logic and seven chapters in which the author deals successively with the *Isagōgē* of Porphyry, the *Categories*, *De Interpretatione*, *Analytica Priora*, *Topica*, *Analytica Posteriora*, and *De Sophisticis Elenchis*.[34] In connection with it we take the *Kĕthābhā dha-Sĕwādh Sophia* or "Book of the Speech of Wisdom," a compendium of dialectics, physics, and metaphysics or theology.[35] The large encyclopædia entitled *Ḥĕwath Ḥekhmĕthā*, "Butyrum Sapientiæ," or less correctly *Ḥekhmath Ḥekhmāthā*, "Sapientia Sapientiarum," comprises the whole Aristotelian discipline. The first volume contains the *Logic*, viz., the *Isagōgē*, *Categories*, *De Interpret.*, *Anal. Pri.* and *Poster.*, *Dialectica*, *De Sophist. Elenchis*, *Rhetoric*, and *Art of Poetry*. The second comprises the *Physics*, viz., *De Auscult. Physica*, *De Cœlo et Mundo*, *De Meteoris*, *De Generatione et Corruptione*, *De Fossilibus*, *De Plantis*, *De Animalibus*, and *De Anima*. The third, in its first section, treats of the *Metaphysics*, viz., of the origin and writers of philosophy, and of theology; in its second section, of ethics, economics, and politics.[36] An abridgment of this large work is the *Tĕgĕrath Tĕgĕrāthā* or "Mercatura Mercaturarum," which goes over the same ground in briefer terms.[37] To this class too belongs a poem "On the Soul, according to the views of the Peripatetics," which is described as "mēmrā shīnāyā," *i.e.*, according to Assemani, riming in the letter *sh*.[38] Bar-Hebræus also translated into Syriac Ibn Sīnā's *Kitāb al-ishārāt wa-'t-tan bīhāt*,[39] under the title of *Kĕthābhā dhĕ-Remzē wa Mĕ'īrānwāthā*,[40] and another work of the same class, entitled *Zubdat al-Asrār* or "the Cream of Secrets," by his elder contemporary, Athīr ad-dīn Mufaddal ibn 'Omar al-Abharī (died in 1262).[41] Nor did he neglect the study of mathematics and astronomy. In 1268 we find him lecturing on Euclid in the new convent at Marāghah, and again in 1272, at the same place, on the *Megistē* ('Η μεγάλη σύνταξις) of Ptolemy.[42] He drew up a *zîj*, *i.e.*, a set of astronomical tables or astronomical almanac, for the use of tiros;[43] but his principal work in this branch of science is the *Sullāḳā Hawnānāyā* or "Ascent of the Mind," a complete treatise on astronomy and cosmography, which he composed in 1279.[44] His medical writings are more numerous, for Bar-Hebræus was famous as a physician[45] and had been in attendance as such on the Tatar "king of kings" in 1263.[1] He made, for example, a translation and an abridgment of Dioscorides's treatise Περὶ ὕλης ἰατρικῆς (De Medicamentis Simplicibus), under the title of *Kĕthābhā dhĕ-Dhioskoridhīs*,[2] and wrote a commentary on the *Aphorisms* of Hippocrates in Arabic,[3] and on the *Quæstiones Medicæ* of Ḥonain ibn Isḥāḳ in Syriac.[4] He also published the *Quæstiones* in an abridged Syriac translation.[5] Further, he is said to have written commentaries in Arabic on Galen's treatises *De Elementis* (Περὶ τῶν καθ' Ἱπποκράτην στοιχείων) and *De Temperamentis* (Περὶ κρασέων).[6] He made an abridged version in Arabic of al-Ghāfiḳī's[7] "Book of Simples" (*al-adwiyah al-mufradah*),[8] and left an unfinished Syriac translation of the *Canon* (*al-Ḳānūn fi 'ṭ-Ṭibb*) of Ibn Sīnā.[9] A large medical treatise of his own composition in Syriac is mentioned, but no special title is given.[10] As a grammarian Bar-Hebræus deserved well of his country, and his writings on this subject are now well known and appreciated by Orientalists. By making use of the work of previous grammarians, especially Jacob of Edessa, he has succeeded in giving a very full sketch of the language according to the Oriental system, with many valuable observations as to dialectic differences, etc. The larger grammar bears the title of *Kĕthābhā dhĕ-Ṣemḥē*, "the Book of Lights" or "Rays."[11] It has been published, according to the Paris MS. Ancien fonds 166, by the Abbé Martin.[12] The smaller metrical grammar, *Kĕthābhā dhĕ-Ghrammatiḳī*,[13] was edited so long ago as 1843 by Professor Bertheau of Göttingen, according to the MS. Orient. 18 in the library of that university, but without the fifth section *De Vocibus Æquivocis*. Martin has republished it in his *Œuvres Grammaticales d'Abou 'l Faradj*, vol. ii., including the fifth section, according to the Paris MS. Ancien fonds 167.[14] A third, still smaller grammar, *Kĕthābhā dha-Bhĕlĕṣūṣīthā* or "the Book of the Spark," was left unfinished by the author.[15] As a theologian, Bar-Hebræus's most useful work undeniably is the *Auṣar Rāzē* or "Storehouse of Secrets," the *Horreum Mysteriorum* as it is commonly called.[16] This is a critical and doctrinal commentary on the text of the Scriptures of the Old and New Testaments, based on the Pĕshīṭṭā, but taking note of the various readings of the Hebrew text, the LXX. and other Greek versions, the later Syriac translations, and even the Armenian and Coptic, besides noting differences of reading between the Nestorians and Jacobites. The doctrinal portion is drawn from the Greek fathers and previous Syrian theologians. of course of the Monophysite school.[17] The *Mĕnārath Ḳudhshē*, or "Lamp of the Sanctuary," is a treatise on the "bases" or first principles on which the church is established.[18] It deals in twelve "bases" with the following subjects: (1) of knowledge in general, (2) of the nature of the universe, (3) of theology, (4) of the incarnation, (5) of the knowledge of celestial substances, *i.e.*, the angels, (6) of the earthly priest hood, (7) of the evil spirits, (8) of the rational soul, (9) of free will and liberty, fate and destiny, (10) of the resurrection, (11) of the end of the world and the last judgment, (12) of paradise. The *Kĕthābhā dhĕ-Zalgē*, or "Book of Rays," is a compendium of theology, going over nearly the same ground as the previous work, in ten sections.[19] The *Kĕthābhā dh'Ithīḳōn*, or *Liber* τῶν ἠθικῶν, was composed at Marāghah in 1279. It has been fully analyzed by Assemani in the *B.O.*, ii. 303 *sq*. Part i. treats of the exercises of the body and mind, such as prayer, manual work, study, vigils, fasting, etc.; part ii., of the regimen of the body; part iii., of the purifying of the soul from evil passions; part iv., of the adorning of the soul with virtues.[20] The *Kĕthābhā dhĕ-Yaunā*, or "Book of the Dove," is a similar work specially intended for the use of ascetics living in solitude as hermits. It is also divided into four parts, viz., (1) of the training of the body, *e.g.*, in alienation from the world, repentance, poverty, humility, patience, fraternal love, etc.; (2) of the training of the soul, *e.g.*, in quiet, religious exercises, prayer, watching, fasting, etc.; (3) of the spiritual rest of the perfect; and (4) an autobiographical sketch of his own spiritual life.[21] Bar-Hebræus also spent part of his time in excerpting, arranging, and commenting upon the *Book of Hierotheus concerning the hidden Mysteries of the House of God*.[22] In the commentary he chiefly follows that of Theodosius, patriarch of Antioch (see above, p. 889).[23] He compiled an anaphora,[24] published a confession of faith or creed,[25] and approved the order of baptism of Severus, as translated by Jacob of Edessa.[26] More valuable than these is his *Kĕthābhā dhĕ-Huddāyē*, "the Book of Directions" or "Nomocanon," which is for the Jacobite Church what the *Kunnāshā dhĕ-Ḳānōnē* of 'Abdh-īshō' is for the Nestorian, both in ecclesiastical and secular matters.[27] To us Europeans the historical writings of Bar-Hebræus surpass in interest and value everything else that he has written. He planned and executed a *Universal History* in three parts.[28] Part i. contains the political *History of the World* from the creation down to his own times.[29] Part ii. is the history of the church from Aaron downwards, the treatment being exceedingly brief till we reach the post-apostolic period, when it becomes a history of the patriarchs of the church of Antioch, and finally, after the age of Severus, of the patriarchs of the Monophysite branch of that church down to the year 1285. The meagre continuation by a later hand reaches to 1495. Part iii. offers us the history of the Eastern division of the Syrian Church from St. Thomas the apostle onwards. From the time of Mārūtha (629) it becomes the history of the Monophysite maphriāns of Taghrīth, though a record is always carefully kept of the catholic patriarchs of the Nestorians. It closes with the year 1286, but there is a continuation by Bar-Hebræus's brother Bar-ṣauma to 1288, and thence by another writer to 1496.[30] In the last years of his life, at the request of some Muslim friends in Maraghah, he undertook to make a recension in Arabic of the political history, which he all but finished within the space of one month before his last illness came on.[1] This edition is enriched with many references to Muḥammadan writers and literature which are wanting in the Syriac. It is entitled *al-Mukhtaṣar fī 'd-Duwal*, or "Compendious History of the Dynasties."[2] As a poet Bar-Hebræus is admired by his countrymen, and even Renan has thought the poem on the theme *Bona Lex sed Melior Philosophia* to be worthy of publication.[3] Some of the poems were badly edited and translated by Von Lengerke in 1836–38 according to the Paris MS. Ancient fonds 130; others have been published by the Maronite priest Augustinus Scebābi (الشّبابي) at Rome, 1877. The *Carmen de Divina Sapientia* was brought out so long ago as 1638 by Gabriel Sionita, and has been republished at Rome in 1880 by Yoḥannā Noṭayn Darauni (يُوحنّا نُطين الدّرعوني).[4] In his youth Bar-Hebræus wrote a book on the interpretation of dreams, *pushshāk helmē*;[5] and in his later years he made a collection of entertaining and humorous stories in Syriac, entitled *Kĕthābhā dhĕ-Thunnāyē Mĕghaḳḳĕkhāne*, with an Arabic counterpart under the title of *Daf' al-Hamm* (دفع الهمّ), "the Driving away of Care."[6] The contents of the *Tunnāyē* are, however, more varied than the title seems to promise, as may be seen from Assemani's enumeration of the chapter, *B.O.*, ii. 306.[7]

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[1] *Ibid.*, ii. 411.
[2] *Ibid.*, ii. 418.
[3] *Ibid.*, i. 697, 701; *B.O.*, ii, 376.
[4] Bar-Hebræus. *Chron. Eccles.*, i. 707; *B.O.*, ii. 377.
[5] Bar-Hebræus, *Chron. Eccles.*, i. 787.
[6] *Ibid.*, i. 748.
[7] See Renaudot, ii. 512.
[8] See Payne Smith, *Catal.*, pp. 379–382, and MS. Berlin, Sachau, 207, 3.
[9] Bodl. Hunt. 1; Poc. 298 (P. Smith, *Catal.*, p. 641); Cod. Vat. cciv. (*Catal.*, iii. 489); Berlin, Sachau, 61, 8.
[10] Bodl. Hunt. 1; Cod. Vat. cciv.
[11] Bodl. Hunt. 1; Poc. 298; Vat. cciv. Edited in part by Cardāhi in the *Liber Thesauri*, pp. 66–68.
[12] Hunt. 1. Palat. Medic. lxii. contains two poems on the love of God and the love of wisdom (*Catal.*, p. 108).
[13] *Catal.* ii. 523. There is one, also in Arabic, on repentance and death in Cod. Vat. ccxx. (*Catal.*, iii. 508).
[14] *B.O.*, ii. 244 *sq.* See Gibbon's Eulogy of him, *Decline and Fall of the Roman Empire*, ed. Smith, 1855, vol. vi. p. 55.
[15] His baptismal name was John, as appears from the inscription on his tombstone; Badger, *The Nestorians*, i. 97. Gregory he probably adopted when he became a bishop.
[16] *B.O.*, ii. 263.
[17] *Ibid.*, ii. 244; Bar-Hebræus, *Hist. Dynast.*, p. 481 (transl., p. 315); *Chron. Syr.*, p. 503 (transl., p. 521).
[18] *B.O.*, ii. 245; Bar-Hebræus, *Hist. Dynast.*, pp. 486–487 (transl., pp. 318–319); *Chron., Syr.*, 504–505 (transl. p. 522).
[19] See the poem No. 29 in Cod. Vat. clxxiv. (*Catal.*, iii. 356).
[20] Bar-Hebræus, *Chron. Eccles.*, i. 667: *B.O.*, ii, 245, 374. From 'Akkō Ṣalībhā was transferred to Aleppo, under the name of Basil (*B.O.*, ii. 375), and promoted in December, 1252, by the patriarch John bar Ma'danī to be maphriān, under the name of Ignatius (*B.O.*, ii. 377, 455). He died in 1258.
[21] *B.O.*, ii. 260.
[22] *Ibid.*, ii. 246; Bar-Hebræus, *Chron. Eccles.*, i. 685.
[23] *B.O.*, ii. 246; Bar-Hebræus, *Chron. Eccles.*, i. 721.
[24] *Ibid.*, i. 721.
[25] *Ibid.*, i. 727.
[26] He sat from 1264 to 1282.
[27] *B.O.*. ii. 246; Bar-Hebræus, *Chron. Eccles.*, i. 749, ii. 433.
[28] *Ibid.*, ii. 431–467; *B.O.*, ii. 248–263.
[29] Bar-Hebræus, *Chron. Eccles.*, ii. 467–485; *B.O.*, ii. 264–274. Two brothers died before him, Michael and Muwaffak. See the poems Nos. 166 and 170 in Cod. Vat. clxxiv. (*Catal.*, iii. 358).
[30] *B.O.*, ii. 266; *Chron. Eccles.*, ii. 473.
[31] *B.O.*, ii, 460.
[32] *The Nestorians*, i, 97. For "1586" read 1587, and for "August" July.
[33] Compare Renan, *De Philos. Peripat. apud Syros* (1852), p. 65 *sq.*
[34] Brit. Mus. Or. 1017; Paris, Anc. fonds 188; Berlin, Alt. Best. 88, 2, 89; Sachau 140, 2, and 198, 8; Cambridge, collection of the S.P.C.K.
[35] Brit. Mus. Or. 1017; Paris, Anc. fonds 138 (Syr. and Arab.); Berlin, Alt. Best. 38, 4; Sachau 91 (Syr. and Arab.), also 140, 1, and 198, 9; Cambridge, coll. of the S.P.C.K.
[36] Palat. Medic. clxxxvi.–vii., clxxvi.–ix. (= clxxxvi.; see Renan, *De Philos. Peripat. apud Syros*, p. 66); Bodl. Hunt. 1 (imperf.); compare also Palat. Medic. clxxxiii.–iv and lxii. (p. 109).
[37] Palat. Medic. cc.; Berlin, Sachau 211; Cambridge, coll. of the S.P.C.K.
[38] *B.O.*, ii. 268, in the note, col. 2, No. 28.
[39] *Theoremata et Exercitationes*, a course of logic, physics, and metaphysics; see Wüstenfeld, *Geschichte d. arab. Aerzte*, p. 73, No. 61; *B.O.*, ii. 270, note 2.
[40] Cod. Vat. cxci.; Palat. Medic. clxxxv. (Arab. and Syr.); Paris, Anc. fonds 163.
[41] See *Hist. Dynast.*, p. 485 (transl., p. 318).
[42] *B.O.*, ii. 258; *Chron. Eccles*., ii. 443.
[43] *B.O.*, ii. 307; but the calendar there indicated is of later date.
[44] Bodl. Hunt. 540; Paris, Anc. fonds 162. On the date see Payne Smith, *Catal.*, p. 584.
[45] Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 240.

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[1] *Chron. Eccles.*, i. 747.

[2] *B.O.*, ii. 268, in the note, col. 1, No. 13, and p. 270.

[3] *Ibid.*, ii. 268, col. 1, No. 15, and p. 270.

[4] Apparently unfinished, for Bar-ṣaumā is careful to add "as far as *Thīriaḳī*," *B.O.*, ii. 272, No. 28; see also p. 268, in the note, col. 2, No. 25.

[5] *B.O.*, ii. 270, No. 16.

[6] Wenrich, *De Auctorum Græc. Verss. et Commentt. Syriacis*, etc., 1842, pp. 242–243, 270; Wüstenfeld, *Gesch. d. arab. Aerzte*, No. 240.

[7] Wüstenfeld, *op. cit.*, No. 176; Ibn Abī Uṣaibi'ah, ed. Müller, ii. 52.

[8] *B.O.*, ii. 270, No. 14; 268, note, col. 1, No. 14.

[9] *Ibid.*, ii. 272, No. 24; 268, note, col. 2, No. 22.

[10] *Ibid.*, ii. 272, No. 26.

[11] *Ibid.*, ii. 307.

[12] *Œuvres Grammaticales d'Abou 'l Faradj, dit Bar Hebreus*, vol. i., 1872. The chapter on the signs of interpunction, etc., was edited by Dr. Phillips in 1869, in *A Letter by Mār Jacob, Bishop of Edessa, on Syriac Orthography*. MSS. of this work are—Cod. Vat. ccccxvi., ccccxxii; Bodl. Hunt. 1, Pocock 298; Paris, Anc. fonds 166; Brit. Mus. Add. 7201; Palat. Medic. cxxii.; Göttingen, Or. 18 b; Berlin, Alt. Best. 43, Sachau 307, 306; Cambridge, coll. of the S.P.C.K.

[13] *B.O.*, ii. 308.

[14] Of this work there are many MSS. in Europe, differing from one another in the quantity of the scholia and the retention or omission of section 5.

[15] *B.O.*, ii. 272, No. 27.

[16] *Ibid.*, ii. 277.

[17] Portions of this work have been edited at various times, but a complete edition is still unachieved. Larsow made a very small beginning in 1858. See the list in Nestle's *Brevis Linguæ Syr. Grammatica*, 1881, pp. 31–32. MSS. of this work—Cod. Vat. clxx., cclxxxii.; Palat. Medic. xxvi.; Bodl. Hunt. 1; Brit. Mus. Add. 7186, 21580, 23596; Berlin, Alt. Best. 11, Sachau 134; Göttingen, Orient. 18 a; Cambridge, coll. of the S.P.C.K.

[18] *B.O.*, ii. 284. MSS.—Cod. Vat. clxviii.; Paris, Anc. fonds 121; Cambridge, coll. of the S.P.C.K. This work has been translated into Arabic—Paris, Anc. fonds 128; Brit. Mus. 18296; Bodl. Hunt. 48; Berlin, Sachau 81; Cambridge, coll. of the S.P.C.K. Mr. R. J. H. Gottheil has recently lithographed, "for private circulation only," a small portion of this work, viz., basis ii., ch. iii. sect. 8, paragr. *b*, on plants (26 pp. of text, 8 pp. of preface); the title is *A List of Plants and their Properties from the Mᵉnārathᵃ Ḳudhᵉšē of Gregorius bar 'Ebhrāyā edited by Richard J. H. Gottheil, B.A.*

[19] *B.O.*, ii. 297. MSS.—Cod. Vat. clxix.; Bodl. Or. 467, Hunt. 521; Paris, Anc. fonds 129, Suppl. 59; Brit. Mus. Or. 1017; Berlin, Sachau 85; Cambridge, coll. of the S.P.C.K.

[20] MSS.—Cod. Vat. clxxi.; Bodl. Marsh. 681, Hunt. 490; Brit. Mus. Add. 7194, 7195; Paris, Anc. fonds 122, Suppl. 75. There are two Arabic translations of this work; see Zotenberg, *Catal.*, p. 201, No. 247.

[21] Bodl. Hunt. 1; Cambridge, coll. of the S.P.C.K. There is an Arabic translation, Paris, Anc. fonds 126, 145 (ff. 292–299).

[22] Probably a production of Stephen bar Ṣūdh-ailē; see Brit. Mus. Add. 7189, where we have the commentary of Theodosius, patriarch of Antioch, and compare Frothingham, *Stephen bar Sudaili*, p. 87 *sq*. See also above, p. 482.

[23] Brit. Mus. Or. 1017. Other MSS.—Paris, Anc. fonds 188; Berlin, Sachau 206. The work seems to have been translated into Arabic (see Zotenberg, *Catal.*, p. 176).

[24] *B.O.*, ii. 275.

[25] *Ibid.*, ii. 276; Cod. Vat. clxxiii.

[26] See Cod. Vat. lii.; Paris, Anc. fonds 97; Medic. Palat. xliv.

[27] *B.O.*, ii. 299. Rendered into Latin by J. A. Assemani in Mai, *Scriptt. Vett. Nova Coll.*, x. MSS.—Cod. Vat. cxxxii., ccclvi.-vii., ccclviii.-ix.; Bodl. Hunt. 1; Paris, Anc. fonds 140; Berlin, Alt. Best. 40; Palat. Medic. lxi. It has been translated into Arabic.

[28] *B.O.*, ii. 311.

[29] This has been edited under the title of *Bar-Hebræi Chronicon Syriacum* by Bruns and Kirsch, with a Latin translation, in two volumes, 1789. Both text and translation are equally bad, and the work deserves a new edition.

[30] Parts ii. and iii., which supplied Assemani with the greatest part of the materials for the second volume of his *Bibl. Orientalis*, have been edited by Abbeloos and Lamy in three volumes, viz., part ii. in two volumes, 1872–74, and part iii. in one volume, 1877, accompanied by a Latin translation and notes. It might be advantageously reprinted, if revised by a competent hand. MSS. of the entire history are: Cod. Vat. clxvi., ccclxxxiii.-viii.; Bodl. Hunt. 1; Palat. Medic. cxviii. Part i. is contained in Cod. Vat., clxvii. and Bodl. Hunt. 52; parts ii. and iii. in Brit. Mus. Add. 7198 and Cambridge Dd. 3. 8, 1, as also in the coll. of the S.P.C.K. Whether the Berlin MSS., Sachau 210, contains the entire work or only a part of it we do not know; it is simply described as "Chronik des Bar-Hebræus." There are excerpts in Cod. Vat. clxxiii.

Daniel bar Khaṭṭāb.

Contemporary with Bar-Hebræus, though somewhat younger, we may place Daniel bar Khaṭṭāb to whom Assemani has devoted two articles in the *B.O.*, ii., at pp. 244 and 463. Among the poems of Bar-Hebræus we find verses addressed to this Daniel by the Nestorian Ḳhamīs bar Kardāhē with his reply and another by Bar-Hebræus.[8] He composed abridgments in Arabic of several of Bar-Hebræus's works, *e.g.*, the *Nomocanon*,[9] *Ethics*, *Auṣar Rāzē Mĕnārath Ḳudhshē*, *Kĕthābhā dhĕ-Bhābhāthā*, and the larger grammar.[10] An independent work of his, also in Arabic, treats of *The Bases, or First Principles, of the Faith and Consolation of the Hearts of Believers*.[11]

With Daniel bar Khaṭṭāb we may close our list of Jacobite writers in the literature of Syria. The Nestorians kept the lamp burning for a little, though not much longer, as we shall presently see.

Solomon of al-Baṣrah.

Shĕlēmōn, or Solomon, of Khilāṭ or Akhlāṭ, on the shores of Lake Van, was present as metropolitan of Pĕrath dĕ-Maishān or al-Baṣrah at the consecration of the catholicus Sabhr-īshō' in 1222.[12] Besides some prayers and short discourses (*mēmrōnē*), he wrote a treatise on the figure of the heavens and the earth,[13] and compiled a volume of analecta, partly theological, partly historical, which he entitled *Kĕthābhā dhĕ-Dhebbōrīthā* or "the Bee," It is dedicated to his friend Narsai, bishop of Khōnī-Shābhōr or Bēth Wāzik, called by the Arabs al-Bawāzig, or al-Bawāzīj,[14] on the lesser Zāb. Of this work an analysis has been given by Assemani in the *B.O.*, iii. 1, 309–324, and there is a German translation of it by Schönfelder, 1866. It has been recently edited by Mr. E. A. W. Budge, of the British Museum, with an English translation, Oxford, 1886.[15]

George Wardā.

Mas'ūd.

Khamīs.

Gabriel Ḳamsā.

John of Mosul.

This was an age of song with the Nestorians, in which lived some of their favorite writers of hymns. (1) One of the most conspicuous of these is George Wardā (the Rose) of Arbēl or Irbil, whose poems have entered so largely into the use of the Nestorian Church that one of their service books is to this day called the *Wārdā*,[16] His date may be gathered from certain of his hymns, which speak of the calamities of the years 1535–38 = 1224–27 A.D.[17] (2) About the same time flourished Mas'ūd of the family Bēth Ḳashshā (in Arabic Ibn al-Ḳass), who was physician (*ḥākīm*) to the caliph al-Musta'ṣim (1242–58), and outlived his patron.[18] One of his poems for the feast of the Epiphany occurs in Cod. Vat. clxxxiv. (*Catal.*, iii. p. 389).[19] (3) Khamīs bar Ḳardāḥē of Arbēl, was a younger contemporary of Bar-Hebræus, as appears from his correspondence with Daniel bar Khaṭṭāb (see above). He too has bequeathed his name to one of the Nestorian service books, which is still called the *Khamīs*.[20] (4) Gabriel Kamsā (the Locust) was a monk of Bēth-Ḳūḳā. He became metropolitan of Mosul, and was present at the consecration of Yabh-alāhā III. in 1281.[21] There is a long poem of his in Cod. Vat. clxxx. (*Catal.*, iii. 376), treating of the creation, the incarnation, the life of our Saviour, the preaching of the apostles, and the praises of the fathers of the church, and concluding with an encomium on Sabhr-īshō', the founder of Bēth-Ḳūḳā. (5) John of Mosul was a monk of the convent of St. Michael near that city.[22] His work entitled *Kĕthābhā dhĕ-Shappīr Dubbārē* was published at Rome in 1868 by E. J. Millos, archbishop of 'Aḳrā, as a school-book, under the title of *Directorium Spirituale*. It is, of course, impossible to say to what extent the original has been tampered with in such an edition, but there is a MS. in the Brit. Mus. Or. 2450.[23] The composition of this work is placed by Millos in 1245, and the death of the author by Cardāḥī (*Lib. Thes.*, p. 120) in 1270.

'Abhd-īshō' bar Bĕrīkhā.

'Abhd-īshō' bar Bĕrīkhā holds nearly the same position in regard to the Nestorian Church that Bar-Hebræus does in relation to the Jacobite, though far inferior in talent and learning to "the son of the Hebrew." He flourished under Yabh-alāhā III., being firstly bishop of Shiggār (Sinjār) and Bēth-'Arbāyē about 1285,[24] and afterwards, before 1291,[25] metropolitan of Nisībis and Armenia. He died in 1318.[26] He has left us a list of his own publications at the end of the *Catalogus Librorum*, in the *B.O.*, iii. 1, 325 *sq*. Several of these seem to be lost,—at least they do not appear in the catalogues of our collections,—such as the commentary on the Old and New Testaments,[27] the *Kĕthābhā Ḳatholīḳos* on the marvellous dispensation or life of our Lord on earth,[28] the *Kĕthābhā Skolastikos* against all the heresies,[29] the book of the mysteries of the Greek philosophers,[30] the twelve discourses comprising all the sciences,[31] and the ecclesiastical decisions and canons,[32] as also an Arabic work with the title *Shah-marwārīd* or "The King-pearl."[33] The *Margānīthā* or "Pearl" is a theological work in five sections, treating of God, the creation, the Christian dispensation, the sacraments of the church, and the things that prefigure the world to come. There is a careful analysis of its contents in *B.O.*, iii. 1, 352–360. It has been edited, with a Latin translation, in Mai, *Scriptt. Vett. Nova Coll.*, x., and done into English by Badger, *The Nestorians*, ii. 380 *sq.* The date of composition is 1298.[1] ‘Abhd-ishō‘ himself translated this work into Arabic in 1312, as we learn from ‘Amr ibn Mattā in the *Majdal*, where large portions of it are quoted.[2] The *Collection of Synodical Canons* or *Nomocanon* is also fully analyzed by Assemani, *B.O.*, iii. 1, 332–351. It has been edited with a Latin translation, in Mai, *Scriptt. Vett. Nova Coll.*, x.[3] As a poet ‘Abhd-ishō‘ does not shine according to our ideas, although his countrymen admire his verses greatly. Not only is he obscure in vocabulary and style, but he has adopted and even exaggerated all the worst faults of Arabic writers of rimed prose and scribblers of verse.[4] His principal effort in poetry is the *Paradise of Eden*, a collection of fifty poems on theological subjects, which has been analyzed by Assemani, *B.O.*, iii. 1, 325–332.[5] This volume was published by the author in 1291, and in 1316 he found that it was necessary to add an explanatory commentary.[6] Another collection of twenty-two poems, which may be regarded as part of one composition, treating of the love of wisdom and knowledge, is found in Cod. Vat. clxxiv. (*Catal.*, iii. 359) and Bodl. Marsh. 201 (P. Smith, *Catal.*, p. 510); and a third, including the above and a selection from the *Paradise*, is contained in Bodl. Marsh. 361.[7] Of his minor works, enumerated in the *B.O.*, iii. 1, 361, the consolatory discourses, the letters, and the commentary on the epistle of Aristotle to Alexander concerning the great art (alchemy) seem to be lost. The *turgāmē* are collected in a MS. at Berlin, Alter Bestand 41, 4. His commentary on an enigmatical poem of Simeon Shanḳĕlāwī we have already mentioned (see above, p. 897). To us his most useful work decidedly is the *Catalogue of Books*, which forms the basis of vol. iii. part 1 of Assemani's *Bibl. Orient.* There is an older edition of it by Abraham Ecchellensis, Rome, 1653. It has been translated into English by Badger.[8] The *Catalogue* consists of four parts, viz., (1) the Scriptures of the Old Testament, with sundry apocrypha, *B.O.*, iii. 1, 5; (2) the Scriptures of the New Testament, p. 8; (3) the Greek fathers who were translated into Syriac, p. 13; (4) the Syriac fathers, chiefly, of course, of the Nestorian church, pp. 65–362. It is to be regretted that ‘Abhd-īshō‘ contented himself merely with enumerating the titles of books, and never thought it worth his while to give the date of the writers, nor even to arrange his notices in any kind of chronological order.[9]

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[1] *B.O.*, ii. 264.

[2] Edited by Pocock, with a Latin translation, in 1663, MSS.—Cod. Vat. clxvii.; Brit. Mus. Add. 6944, 6962, 1, 23304–5; Bodl. Pocock 54, 162; Palat. Medic. cxvii.

[3] *De Philos. Peripat. ap Syros*, p. 67.

[4] *B.O.*, ii. 308. MSS.—Cod. Vat. clxxiv.; Bodl. Hunt. 1, Marsh. 201; Paris, Anc. fonds 118, 130, 157; Palat. Medic. lxii. (*Catal.*, p. 110); see also Cod. Vat. ccccxxii.; Bodl. Poc. 298; Berlin, Alt. Best. 41, 2, 3, and Sachau 61, 4–6.

[5] *B.O.*, ii. 271, No. 20.

[6] *Ibid.*, ii. 268, note, col. 2, No. 31; p, 272, note 1.

[7] See a few short specimens in Kirsch and Bernstein's *Chrest. Syr.*, pp. 1–4, and in an article by L. Morales in the *Z.D.M.G.*, xl. p. 410 *s.q.* MSS.—Cod. Vat. clxxiii.; Ind. Off. No. 9, "Tracts in Syriac," ff. 351-413. The *Daf' al-Hamm* is contained in Paris, Anc. fonds 160. The catalogue of Bar-Hebræus's works in *B.O.*, ii. 268, note, adds one Arabic book to this long list (col. 1, No. 19, at the foot) of which we know nothing but the title there given in Syriac, *Kĕthābhā dhĕ-Henyān Yuthrānē*, "On the Pleasure of Gain"

[8] Payne Smith, *Catal.*, p. 377; *Catal. Vat.*, iii. 358.

[9] *B.O.*, ii. 463; Cod. Vat. Arab. dcxxxvi. (Mai, *Scriptt. Vett. Nova Coll.*, iv. 578).

[10] *B.O.*, ii. 464.

[11] *Ibid.*, ii. 244; Cod. Vat. Arab. lxxiv. (Mai. *op. cit.*, iv. 153).

[12] *B.O.*, ii. 453, No. 75; Bar-Hebræus, *Chron. Eccles.*, ii. 371.

[13] *B.O.*, iii. 1, 310. [14] See Hoffmann, *Auszüge*, pp. 189 and 296.

[15] MSS.—Cod. Vat. clxxvi., clxxvi.; Brit. Mus. Add. 25875; RAS. Add. 76; Munich, Cod. Syr. 7 (with an Arabic translation). Bodl. Pocock 79 and Paris, Anc. fonds 113, contain only an Arabic translation, different from that in the Munich MS.

[16] Badger, *The Nestorians*, ii. 25. A few specimens are given by Cardāḥī in the *Liber Thesauri*, p. 51. Badger has translated one, *op. cit.*, pp. 51–57.

[17] *Catal. Vat.*, iii. 381, at the top. Important MSS. of Wardā's hymns are Cod. Vat. clxxxiv.; Berlin, Alt. Best. 24, Sachau 188; Cambridge, coll. of the S.P.C.K.

[18] *B.O.*, iii. 1, 561; Bar-Hebræus, *Hist. Dynast.*, pp. 522-523 (transl., pp. 341-342).

[19] See Cardāḥī, *Liber Thesauri*, pp. 125–128.

[20] Badger, *The Nestorians*, ii. 24; see one of his poems translated, pp. 38–49. Cardāḥī gives some specimens in *Liber Thesauri*, pp. 59–62. Important MSS. of his poems are—Cod. Vat. clxxxv.-vi.-viii.; Brit. Mus. Add. 18716, f. 44a, and Orient, 2304; Berlin, Sachau 178; see also Cod. Vat. lxxxix. and Brit. Mus. Or. 1300 at the end. Berlin, Sachau 229, contains a poem of Bar-Hebræus, amplified by Khamīs and later poets; compare *B.O.*, ii. 308, iii. 1, 566.

[21] *B.O.*, ii. 456. Cardāḥī has published a specimen, *Liber Thesauri*, pp. 107–118.

[22] Cardāḥī (*Liber Thesauri*, p. 118) wrongly says "at Baghdādh."

[23] The most reverend editor inveighs in his preface against "the Prōṭāyē (Protestants), who believe in nothing at all"; see p. 14, l. 12.

[24] *B.O.*, i. 539.

[25] *Ibid.*, i. 538; iii. 1, 327, col. 2.

[26] *Ibid.*, i. 539; iii. 1, 3 notes, 2, 3, 325 note 1.

[27] *Ibid*, iii. 1, 325.

[28] Id., *ibid.*

[29] Id., p. 360.

[30] Id., *ibid.*

[31] Id., *ibid.*

[32] Id., *ibid.*

[33] Perhaps only an Arabic recension or abridgment of the *Margānīthā*.

After ‘Abhd-īshō‘ there are hardly any names among the Nestorians worthy of a place in the literary history of the Syrian nation. We may make an exception in favor of the catholicus Timothy II., who was elected in succession to Yabh-alāhā III. in 1318, having previously been metropolitan of Mosul and Irbil under the name of Joseph.[10] He wrote a work on the sacraments of the church, of which Assemani has given an analysis in *B.O.*, iii. 1, 572–580.[11] His death took place in 1328.

Timothy II.

(W. W*.)

SYZRAŇ, a district town of Russia, in the government of Simbirsk, lies 90 miles to the south of Simbirsk, a few miles from the Volga. It originated in a fort, erected in 1683, to protect the district from Tatars and Circassians. Most of its inhabitants (24,500 in 1882) are engaged in gardening and tillage. In the large villages of the surrounding district, one of the richest in Simbirsk, various petty trades are carried on. Syzrañ has long been in repute for its tanneries and manufactures of leather (£20,000 [$97,200] annually). Several flour-mills and other manufactures have recently sprung up. The town is connected by rail with Penza and Morshansk in the west, and with Orenburg in the east, and much grain is exported; timber is brought from the upper Volga, and manufactured wares from Nijni-Novgorod. In 1882 the goods shipped from Syzrañ and Batraki (a port on the Volga) were valued at £153,540 [$746,204.40]. In the same year the grain and other wares sent by rail exceeded one million cwts. Syzrañ is a badly built town, most of the houses being of wood.

SZABADKA (German, *Maria-Theresiopel*), a royal free town of Hungary, in the county of Bács, on Lake Palics, in 46° 8′ N. lat. and 19° 42′ E. long. It is the centre of an immense agricultural district and has little claim to special distinction. There are a chamber of advocates, an upper gymnasium, a state training institute for governesses, and an industrial and commercial school. The population (61,367 in 1880) was about 63,500 in 1885, mostly Hungarians, but partly Bunyevácz (a branch of Servians).

SZARVAS, a town of Hungary, on the Körös, in the county of Békés, is a place noted for the wealth of its peasantry and the excellence of its breed of horses. The population was 22,504 in 1880, and about 24,000 in 1885, chiefly Slovaks, but all speaking Hungarian.

SZATMÁR-NÉMETI, a royal free town of Hungary, in the county of Szatmár, is situated on the river Szamos and the Hungarian North-Eastern Railway, in 47° 49′ N. lat. and 22° 51′ E. long. It is the seat of a Roman Catholic bishop and has a seminary, a male and female normal school, and several Government offices. The town has a considerable trade in wine and wood. The population numbered 19,708 in 1880, and about 22,000 in 1885. They are mostly Magyars, and by religion Romanists, Protestants, and Greeks in almost equal proportions.

SZEGEDIN, a royal free city of Hungary, second only to Budapest, is situated on both banks of the Theiss at the influx of the Maros, in 46° 16′ N. lat. and 20° 10′ E. long., in the county of Csongrád. It is a great centre of the commerce and agriculture of the Alföld, has a Roman Catholic gymnasium, a state real school, and a library with about 80,000 volumes. There are a Franciscan, a Piarist, and a Minorite convent, and a large hospital, as well as various Government offices, a superior law court, and a chamber of advocates. The inner town consists of fine broad streets and large squares adorned with many palatial edifices, but the suburbs, inhabited by the peasantry, are little superior to ordinary Hungarian villages. The river is spanned by a railway bridge of stone and a fine suspension bridge. Szegedin possesses factories of soap, soda, matches, candles, leather, and spirits, steam and saw mills, and salt and tobacco magazines. It is the chief seat of the manufacture of *paprika* (a kind of pepsicum) and of a pastry *tarhonya*, both largely exported to all parts of the world. During the summer the shipping trade is very brisk, especially in corn and timber. Szegedin is an important station on the Alföld-Fiume and the Austrian-Hungarian State Railways, and is a terminus of the Arad-Csanád Railway. The inhabitants in 1880 numbered 73,675, and in 1885 76,600 (estimated), entirely Magyars.

Since the 15th century Szegeden has been one of the most prominent cities in Hungary. From 1526 till 1686 it was in possession of the Turks, who fortified it. It is also notorious for its many witchcraft trials. In 1848 it sent strong detachments to the national Hungarian army. In July, 1849, the seat of the Government was transferred hither for a short time. In March, 1879, the town was almost completely destroyed by an inundation. In the reconstruction the site of the old fortress was laid out as a public garden.

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[1] MSS.—Cod. Vat. clxxv.-vi., cccclvi.; RAS. Add. 76; Berlin, Sachau 4, 312; Cambridge, coll. of the S.P.C.K.

[2] *B.O.*, iii. 1, 360, note 4; see Cod. Vat. lxv., cccvii., and Cod. Vat. Arab. cx. (Mai, *Scriptt. Vett. Nova Coll.*, iv.); compare *B.O.*, iii. 1, 589.

[3] MSS.—Cod. Vat. cxxviii., cxxix., ccclv.

[4] See Payne Smith's minute descriptions in his *Catal.*, p. 523 *sq.*

[5] MSS.—Cod. Vat. ccxlv., ccclxxix.; Paris, Anc. fonds 166; Berlin, Alt. Best. 41, 1, Sachau 1, 21, 80; Brit. Mus. Orient., 2302-3; Cambridge, coll. of the S.P.C.K.

[6] *B.O.*, iii. 1, 327, col. 2.

[7] Payne Smith, *Catal.*, p. 523; see also p. 531, Nos. 30, 31. In Paris, Anc. fonds 104, there is a poem explanatory of the ecclesiastical calendar (Zotenberg, *Catal.*, p. 128).

[8] *The Nestorians*, ii. 361. Badger ascribes the work to the year 1298, probably on the authority of his MS.

[9] MSS.—Cod. Vat. clxxvi.; RAS. Add. 76 (imperfect); Rome, Bibl. Vitt. Eman. A. 1194, MSS. Sessor. 162; Cambridge, coll. of the S.P.C.K.

[10] *B.O.*, iii. 1, 567.

[11] Vat. cii.

SZENTES, a market town of Hungary, in the county of Csongrád, on the left bank of the Theiss, 30 miles north of Szegedin. It has a county hall (1885) and a promenade. The inhabitants are chiefly employed in agriculture, in breeding geese, and in fishing. The population (28,712 in 1880) numbered about 30,000 in 1885, all Magyars.

SZIGET (*Mármaros-Sziget*), chief town of the county of Mármaros in the northeast of Hungary, is the centre of a salt-mining district, with mining and forestry head departments. The town lies in a valley which abounds in picturesque scenery and is ri mineral springs. It has a county-hall, Protestan Catholic gymnasia, a convent, a nunnery, and a tra ing-school for teachers. The population (10,5 1880) was about 11,200 in 1885.

SZOLNOK, the capital of the county of Jász-N Kün-Szolnok, Hungary, is situated on the Theiss the Zagyva, and is the junction of four railways. It ries on a brisk trade in tobacco, salt, and especially wood. In 1880 the population (Magyars), chiefly R Catholics, numbered 18,247, and in 1885 about 19,

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